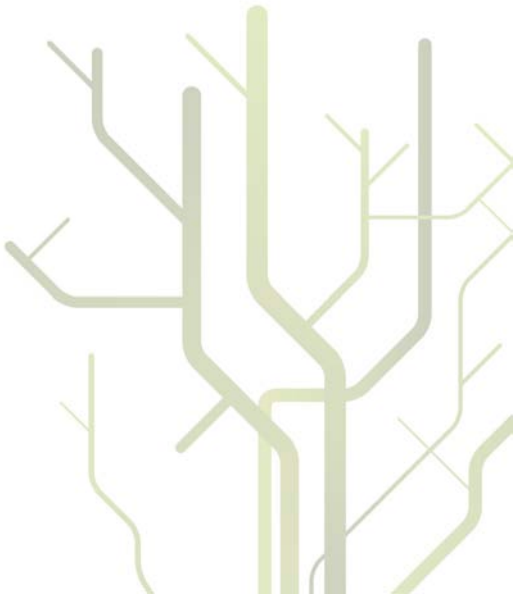
UNIVERSITY OF TROMSØ UIT

FACULTY OF SCIENCE AND TECHNOLOGY
DEPARTMENT OF COMPUTER SCIENCE

"Managing Health-Related Personal Information Based on Context Awareness"

Priya S. Kamble

INF-3997
Master's Thesis in Telemedicine and E-health
June, 2010



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Dedicated

With Love

To my Husband and

Our family

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Abstract

The aim of this thesis was to implement prototype which, provides relevant information to the user at right time. The personal information that is targeted here was health-related information. This may include various type of information, such as drug information, education information, health monitor data for instance glucoses meter, step counter, personal notes, health related images ,PDF files. To implement prototype, we use metadata of the information. Some of the metadata of the information describes the context of the information. We used time, date and location context of information to implement our goal successfully. By using these contexts of the information, the relevant information to user is provided.

The four components were implemented to implement prototype: Metadata extractor, Information manger, controller and user interface. The metadata extractor allows user to download files and automatically store file in to the download folder and context of these files was extracted and stored in to the database. The second component was information manger; the main function of this component was to reads the context of downloaded files and make association of similar files by using context. The third component was controller, it was use to represent related files to the end users and the user interface allows user to interact with our system.

The implemented prototype was tested for providing related information to the users. The information access was based on the context of the information, which eases to get results and to recognize useful information for the users. It was also tested whether the prototype stores updated files or not. The prototype makes association of new downloaded files to the database and it also avoids redundancy of files. Thus, it helps users to access the updated information and to reduce redundancy of data. The prototype provides user with the right set of information to the right time, by identifying the need of the users by matching with available information.

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Notations/Abbreviations

API	------	Application Programming Interface
DC	------	Dublin Core
E- health	------	Electronic health
e-HIM	------	Electronic health information management
EHR	------	Electronic health record
EMR	------	Electronic medical record
ePHR	------	Electronic personal health record
E-HIM	------	Electronic health information management
EPR	------	Electronic personal record
EXIF	------	Exchangeable Image File Format
ETL	------	Extraction, Transform, load
GPS	------	Global Positioning System
GB	------	Gigabytes
IM	------	Information management
PIM	------	Personal information management
PHRI	------	Personal health related information
PC	------	Personal computer
PHR	------	Personal health record

PDA	------	Personal Digital Assistant
PDF	------	Portable document format
RDF	-------	Resource description framework
RDFS	------	Resource discretion framework schema
URL	-------	Uniform Resource Locator
URI	------	Uniform resource identifier
MB	------	Megabytes
MPEG	------	Moving Picture Experts Group
SQL	------	Structured Query Language
XML	------	Extensible Markup Language
GUI	------	Graphical User Interface

CHAPTER: 1

1. Introduction

In this thesis, the health related personal information management prototype was implemented and that prototype enables users to provide related information. In this chapter, the motivation for the thesis was presented. Then the main goal and contribution for the thesis, and organization of thesis will be described.

1.1. Motivation/background

Information is the knowledge which gives meaning to its receiver. When a person stores some information in to the computer, it can be referred as data. Data is raw input, after some process this data gives output and that output is known as information. In today's world, the information is spread over in various forms and it is stored in the different kinds of devices. Getting an access to the right information on the right time in a very structured manner is an important need.

Personal information can be information or opinion about the particular person. This personal information can include a written record about person, images, photographs, medical record, health related record, or videos.

This personal information is mostly stored in digital format. This digital information is stored in the different devices like computer, cell phone, PDA, glucose monitor for monitoring or accessing the health. The user wants to access as well as add their personal information collections easily. They also desire to make their own guides, which will remind them to record information that they themselves identify as important ones.

Personal information tends to be in a very scattered manner. This might be due to the collection of all information from different sources or the users might not have the suitable system which can assemble gathered information in a very structured manner. This stored information has some technical challenges like where the data should be stored, accessed, or presented to the users. This logically related information can be found on various devices and is managed without consideration for the relationship between information units.

It is hard for the users to find the relevant and important information by using traditional search engines, because most of the search engines are not aware of the user context. They do not consider users context to provide personal health relevant information. Because of this reason, users find it difficult to get desired results for what they are looking. This issue becomes very important when it comes for the health information, as seeking relevant information is very important for a patient's health. It becomes difficult to patients to recognize useful and useless information without accurate context. Here in this thesis, the system was implement, which can provide the related information based on the information context. Further this system will provide an easy access of the related information to the users as per their need.

One main topic of this thesis is health related personal information management. The health related personal information management system was developed. The personal health related information includes the information related to the health of the particular person. This personal health related information is maintained by the individuals. The implemented system will allow to present relevant information to the user by extracting the context from the information for its management. Further, the suggested method was tested.

This is a background for the designing of the health related personal information management system. The main goal is to provide relevant information according to the user's requests.

1.2. Method

The existing personal information management (PIM) systems were studied to check the use of general as well as personal health information context for the information management. Simple laptop environment was considered and how information management can be applied in such environment was tested. The prototype providing related information for personal health information management was designed and developed. The suggested method for the prototype was tested.

During the designs and implementation of the prototype, in the presented project, the approach was to go back to discuss alternative solutions as encountered problems. Some testing was done by the colleagues and their feedback gave me an important pointer.

1.3. Goal

The general idea of the present work was to enable user to access the right information at the right time and at the right place. This prototype should provide the "relevant" results or information, when the user is accessing information in line with the results.

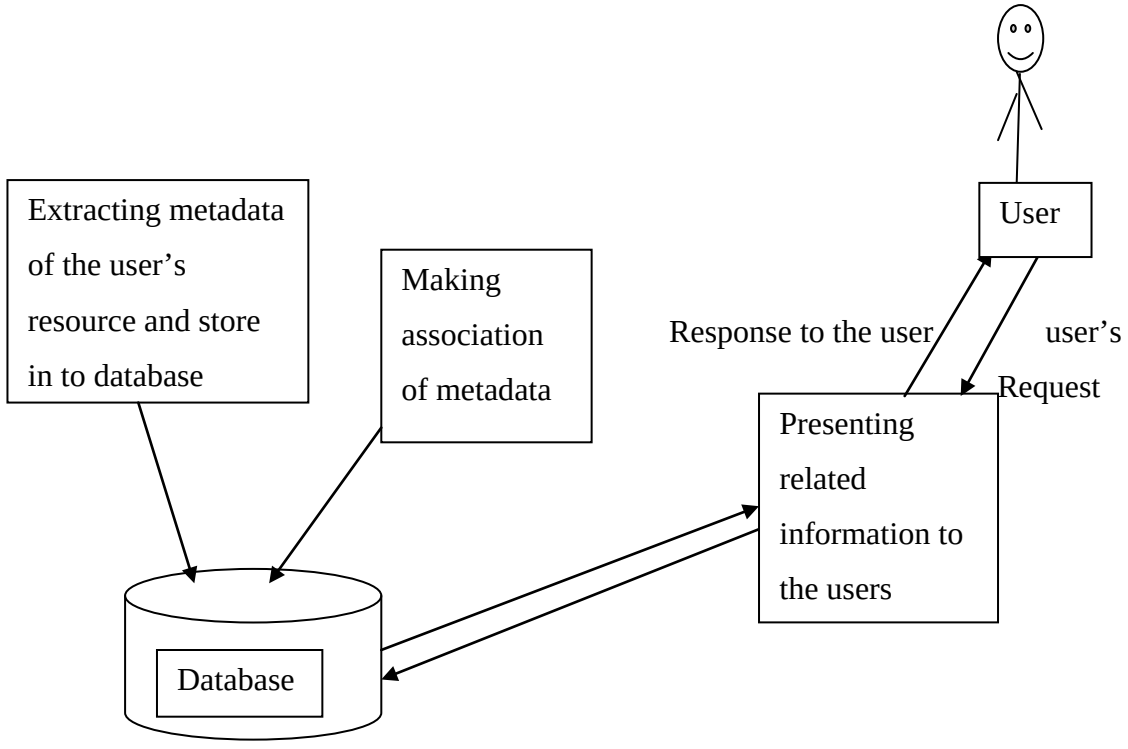

Figure 1: Goal of thesis, this figure shows the goal of thesis

The specific goal of the project was to design a health related information management system based on context-awareness for the patients. The information context and user's context was used to provide the users relevant information automatically. The information context was experienced for information management by designing a system and the developed system should allow users to access relevant information automatically. An intermediate aim of this thesis was to implement system for management of health related information to provide a convenient, an easy and useful system for the patients.

1.4. Contribution

The thesis topic was about to research and development of a prototype for managing health related personal information. The task was to design and implement method for a given topic. The prototype for the user to provide relevant information to the users was developed. However, the main contributions are related to the design and development of our health related personal information management prototype. Providing related information to the user was the main contribution in this thesis.

Other than this development and implementation part, the contributions of previous researchers in this field was described. This was necessary to understand the past developments in this field. The summary of theory that is used in the developing the system was described. The theory includes motivation for our system, discussions about the techniques, utilized concepts, and important concerns to remember when designing prototype. This theory can be viewed in the Chapter 2 and the description of systems that relating to the system is in the Chapter 3.

1.5. Organization of thesis

The thesis is organized into the following chapters:

Chapter 1: Introduction

This chapter gives short introduction to the thesis. It describes the motivation and background for the thesis and the goal of the thesis.

Chapter 2: Theoretical framework

This chapter reviews the background material and theory of the thesis. The background material provides information about the personal information management, personal health related information management, information annotation, and semantic gap. It also includes the discussion of the context, context awareness and context awareness applications and how to use context for the information management.

Chapter 3: Relevant work

This chapter is about overview of the systems related to our work. These systems were important while designing our personal information management system.

Chapter 4: Approach and requirement specification

This chapter is about the approach and it analyses the various requirements as well as specifies the actual functional and non-functional requirements to implement prototype.

Chapter 5: Design and architecture

The design chapter gives detail outline of the design process. It also gives prototype architecture and description about its components.

Chapter 6: Implementation

The implementation of the prototype is described in this chapter. It includes the details of extracting information context from the different information sources. Also it describes the programming techniques and includes the code for some important modules.

Chapter 7: Testing and evaluation

This chapter is about brief information of the testing and evaluation of implemented prototype. It includes the general findings and the specific results from the experimental qualitative and qualitative evaluation of the prototype. This chapter provides the analyses and interpretations of the results.

Chapter 8: Conclusions and future work

This chapter gives the summary of the thesis and concludes the research and offers suggestions for the future work.

CHAPTER: 2

2. Theoretical framework

In this chapter, a brief overview about the health information, personal health information and context of the personal health information is given. Also, the overview about the context and context awareness is discussed. Latter, the relevant works of this project is discussed.

2.1. Personal information management (PIM)

Before dealing with the personal health information management, the description of PIM will be discussed in the following section.

Personal information management is defined the both as practice and study of the activities, which people perform to acquire, organize, maintain, retrieve, use, and control the distribution of information items such as documents (paper based and digital), web pages, and email messages for everyday use to complete tasks (work-related and not) and to fulfill a person's various roles (as parent, employee, friend, member of a community, etc.)[1-2]

It means that PIM task includes keeping, finding, maintaining, distributing and organizing. The main motivation of the personal information management is to innate a sense of order i.e. to refine information for future use and remembering it. PIM contains documents, emails, calendar, images, and videos and so on. [1-3]

Personal information management (PIM) is about the collection and management of the information from one or more sources and the distribution of that information to one or more audiences. This information management involves an organization and control over the structure, processing and delivery of the information. PIM is the ability to capture, manage, preserve, store and deliver the right information to the right people at the right

time. The information management encompasses people, process, technology, content and context [2]

PIM is fragmented into specific subjects, such as email managements, web bookmark management and file management. Different approaches are there for management of the personal information, which are described in next sections.

2.1.1. Hierarchical structure

Systems such as file systems and email system use hierarchical structure. This approach uses the tree structured for arranging the information items. The information items relating to each other can be structured logically and their relation are explicitly captured. It reduces the search space and facilitates information search and retrieval. The hierarchical structure is pervasive in the information management. This structure has some drawbacks when the information is stored on different PIM tools. This is because they use their own hierarchies. In addition, they do not facilitate user to group relevant items together. To solve these problems, the users need to create a similar hieratical over different PIM tool. However, it is hard to maintain same consistency with different PIM tools [4].

2.1.2. Flat structure

In this structure, the user assigns tags to the information items. It provides flexible way for organizing the information items. Tagging is used to group or regroup and retrieve the information. This flat structure is used to associate multiple tagging with information and items. However, this might results in the inconsistency in assigning tags. e.g. If user tags health related items with “health”, “disease”, “symptoms ”, then user does not use these tags consistently. The user can use “health, “disease” one time and at other time “disease”, “symptoms” can be used. When user need to retrieve all health related items by using “health”, the user will miss some of the relevant items due to such inconsistency [4].

2.1.3. Linear structure

Linear structure is arranged in a list based on a certain order. The example of linear structure is Lifestreams. In this system, the user documents are stored as a Lifestream, which is a main stream of the documents arranged in the chronological order. The system is responsible for placing the items in Lifestream and it assigns identifiers to items. But as new items or information is stored, the Lifestream becomes long and difficult to manage. Linear structure shows only single dimension of an information collection at a time and it dose not capture relationship between information items explicitly [4].

2.1.4. Spatial structure

The very common example of spatial approach is a computer desktop, where files, folders and other items are arranged statically for their access. This approach uses location as a main method to organize the information items. But this approach is limited by the size of the computer monitor. The user cannot arrange thousands of information items statically without cluttering their desktop. This leads to a poor performance in the information retrieval.

These structures have their own strengths and weakness. This is because a single structure cannot suite every user. A hierarchical structure is useful for those who categorize information their items regularly. Spatial structure is used by those who want to maintain the visibility of their documents [4].

According to the **Indratmo** and **Julita Vassileva,** PIM system should supports the logical organization by providing an interoperability to improve the current practice in PIM. The interoperability of PIM is useful for portable devices for seamless access to the information items across the different devices [4].

2.2. Health information

As we are going to deal with the personal health context, it is important to provide some background about the health information. The health information is a set of different observations about the patients. The observation can be made concurrently. Health information should be in a meaningful form. It could be understood by any practitioner for taking decision or action to understand the patient's problem [5-6].

When the doctor sees the patient every day, he might have little new information about the patient. The health information can be a single observation e.g. past history of rubella, blood pressure reading, or temperature reading.

This health information field includes different terms such as Electronic Health Record (EHR), Electronic Medical Record (EMR), and Electronic Patient Record (EPR). We can look on these terms step by step [5-6].

2.2.1. Electronic health record and Electronic medical record

With the emergence of new technologies on the horizons, E-health has introduced a new electronic system to maintain medical records. E-health has become one of the important parts of the health care systems. E-health is the based on electronically and it is the technology in the health care for better quality, efficacy and efficiency of health process. It can be used for improving patient's health status [7-10]. Many countries have adopted the E-health applications for delivery of the health care. In the E-health, two concepts namely Electronic Health Record (EHR) and Electronic Medical Record (EMR) are emerged. We can look on these concepts briefly [7-10].

If we want to differentiate between EHR and EMR, we can see the word difference between them. In this Electronic medical record and Electronic health record, the difference is Health and medical. Recently the National Alliance for Health Information Technology has given definitions for EHR and EMR.

2.2.2. Electronic health record

Electronic health record is defined as the aggregate electronic record of health-related information on an individual that is created and gathered cumulatively across more than one health care organization and is managed and consulted by licensed clinicians and staff involved in the individual's health and care[8].

The collection of a patient's health information in digital format is called as Electronic Health Record. Any digitized health related information can be stored in an EHR. They can contain both structured and unstructured data.

EHR systems facilitate the data entry and retrieval to/from such records. One of the advantages of such a system is that data can be transferred quickly between the locations connected by a network. Computers are typically used for both updating and viewing EHRs.

The format of an EHR can make use of various standards so that it can be easily integrated with other information systems in the health environment. There is no difference between the EPR and EHR functionality. The term EPR is used as an alternative to EHR or to define a subset of EHR systems. This EHR system is intended to be accessed by both the patients as well as the health care person [7-10].

2.2.3. Electronic medical record

The definition of electronic medical record is that the electronic record of health-related information on an individual that is created, gathered, managed, and consulted by licensed clinicians and staff from a single organization who are involved in the individual's health and care [8].

By these definitions, it can be identified that electronic health record (EHR) is more comprehensive view of patient's overall health conditions. An EHR document is shared across different health providers. Electronic Medical Record (EMR) is a record about the single diagnosis or treatment and mostly related with a single health office [7-10].

Additionally, it cannot be said as complete in all aspects because EMR deals with data of a single patient of a clinic [7-10].

In case of EHR, it contains up-to-date data of patient's health condition. Thus, it is more useful in the treatment of patient [7-10].

2.3. Personals health record and Electronic Personal Health Record

As this project is about the managing of personal health related information, it is necessary to know about personal health record and electronic personal health record.

2.3.1. Personal health record (PHR)

American health information management association has launched myPHR in October 2003 for the public interest to guide and understand how to manage personal health information. It also provides the instruction for accessing the health information and compiling and keeping records of the personal health information [12].

The American work group E-HIM have studied the PHR, this group has formulated the definition of PHR as following.

"The personal health record (PHR) is an electronic, universally available, lifelong resource of health information needed by individuals to make health decisions" [12]. The individual people have their own and manage their information in the PHR, which comes from healthcare providers and the individual [12]. The PHR is maintained in a secure and private environment, with the individual determining rights of access. The PHR is separate from and does not replace the legal record of any provider" [12].

2.3.2. Electronic personal health record

According to the definition of National Alliance for Health Information Technology the Electronic personal health record is defined as:

"An electronic, cumulative record of health-related information on an individual, drawn from multiple sources, that is created, gathered, and managed by the individual. The integrity of the data in the ePHR and control of access to that data is the responsibility of the individual".

Electronic personal health record (ePHR) is used to keep all health related information in one place. This health related information comes from lot of different places such as personal doctor, nurses, and other health care providers as well as from the person himself. This health information can be stored in separate files and it consists of medical records. The main importance of this health related information is that it can be used for different purposes like for research to identify trends, illness and disease and for finding new cares. ePHR mostly gives you more knowledge about your health and promotes active role of patient in disease prevention, care and care management[13-14].

This record is also used as a legal document in case of the personal injury. Also, an insurance agency can use this information for billing and patent. But now days, with the popularity of many advanced devices such as Laptop, PDA, Mobile phones, everyone have started to store this information in the form of digital format such as PDF (Portable document format),Doc(document) , Jpeg(Joint Photographic Experts Group*)*, or folder[13-14].

The PHR is mostly demanded by the patients to store, update, aggregate, integrate and share data. This also enables patients to carry critical information with him to make it available to the health care provider. Additionally, a person can use this information for personal use at the point of care [13-14].

Electronic personal health record is different from electronic health recorder that is control by the doctors and ePHR is controlled by the patient himself, which enable you to enter your information by yourself.

The personal health record contains the following information related to patient health [13-14]

- Names and phone numbers of people who should be contacted in case of emergency
- Names, phone numbers, addresses of the doctors including specialists and dentists
- Health insurance information like the name of the insurance company and key
- Phone numbers for service (if you have other insurance in addition to Medicare)
- Current medications and dosages
- Allergies to foods, drugs and other substances
- Important dates, events, and hereditary conditions in the family history
- A list and dates of significant illnesses and surgical process
- Results from recent doctor visits, important tests results such as eye and dental records, immunization records [13-14].

In this ePHR, the data is stored in one server and it can access from the different locations such as patient's personal computer, portable device like PDA, mobile, and so on. The patients can always access on their own data. The patients do have exclusive control on this data.

2.4. Management of personal health related information (PHRI)

The attributes given by the e-HIM groups explains how Personal health related information (PHRI) is managed in different types. In the following section, we will discuss these different types in more details. According to them, PHRI is divided into the various subtypes like paper-based, PC- based and web-based management [12].

2.4.1. Paper-based management

People store their health related information in to the files or folders. This information is mainly arises from the hospitals, pharmacies, insurance company, and from the doctors. Some of them also create an emergency contact list, drug sensitivities and PHR form in written based format [12].

2.4.2. PC-based management

Some patients store their information on their personal computer into generic software or specific application like personal health record. However, only patients have access to this information but not to their health care providers. Thus, health care providers do not update or access that information when they needed [12].

2.4.3. Web-based management

Some of the patients use online services. These services provide an online account that allows patients to maintain their personal health related information on the internet. On this account, they can manage their health information by logging in with unique user name and password. The devices with internet connection have ability to access this information. The most famous example of this type PHR is My Personal MD [70] and Health Tracer [12]. The benefit of this kind of PHR is that it works as an excellent information source in the emergency [12].

Apart from the above mentioned types of personal health related information management systems, we have Hybrid desktop and portable devices PHRs management systems. The former solution allows individuals to maintain their PHRs on their personal computer and upload facility to secure web server. The latter one is expanding rapidly and it is leading to new generation of PHRs applications. They have ability to store health related information in the smart cards, PDA, mobile phone and memory device which can be plugged in to the personal computers [12].

2.4.4. Personal health related information source

Health care is one aspect of everyone's life. The patients must prepare in advanced before consulting to the doctor. Information given by the consultant needs to be stored for future use. Patients have to have some responsibility for monitoring their own health status, their history and their communications with the health care providers.

The patients want to maintain many kind of personal health related information, such as medication schedules, contact information, phone calls, and online research about their health condition, their emails, health documents, and web pages [3].

Figure 2: Personal health related information source [3]

The figure 3 shows that the personal health information is gathered from various resources that are used by patient like glucose meter, electronic diary, step counter, insulin pen and other resources. The information from these different source have some context such as time, date of stored information, resource name ,or location from where this information has been taken or downloaded. The context of information is changing depending on the patient's condition [3].

e.g. If we take an example of a diabetes patient who needs to take the insulin as medicine and he needs to have balanced diet and exercise in order to maintain the glucose level. To maintain his health, it is very important to remember the particular time for the insulin dose and what the units of insulin should take. If the insulin level goes up, then the patient will

have to balance his diet and should exercise to be fit. All this health related information is very important and it needs to be store on some personal device.

At the time of need, the patient has to have relevant information of his health. To do so, context of this personal health related information needs to be used, so that patient can have relevant information and can avoid risk of duplication and loss of data. Further, it also becomes easy to maintain information [3].

2.5. Information annotation

The main goal of annotation is to provide a semantic meaning to the information. To access the most powerful and accurate information annotation is important. The annotation technique forms the context of the Personal information and it makes data more easily understandable. The annotation technique gives meaningful information. There are several approaches for an annotation, which are discussed in the following section:

2.5.1. Manual annotation

This annotation is totally human oriented task, which is done by writing text to the information. This approach provides full accurate semantic information. This manual annotation can handle only when the quantity of information is small. However, it would take very long time to make manual annotation for the large quantity of information. The name given to particular information can differ from person to person. Also, it can differ from time to time. To retrieve the relevant information, the annotator and retrieval of information need to know a common vocabulary and a common understanding of the word. This situation may leads to no relevant results even if they potentially exist [15].

2.5.2. Semi –annotation

The semi annotation employs both the machine and human intervention. Some information is added to the information form and then user can add additional information in it. It is a combination of the manual annotation and an automatic annotation. This annotation technique provides efficiency of the automatic annotation and accuracy of the manual annotation to the information [16].

2.5.3. Automatic annotation

Automatic annotation is totally machine annotation with subsequent verification of the task by human. Automatic annotation plays main role then manual annotation when there is large amount of information. Because manual annotation is time consuming to annotate each file. By using automatic annotation, large amount of information may be stored in the database annotated by using date, time, and location and some other information.

2.6. The semantic gap

The biggest challenge in the personal information management is the bridging semantic gap.
It is always difficult to have query that computer can understand and provide relevant information according to the users need. A low level query can be measured and understood easily by the computer as compared to a high level concept query. However, conversion of a high level query into the low level is a major obstacle. The high level information is a real world concept, which cannot be analyzed by the machine unlike low level information. This creates the gap between what user wants and what he is capable to express in his request. This gap is called as a semantic gap. It is an important problem in the information management [17-18].

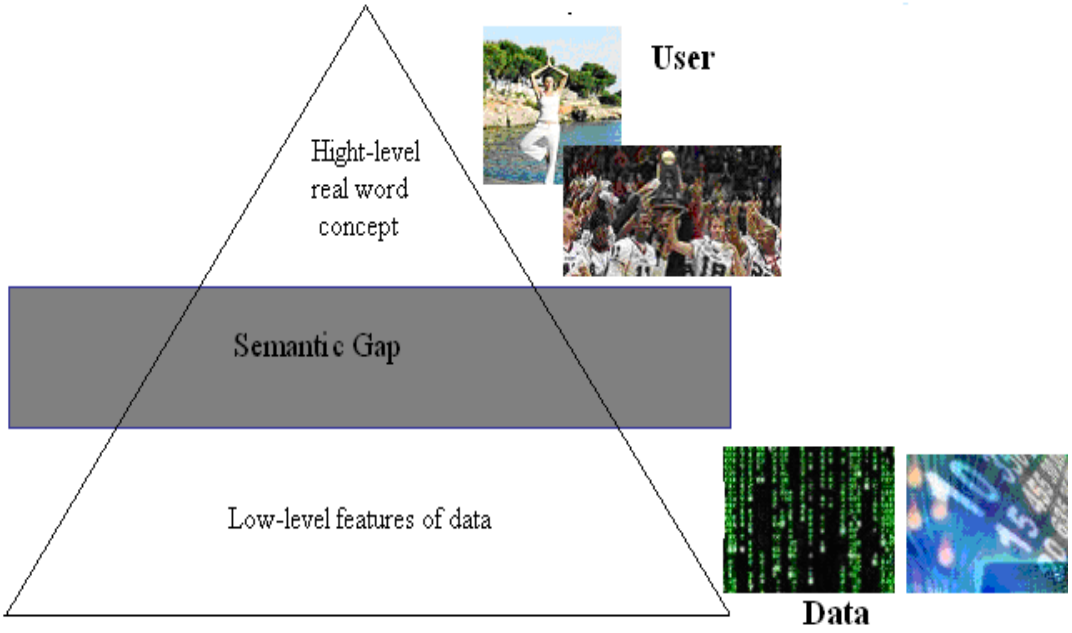

Figure 3 : Showing the Semantic Gap [19]

The figure 3 illustrates the semantic gap. The search engines such as Google, yahoo find results by matching based on the keywords without considering a meaning of those keywords. This type of results cannot satisfy every time according to the user needs. The thousands of page results come with the fewer relevancies. This ultimately causes the information overload [17-18].

2.7. Context

In order to use context in application, one should have better understanding about what context is. We would like to look on the pervious definition of the context. In the following section, we will discuss several definitions of the context:

2.7.1. Definitions of context

A context deals with the individual surroundings, lifestyle, situation, and capability of device. These factors can be known as context. The previous researches on the context have given various definitions of the context:

The first definition of context is given by **Schilit and Theimer** [22]. They define context as a "Knowledge about the user's and IT device's state, including surroundings, situation, and to a location". It refers to the location, entities of nearby people and objects, and changes to those objects [22].

Schilit define the important aspects of context are where you are, who you are and what resources are nearby [22].

Santo *et al*. has given definition of context as "Context is a pattern of behavior or relations among variables that are outside of the subjects of design manipulation and potentially affect user behaviors and system performance" [23].

Ryan *et al*. defined context as the user's location, environment, identity and time [24].

Ward *et al*. views context as the state of the application's surroundings [25].

Dourish have argued between two views of context like one is that context can be described independently of the action done and the second one is that context emerges from the activities and cannot be described independently [26] .

Anind K. Dey and Gregory D. Abowd et al defined context as any information that can be used to characterize the situation of an entity. An entity here is a person, place, or objects that is considered relevant to the interactions between a user and an application, including the user and applications themselves [27-28]. It describes context is everything about the situation that is relevant to the application and its users.

Context is typically the location identity and state of people, computational and physical objects. Context is user situation or situation of a particular entity. If we have given identity of person, we can acquire much information related to the user like address, phone number, and health related information. Context such as location, time, identity and activity gives special characteristics for any entity.

These types of context gives the answers to who, what, where and when. In this, when describes the time; what describes the name of the source; from where describes the source location and by whom describes the author. By telling a computer how these data items are relevant to each other and how these relations can be evaluated automatically, it becomes possible to process even more complex filter and search operations [27-28].

Context information can be classified as static context and dynamic context. The main difference between these two contexts is that the unlike static context, the dynamic context has frequently changing behavior. e.g. The time and situation can be changed according to the user. Thus, the user can have context such as user situation, location, nearby people, user profile and so on [27-28].

2.7.2. Classification of information context

There is no universally accepted classification for information context. Different types and classes of context information are used. Different project have used different classification of information.

2.7.2.1.Different aspect of information context

According to the Schilit, context has following three categories like computing, user and physical context [29]:

Computing context:

This context is about network; communication, bandwidth, and resource near by user such as printer, display or work station [29].

User context:

It deals with the user profile, location, and people nearby. Additionally, it deals with the user's social situation [29].

Physical context:

This context includes lighting, noise levels, traffic conditions, and temperature [29].

Temporal context:

Other than the above specified three contexts by Schilit, temporal context provides information like time of day, week, month or year.

The combination of several context values generates a more powerful understanding of the situation. Context not only refers to the information about the users like person name, address, phone number location of the user, but also refers to the information which gets managed by the user.
E.g. Doctor's appointment, emails massages and contact list in which stored information metadata describes the context of the information.

2.7.3. Context of different digital information source

The electronic personal health related information has different categories:

1. Text
2. Video
3. Images

The information stored in the audio, text, still images and video has context. The context of the information eases the search of relevant information. Also, it allows data developers and users to search for the existing data and avoids data duplication. In the following section, we can look details on the context of this information:

2.7.3.1. Text file

Text files can contain context of the person name who created the file (obtained from the operating system), the name of the person who last edited the file, how many times the file has been printed, size of the file and even how many revisions have been made on the file. Other saved material such as deleted text (saved in case of an undelete command), document comments is also commonly referred to as context.

2.7.3.2. Image

The images have context like date and time at which they were created. They also have the details of the camera settings such as focal length, aperture, and exposure and the location of the picture from where it was taken. Most image editing software's include at least some metadata in the digital image and can include content about the image's provenance and licensing [30].

2.7.3.3. Video

The patient can have video related to their health. This videos have some context such as title, director, actors, summary of the contents, length of the recording, critical rating the data and the source of this recording [30]

From the above discussion, we have an idea that the information has some surrounding metadata and some of the metadata explains the context of the information. The personal health related information also has some context and we are going to use that context for the management of the health related information [30].

2.8. Context awareness

It was necessary to know about the meaning of the context to understand the context awareness. Context-aware computing was first discussed by **Schilit** and **Theimer**[22].
Most of the research is going on the context awareness applications and to develop context awareness systems. We will have definition of context awareness in the following.

Dey defined context awareness computing as "A system is context-aware, if it uses context to provide relevant information and/or services to the user, where relevancy depends on the user's task" [31-34].

The context awareness applications adopt their behavior according to the context without any intervention of users. Context awareness system collects context information and adopts systems behaviors consequently. The success of the system is depends on their ability to filter context and deliver information at the right place and the right time [32]. As context can change every time, it is very important that these applications response effectively in order to provide a relevant information according to the user need [32].

2.8.1. Location and time context

Time and location these two contexts are commonly used in context awareness system. We consider that the information files are associated with the multiple contexts. The static context is attached to the file, when the file is created or downloaded. Context such as time, date, location are automatically annotated to file, when user downloaded it. As mentioned previously, unlike the dynamic context, the static context remains unchanged. When any file is downloaded from the certain site or location at certain time, then there is no way to change this context. Thus, these two types of contexts are useful for context awareness system as they remain unchanged.

Location is comely used context in the context computing. Context-aware systems dealing with the location context information are widely used and their demand is also growing due to the increasing spread of the technologically advanced devices like mobiles or PDA. Location can be detected easily and can be used for developing both an indoor and outdoor applications. A location-aware application utilizes the knowledge about the physical location of the real-world objects such as persons and devices to adapt their functional behavior and their appearance to the user [36].

This location context says lot about the semantic of the file. Location is a universally understood context if it is presented properly**.**

2.9. Context awareness applications

The context awareness will help to shift some of the activities from human to machines. The technologies such as wireless, mobile, sensors, wearable instruments, handled computer and intelligent artifacts are now available for supporting the development of context aware applications. [37].

Many contexts awareness applications have been developed in various fields. In the following discussion, we will have look on different context awareness applications.

2.9.1. Context aware hospital bed and context aware pill container

The centre for the pervasive health care in Denmark has proposed this context aware bed and context aware pill container. The context aware hospital bed has built–in-display. This built-in-display can be used by the patients for their entertainment (e.g. for viewing television) and by clinicians for accessing the medical data. Context aware bed knows who is using it by identifying the patient, and what and who is nearby it [38-39].

The context aware pill container is aware of the patient. When the container is near to the patient, it lightens itself with the name of the patient. This function of the container helps it to reveal as a proper ones [38-39].

The context aware bed also includes context aware EPR of the patient, and when the pill container place on the table, the bed react to the changes in this environment. The beds know the nurse, the patient and the medicine tray and display relevant information according to this context such as a medicine schema and patient record [38-39].

2.9.2. Time and location context application

Location and time information is used in a number of applications.

Fogarty *et. al* [40]. Describes the context aware communication system **MYvine**, which is able to indicate the availability of individuals. The contexts used by **Myvine** system are the speech detection, location, computer activity and calendar entries. These contexts are used in the hope that they could help people to avoid the disruptions through an interruption in relation to their availability. Further, they can also be obtained without installing any additional hardware or sensing infrastructures. These properties make them reasonable to consider their large-scale deployment [40].

Mobisaic Web Browser [41] system is a mobile application with the location and time context. This system enables information browsing in a mobile computing environment by using World Wide Web. It requires minimum user input and allows user to execute general

queries. It allows users to interact with their environment as they work within it. This system has used the concept of dynamic URLs. This allows user to refer dynamic contextual information in the dynamic URLs, which may contain environment variables. The dynamic URL is interpreted using the current values of the environment variables. As a result, an appropriate page is returned. The web page gets updated when dynamic information changes [41].

The **Cyberguide**[42] system is used for an indoor and outdoor use for the tourist. It provides information service about the current location of the user. The user can find directions, retrieve background information and leave comments on the interactive map. The Cyberguide is based on the assumption that the user wants information about his surroundings and such information is given to the user without further instructions. Automatically it can compile traveling details of the tourist over the time and make suggestion for interesting places [42].

The **Cyberminder** is a location aware system for sending and receiving reminder to the users [43]. The reminder can be triggered by user's context such as time, location and situation context.

The **Active badge** is another location aware system for indoor use [44]. In the premise, staffs wear the badges, which provide their location to the central location service through network sensors. This system is meant for keeping track of employees in the big organization such as hospitals, where the employees are often hard to localize.

In above discussion we saw different type of system based on context. We also saw the use of those contexts in context awareness system. In our implementation we also used context of information to develop context awareness system for providing related information to the users.

2.10. Summary

This chapter deals with the background for the thesis. The different approaches for the personal information managements and their drawbacks were seen in the section 2.1. The health domain and different ways of managing the personal health related information is highlighted. Also, the concept of electronic health record, electronic medical record and the personal health record is discussed before discussing the health related personal information. Before processing the health related personal information management, the brief idea about the sources of information providing the personal health related information is given.

Further, the ways of annotating file from manual annotations, semi automatic annotation and automatic annotations have discussed. Bridging semantic gap is always difficult task in the personal information management. This leads to lack of capability to understand the user request and their needs.

The role, the definitions of the context, the context awareness and its use for personal information management for providing relevant information to the user has been also discussed. To understand the context and context awareness, definition given by **Dey** has been used. Besides that, an idea about the use of the contextual metadata of information for interoperability has discussed.

CHAPTER 3

3. Relevant work

An idea of the personal information management named ‘Memax’ was introduced in 1945 by Bush. Memax [52] would allow one to browse the personal information through an association among the concepts. This concept led towards several progresses in the personal information management. The relevant PIM systems will be described in this section. Instead of giving a full description of every system, we have described the systems exploring similar concepts, as that of used in this thesis. Additionally, a short description of the limitation of these systems will be discussed.

3.1. MIsearch

Juan M.Silva *et al*.[53] have developed web based **MI search** [53] (Medical Information search) system for the personal health related information based on the context awareness. MIsearch is search tool to find relevant health information on the web. This system uses the personal health information as a context. The context of the information used in this project is about demographics, health conditions, drugs, allergies and hereditary.

3.1.1. System architecture of MIsearch

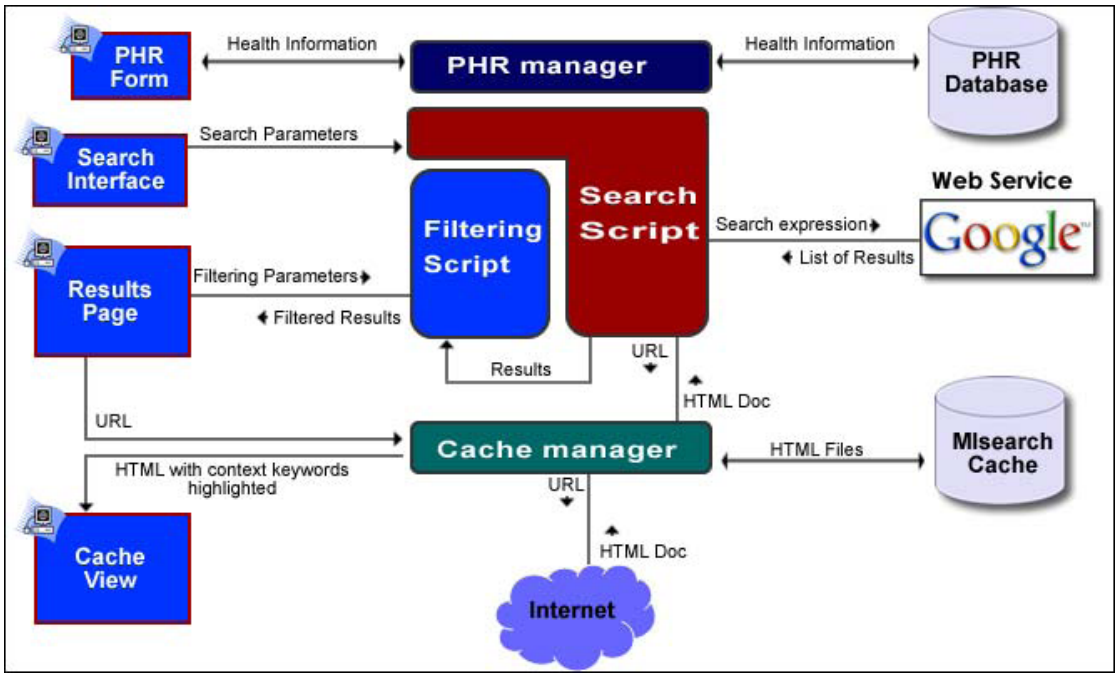

Figure 4: System architecture of the MIsearch [53]

The figure 5 is about the architecture of MIsearch system. This architecture is divided into three components: application core, user interface, and information sources. At the application core, it has functionality of managing the personal health record by searching, filtering and caching the information. The user interfaces are mainly html documents that allow the user to interact with the core scripts. The information resource is web itself i.e. the personal health record database stored on the web server [53].

MIsearch have its own electronic PHR and it contains information about demographics, health conditions, drugs, allergies and hereditary .This PHR database contains Date, Time and description columns and this information is kept over web server. The PHR manager handles information of the database. Users fill the information into the system by using these PHRs controller. The stored information keywords are extracted. These extracted keywords are used on the retrieval process as the contextual information [53].

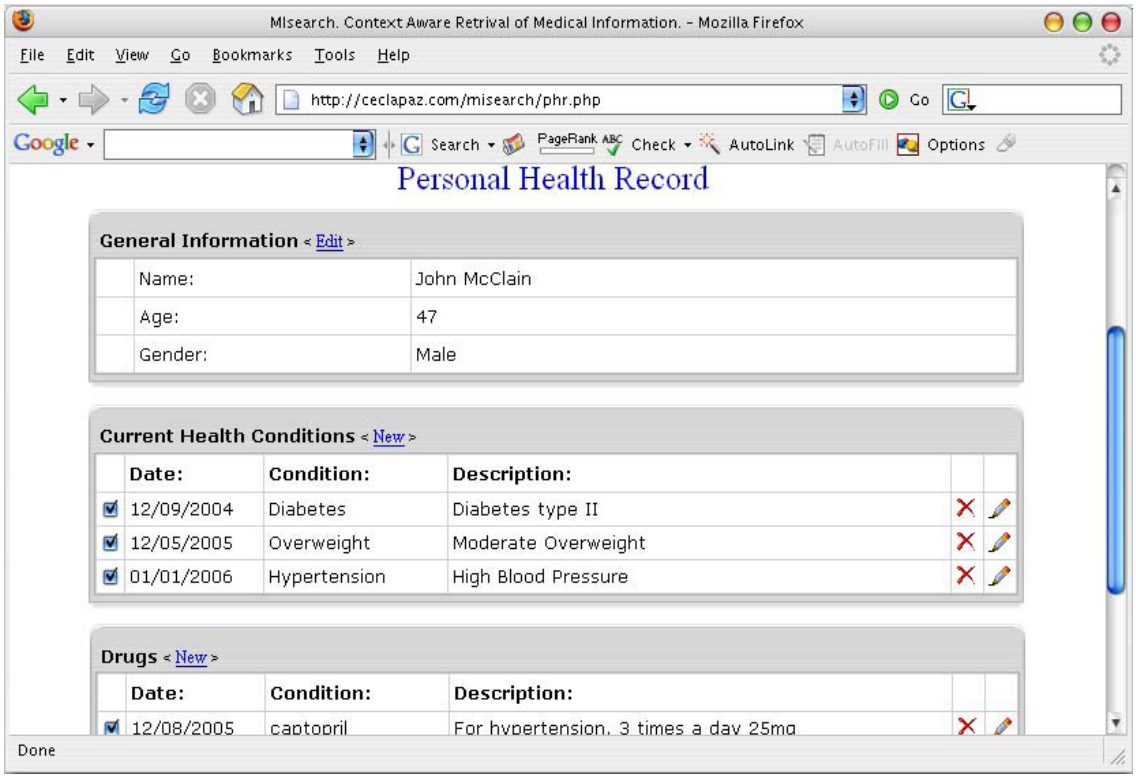

Figure 5 : Personal Health Record control panel [53]

To retrieve the relevant information MIsearch retrieves the context keywords from its PHR database. The context keyword consist the list of terms as they appear on the title column for each item of PHR´s topics. The keywords based search results returned by the Google is depend on their similarities to the search terms on the query string. These Google search results are html type documents referenced by the URL´s. MIsearch looks on these Google search results. Then, MIsearch matches the keywords and increase the rating of the documents. The rating is assigned to the search results and subsequently recorded in it. According to the search results, the MIsearch system displays the search results based on contextual information found in the PHR [53].

The MIsearch system does not restricts how much context should be taken into the consideration. This system uses title of the each item instead of using the context keyword for the search of PHRs information. So it may be possible that the content of accessed information may not be relevant for the users need. It also does not keeps the update of the

record in PHRs that can be helpful for giving priority to relate the most relevant context information [53] .

This MIsearch system is similar to our system, as it uses the health related information as a context. Also, in this system, it has extracted the context of the information such as title, keywords from the database for the information retrieval. However, MI search dose not does have an updated information management which is different from our system.

3.2. Gnowsis

Gnowsis [54-57] is a project that is based on the semantic desktop concept for organizing personal information. The Gnowsis system has a concept of web resource, where it considers all desktop files as the web resources. The RDF technology is used for this system, as it is based on the idea of identifying things by using web identifier (e.g. URI´s) and it describes the resources in terms of the properties and the property values [54-57].

3.2.1. Working of the Gnowsis

This application is used for personal information management. When user needs to know more information about the one musical file, the user can browse his or her semantic desktop simply by right clicking the file. The system uses the URL´s of files as context of the information. The file URL gets passes to the local Gnowsis server, which browses identifier of the file. There are several adaptors registered in to the system. One adaptor handles local files and can extract file-size and name. Another adapter can extract the ID3-Tag information of the MP3 file, like artist and track number. The adopters are shipped with RDFS vocabulary and it describers the possible values that adopters can extract.

The central server sends query to the both adaptors about the MP3 files by using the two different adaptors. The adaptors extract their part of information; also a central RDF database is queried to identify the related resources or additional annotations [56].

The RDF/XML string or Jena Model is used for integrating and accessing the results of query. The server starts a user interface module to display the information about the resource

and to manipulate the resource. Clicking on the resource, tells the server to open the file using the standard application for the music. The second resource can be selected in another application and it can be linked to the resource and information can be accessed [54-57].

3.3. Semex

Semex [58] offers a platform for the personal information management. Semex system provides a logical and integrated view of the personal information. It gives semantic meaning to the data by providing domain model containing the classes and the association between those classes.

The main aim of this system is to enable browsing by creating an automatic association between data items on the desktop. Semex database consists of the objects and the relationships between the objects obtained from one's personal information. Semex supports on-the-fly integration of the personal and public data [58-60].

3.3.1. Architecture of Semex

In the architecture of Semex, we can observe that the personal information comes from the various sources such as word, excel, power-point, PDF, email, calendar, Latex and Bibtex and database etc. Semex extract the data from these sources. The extraction creates instance of the classes in the domain model. Semex have multiple modules for extracting the association. Semex stores objects in the domain ontology. These objects contain the classes and relationships or the associations. The figure 7 represents the architecture of Semex system. In that architecture we see that Semex employs different kinds of modules for extracting associations [59]: we following part we see the description of each module.

- External: External sources define the association explicitly.
- Extracted: Objects and the association can be extracted by analyzing the specific file format.
- Define: We can define objects and association from the simpler ones, as it defines relationship in the database.

- Simple: This module extracts association, which is already stored in the data source and extract it into the domain model.

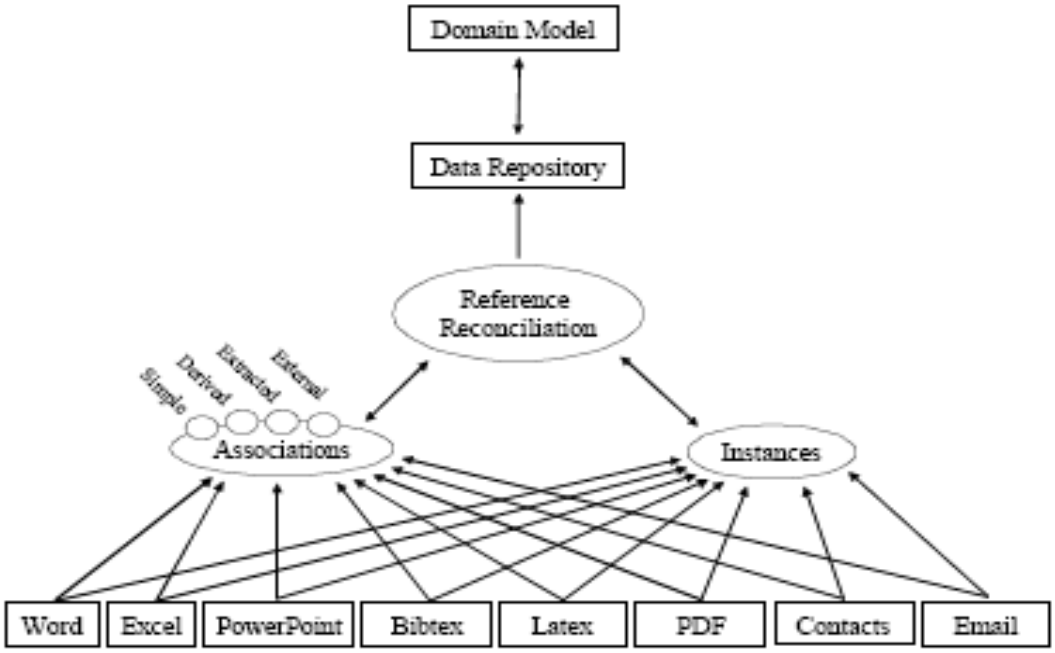

Figure 6: Architecture of the Semex [58]

To combine all associations seamlessly, Semex automatically reconciles the multiple references to the same real-world object. The domain model is used for browsing query from the users. Further, it allows several ways for query browsing so that user can manually personalize it. In domain model, the browsing pattern can already define a new class or association. User can refine, modify or generalize the pattern or combine it with the other patterns to create the desired class [58-60].

3.3.2. Working of the Semex

Semex scans user's hard disk or the specified directories and consider the following file formats:

- Emails: Outlook emails, Pine mails,
- LATEX files: .text, .bib, .bbl
- MS office files: .doc, .ppt
- Text files: .txt, .PDF, .ps, .html/.htm
- Images: .gif, .jpg/.jpeg, .png, .tiff, .eps, .bmp

Semex extracts instances from these files such as Person, Message, Article, Presentation, Conference, Journal, Image, Documents, and Webpage. Semex automatically reconciles the extracted instances that refer to the same real-world instances. When user place a query Semex classifies the returned objects into their classes. Then, user can select a particular object instance to see detailed information, including its attribute values and its associated instances, which have been grouped by the associations [58-60].

Semex has keyword based and advanced search technique. The keyword based technique dose not only searches for the keyword but also it returns relevant instance and searches for the web pages relevant to that keyword.

The ranking of the results provide three options: one is by the relevance score, and the second is by the importance score and third one is by the timeline. User can choose to rank the returned instances according to their importance in the personal information space which is computed in a way close to the Page Rank. Users can choose to rank certain instances such as Articles and Emails by their latest modification time.

Semex also find out how returned instance is related to the users, how user know the person, when is the first time user heard about this person and when the last time user is contacted to this person. Semex will also look for the persons, papers and cities that the user already knows, by providing an external data source. Semex will look for the instances that already exist in the user's information space. Semex is a system for the efficient storing, managing and retrieving the personal information [58-60].

3.4. Haystack

The aim of Haystack [61] is to unify the management of the personal information including emails, web pages, and documents in the file system, and calendars. Further, it allows people to create the collections from their digitalized information and to categories their information in the flexible ways. It helps them to find effectively what they need [61].

This PIM system aims for creating, manipulating and visualize arbitrary RDF data in a comprehensive platform. This system is a well known project for the individuals to manage their information in a very free and an integrated way [61]. As the haystack data type is not hard wired, the additional information that user want to work can be easily incorporated. The user can easily define a new object attributes, which help to categories and retrievals and to create a new relationships between objects [61].

The Haystack system provides related material with user's work E.g. it links musicians to their played concerts, performed songs, and their photographs. Further, it does place songs or albums in a calendar according to the release date.

The Haystack [61] and Semex [58] system employs an extract, transform and load cycle (ETL cycle) to extract information from the desktop data sources into a repository and represents that information in a domain model. The domain model is a high-level mediated schema over the personal information sources. These systems focus on creating query able information and non-updatable views on the user's personal information.

Apart from the above mentioned examples of the personal information management systems, the other examples of this system are Lifestreams [62], The Placeless document system [63].

3.5. Similarities between the related works

Table 1: Similarities of various systems with our prototype

	MI search	Gnowsis	Semex	Haystack	Our prototype
Personal information management		**X**	**X**	**X**	**X**
Use of personal information context for management	**X**	**X**	**X**	**X**	**X**
Provides related information to the users	**X**	**X**	**X**	**X**	**X**

The table 1, Illustrates the similarities of the various systems and their relation to our prototype. Here, it can clearly observe that these different types of personal information management systems use the context information for the information management. A difference between these systems and our prototype is that, these system uses query based information access technique that is not used in our prototype. We are implementing an automatic information access technique with different types of functionalities.

3.6. Summary

In this chapter, we have described systems which are related to our prototype. We have emphasized systems, which utilize that the use of context to provide the personal information to the users. By describing these systems, we have enlightened the different types of the personal information management systems to serve the same purpose.

The MIsearch system is a context awareness system for the personal health information. It extracts information of the patient from PHR, which is used to provide the relevant information to the users. It adds a context to the retrieval process. Further, an ability of the extracted context information functionality to improve the relevance of the search results for the patients has been shown.

The other systems have used the semantic technology for the personal information management. The Gnowsis system uses the Semantic Desktop approach to the personal information management. It has created a software architecture model for the semantic desktop and shown its ability to improve the personal information management. It has suggested the data integration framework and has extracted information on the fly from common applications. The second system is the Semex system. This system enables user to browse the personal information by the semantically meaningful associations and creates an automatic association between the data items. It has offered a flexible platform for the personal information management by creating an enough associations. Thus, this system becomes an essential tool and provides an ability to integrate the external information sources.

The other information management system is Haystack. The Haystack framework demonstrates some of the benefits of managing user information uniformly in a semi structured data model. This system looks on the information objects, which needs to be stored, viewed and retrieved. Along with this, the system also looks on the storage as well as the presentation of the required related information or attributes to the user.

CHAPTER: 4

4. Approach and requirements specification

4.1. Approach

As it described in the main goal the implemented prototype should provide related information to the user. In theoretical part it was seen what is meant by related information and what can be the source of the related information. The related information means linked or associated information with other information. A person has some related information to him, such as his name, surname, his age, his wife and his kids; these are related information to that person. If we look at the related information of health, then it includes the information about the contacts, medical bills, receipts, health-related articles, web pages, medication and appointment schedules, medical records (x-rays, labs, etc), educational materials, family history, genealogy and many more.

To provide this related information to the users, we have used information metadata which describes context of the information. Metadata is anything known about the documents, which you are searching beyond the words they contain [67-68].The most common definition of metadata is data about data. This term refers to any data used to assist the identification, description and location of the network electronic resource [44]. Metadata helps in understanding the meaning of the information and the representation of data. The meaning of the data and the context of data becomes easier because of this metadata. Metadata information comes in the structured format and it is created specifically to describe another resource. It answers who, what, when, where, why, and how about every fact of the data that are being documented [46].

4.1.1. Standards for describing digital metadata

There are several standards for organizing and storing digital metadata.

- Dublin Core (DC) standard describes the metadata for the digital objects to increase their visibility, accessibility and interoperability [47].
- EXIF (Exchangeable Image File Format) is a standard used in most of the today's digital cameras for storing the metadata in the image files [48].
- MPEG-7 is an ISO/IEC standard developed by the MPEG (Moving Picture) for describing the multimedia content data in a broad range of applications [49].

The information stored by the user has some metadata. Some of the metadata of the information explains context of the information. The metadata of personal health information depends on the patient's disease. The stored information of a patient is different and so the metadata. The metadata explains, some information such as when and where it has been stored; who has stored it; the date and time of creation of that information.. The meaning of each documents and understanding of full context can be enhanced with the help of the metadata. [67-68].

The role of metadata in the information integration is as follows:

- Extraction, normalization and organization of the information stored from many heterogeneous content sources of different formats with the help of metadata. .
- Identification of an interesting and relevant knowledge from the different sources by using metadata.
- Metadata allows analysis of the previously unknown, non-obvious relationships between the documents.
- Maintenance, extraction and normalization of the knowledge and content with a high level of automation can be by using metadata [67].

Metadata that describes context have important role in the information management and retrieval. User can have quick access to needed information in his current context. The user can access the information automatically with minimum interaction. By using the context of the information, the needed information can be accessed to the users current context. In this thesis, the information is used as entity and the surrounding context of the information was used. To achieve the main goal of the thesis location, time and date context of information for personal information management was used.

4.2. Information context

In our implementation, the information context was used to provide related information to the users. The context that were used here are time, date and resource name. Where time and date describes when the file has been downloaded and at what time it has been downloaded. The resource name describes the location of the file from where it has been downloaded.

4.2.1. Time and date as context

The two contexts of information were used which are, time and date. Time context is important for information management, as it gives information about the time at which the information has been downloaded, created, stored, uploaded and edited. The time context is automatically added to any file. This time context can be used for the information management, but using only time context will not be useful for association of information in information management. There might be a little change of some seconds or minute, when any related file is downloaded. Also, it cannot be guessed that user downloaded the same relevant file at the same time or on the same date.

e.g. If the user has downloaded a health related file at 10.00 am on his or her laptop and if he downloads some files related to a movie at 10.10am, then making association of these two files only by using the time context does not provide any kind of relevancy between these two files. Also, when any user has downloaded some files at particular time, but on a different date then it is difficult to make a search based on only time. Therefore, it is

necessary to use the date context for search, so that by matching particular date and time the relevant file can be searched.

In this thesis, time and date metadata that describes contexts was extracted from the file. The time and date parameters are optional to the user. If these two parameters are selected by user on user interface form then, the resulted file will have the specific time and date selected by the user. If these parameters are not selected, then the user will receive only those files which have relevant or same resource name. The service can of course be designed with more options, for instance an option for a maximum or minimum amount of files a user wants see.

4.2.2. Location as context

The source name is location of file from where it has been downloaded. As it is discussed earlier, location context is used very commonly. Location context, suggests the location of particular file as to from where it has been taken.

The file that is downloaded from particular device or from internet has some source name of that downloaded file. By using location name related information was provided to the user. Every source of information has some different information units. For example, if user has diabetes and he has glucose meter as source of his health related information, then the information stored in that glucose meter is stored in mg/dl unit. So if we use these units of glucose meter (mg/dl), it is possible to make a relation of information stored in glucose meter and will provide relevant information to the diabetes patient. To make relation of this related information the resource name has been used as information context.

In this implementation location context of the information, which is URL of downloaded file was used. This URL of file gives the resource name as to from where the file was downloaded. Location names were extracted from the URL. By using the location names, context from where the file has been downloaded and from which source it has been taken can be identified. The source name contains interrelated files, by using single source name it is possible to access bunch of data which are related to each other. An association of files from similar source was made to provide related files to the users.

4.3. Requirement Specifications

4.3.1. Use of the prototype

To know the use of implemented prototype we can have look on one scenario.

Scenario 1

Sara is very much concerned about her mother. Her mother has diabetes. While her mother was under treatment, Sara took the responsibility of her mother's health care. She found information on the internet about Type- 2 diabetes regarding, medication, its cure, and whom she can contact. But at one stage, she found that she had already downloaded similar information before. She was overloaded with lot of information; therefore it was difficult for her to find out the relevant information.

If, Sara would have used the PIM system to manage all collected information related to her context i.e. diabetes. It could have been very easy for Sara to search the related information, if she had a system which could manage information and provide related information.

In the above scenario, we can see that the context of Sara was diabetes and that diabetes information can be stored in some device. This stored information has some context, by using that context of the information, related information can be provided to the users of the system.

4.3.2. Functional requirements

The developed prototype should provide related files to the users. The prototype must be able to store downloaded file into the download folder automatically. Even though, if the user stores downloaded files into different folder, it must get stored into the download folder.

To achieve the main goal, the implemented service should use context of the downloaded files and present relevant information to the users. Also the service should read metadata which describes the context. Then it should extract those metadata of the file and store it in to the database. The context to be extracted here are time, date, resource name, URL of file, URL path, and file name.

The association of file context is most important. The prototype should make association of time, date, and resource name context to present the files with related information to the users.

To present files and their related files, the prototype must have user interface. The prototype should have simple GUI form with simple instructions, so that user can follow those instructions. GUI form should be able to display files and related files information to the users of the prototype. It should provide new window to open user requested files to avoid confusion of users.

Here, the figure 7 represents the use case diagram. The use case diagram is developed to define the prototype. It describes an interaction between a user and a prototype. The use case diagram gives an overview of the requirements and planning of the project. The use case diagram graphically illustrates the prototype and interactions with the user of the prototype as shown in figure 7:

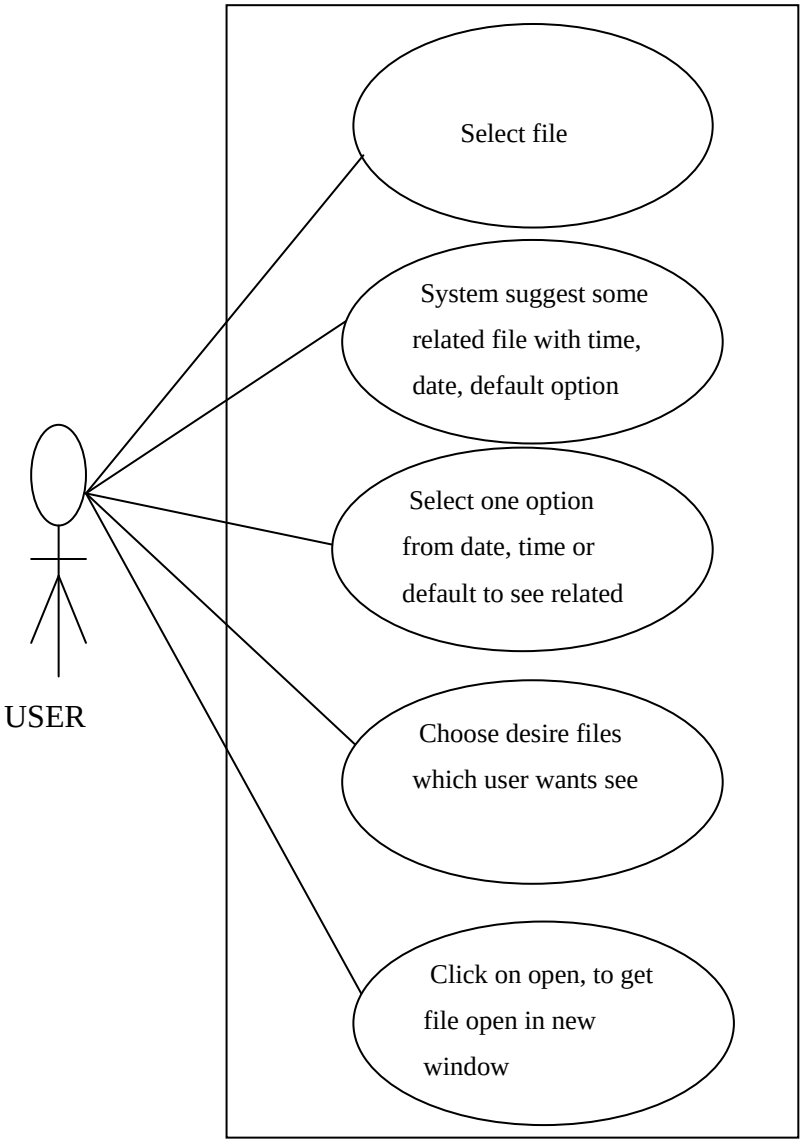

Figure 7: Use case

The use case diagram is a visual aid for the functionality of the prototype. However, further the detailed requirements are described.

Use case diagram description

1. User selects one file to open
2. Prototype suggests some related file with time, date and default option to the user.
3. User selects time, date, or default options to get the related files.
4. Selects desired file from related files suggested by the prototype.
5. User clicks on open to open the selected file in a new window.

4.3.3. Non functional requirements

4.3.3.1. Simplicity or Usability

The graphical user interface should have the simple and an easy view. Also, the user should not have hesitation while operating the system. Many personal information management systems have been implemented, but some of them are abandoned due to their usability or they are not interesting enough to the users. The prototype in this project should enhance the usability and satisfaction of the user.

4.3.3.2. Performance

Performance of the prototype is based on the use of limited resource of the Laptop or PC. It must use minimum memory of the laptop or PC. It should not have significant changes in the resources. Resource should not slowed down or become less efficient in any way.

4.3.3.3. Security

It is assumed that only user have an access to their personal area network. This is important because health related data is confidential. To achieve this goal, users have their own account and password for the security.

4.3.3.4.Legal

According to the legal rule, any experiments may not be done on real patients. There should not be any transmission of the patient data over non-secure channels without proper authorization. The prototype dose not requires transmission of the health information in any form.

4.4. Summary

This chapter provides the description of the approach that was used in this thesis. Information metadata was used that describes the context of the information to achieve the main goal. The importance of the context in information management and how the context can be used to achieve goal was discussed. Time, date and resource name context of the information was described. In the requirement specifications; the functional and non-functional requirements was discussed.

CHAPTER: 5

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5. Design and architecture

5.1. Overview of Prototype

The information management is about the structure, analysis, storage, searching and retrieval of information. Here, the aim was to provide related information based on context awareness. The following discussion provides the overview of the prototype.

First the user of the implemented prototype collects information from different source. In this thesis internet was considered as a source from where users download information. When users downloaded any PDF, image file from internet, those downloaded file always get store automatically in download folder. The relevant knowledge of different sources and relationships between different files can be analyzed by using metadata. The downloaded files in download folders have some metadata. The implemented service connects the download folder to the database and automatically uploads the metadata of the files of download folder.

The file name, time, date, URL path, URL, resource name were extracted and stored it into the database. Among these metadata, time; date and resource name metadata were used and association of these metadata was made. The information manger checks for the similar metadata in to the database. When this information manger finds some association of the metadata it makes the grouping of those files which are co-related or associated with each other. When user downloads any new file, the information manager automatically updates the xml file and detects the downloaded file's association and saves it in database. The information manger ensures that the vital information should not be ignored.

At the user interface when user selects one file to open, the developed prototype always checks for the available related files to the selected file. If the prototype finds some related files then it ask user weather he/she wants to see related files or not. If user says yes then the

prototype shows all related files list to user, from those files user select one file to open. The overview of the user interface can be seen through the information flow diagram.

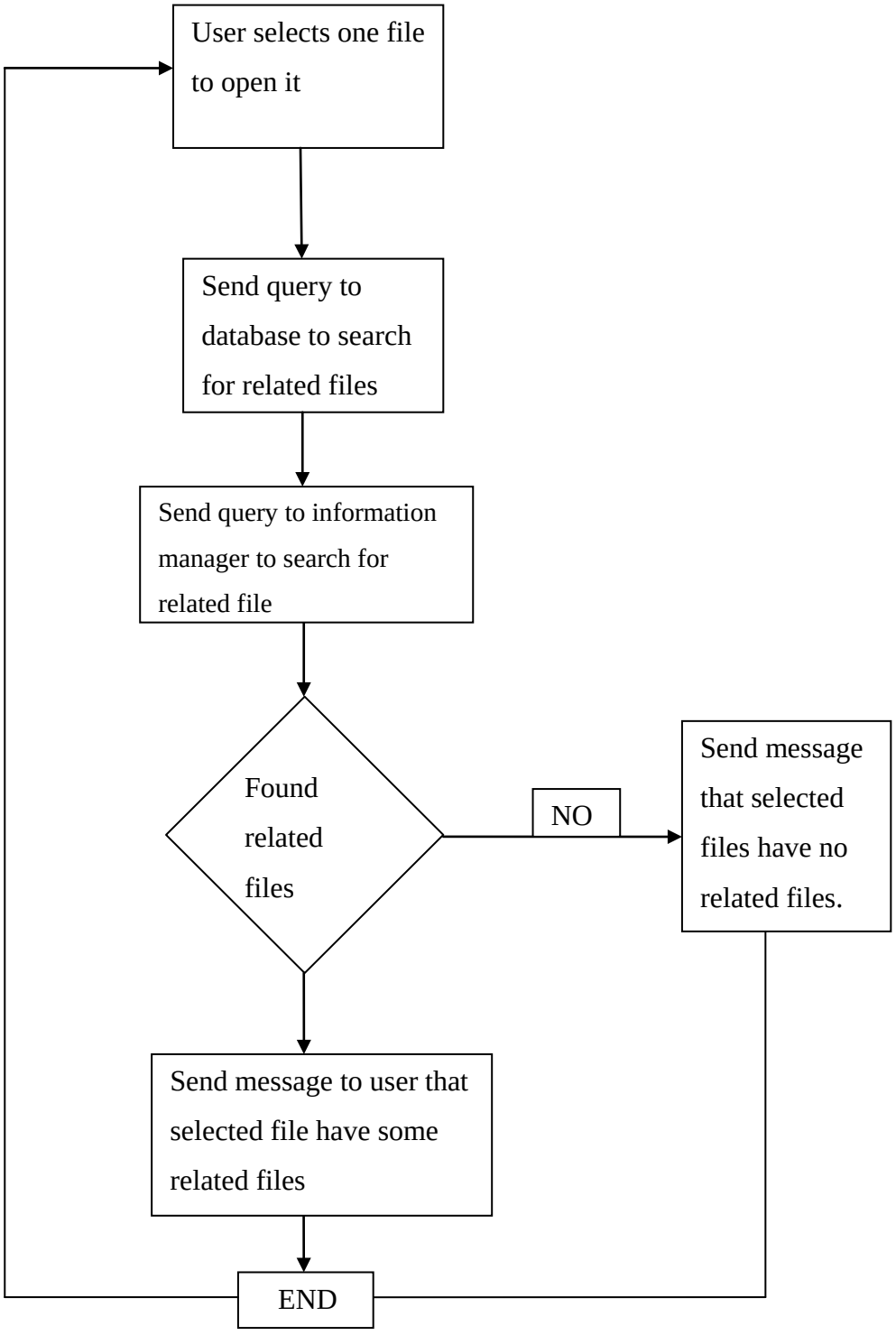


Figure 8: Information flow diagram -1

The figure 8 shows how the information flows in prototype. In figure 8, it is seen that the user first select one file to open, then the query is sent to the database to search for the selected

file. The database sends query to information manager to get selected file. The information manager also checks for the related file, if it finds related file, then prototype send a message to users that selected file have some related files. If information manager does not find any related files then it sends a message to user, saying that selected file does not have related files

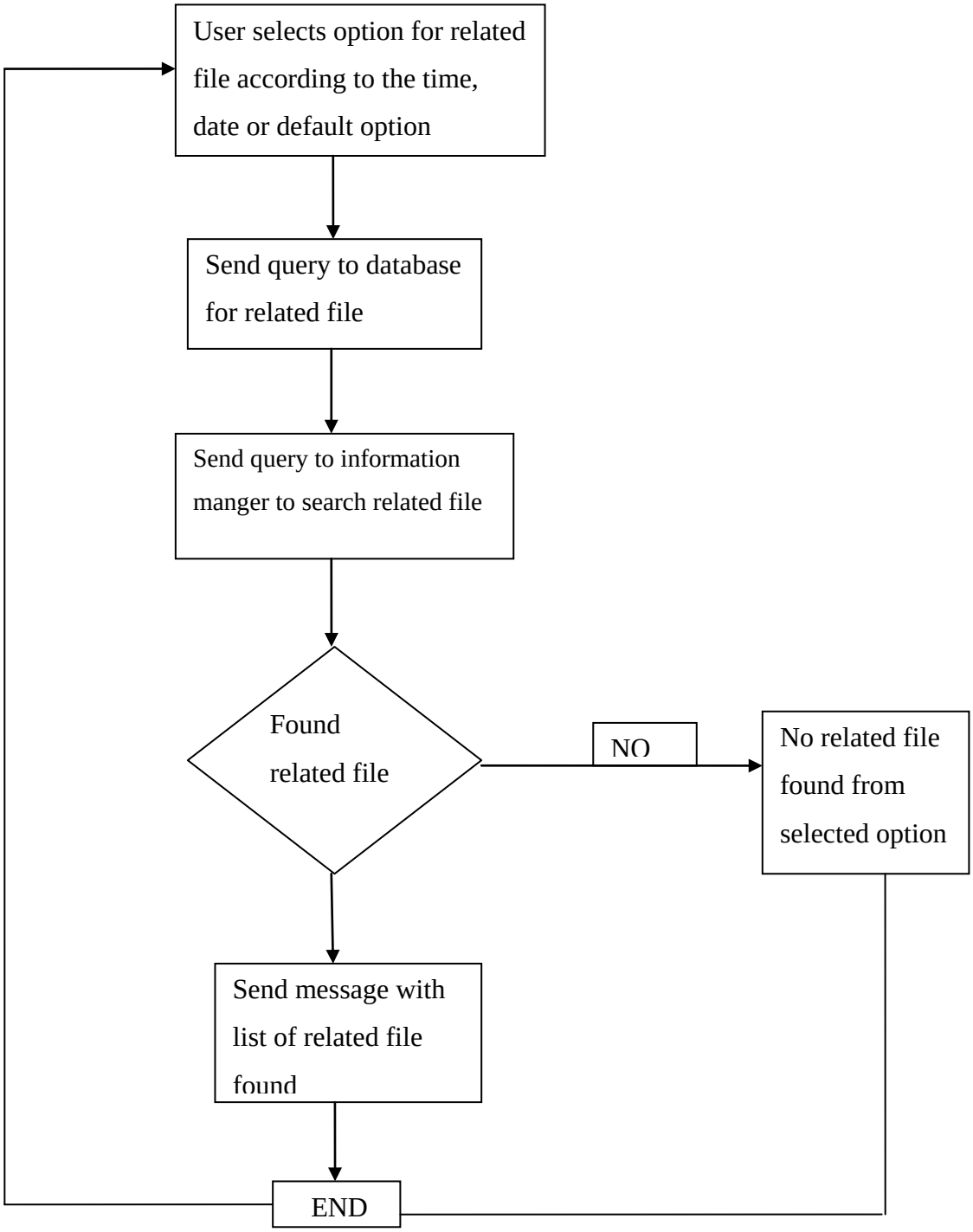


Figure 9: Information flow diagram -2

In figure 9, it is seen that when the prototype asks the user if he /she want to see related files to his request or not. When user says yes then prototype provides time, date, and default option to the user. If user selects one of these options, then the prototype sends query to the database to search related file according to the given option. Then the database sends a query to information manager for related file. If information manager finds some related files from selected options, then it sends message to user with the list of related files. If the user selects one file from that list, then the prototype will display only the selected file to the user. If prototype does not find any related file from selected option, then information manager send message, saying that no related file was found from selected option.

5.2. Architecture of prototype

In the following section the architecture of the prototype is described. The figure 10 shows the architecture of the prototype. This architecture contains four components: Metadata extractor, Information manager, controller and user interface. Each of these components is described in the following part.

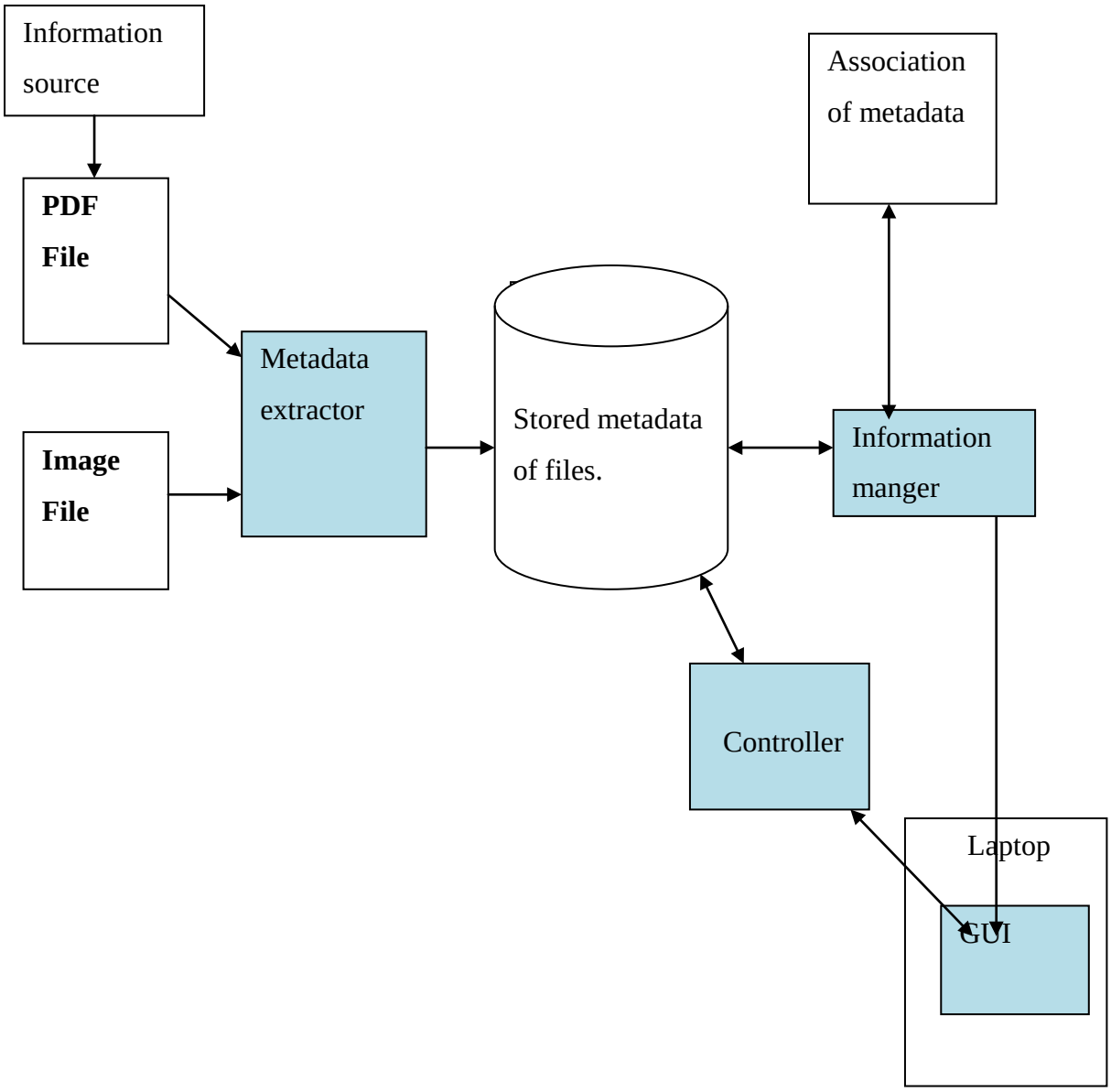


Figure 10: Architecture of our prototype

In the figure 10, that source of information such as PDF, Image files are seen. These sources have some metadata. This metadata needs to be extracted and stored into the database in order to access information.

Further this metadata information needs to be associated with its relevant information and should be presented to the user with the help of controllers. To follow this approach the prototype needs to build on some principles. The stored metadata in database should organize by our prototype and this organization includes extraction of metadata, association and representation of data.

5.2.1. Components of prototype

In the above architecture the prototype contains metadata extractor, information components, controller and GUI form. These four components are described in the following section.

5.2.1.1.Metadata extractor

The metadata extractor is for extracting the metadata that describes context of the information files. When user installs this software on his/her system, this metadata extractor starts functioning while user is working. It always checks for the new downloaded file from the internet and extracts the URL of the file from the history of the internet. This metadata extractor functions after one million second and checks for new download file. Besides extracting URL it also extract time, date, file name, URL path and resource name from URL and stores all the metadata into the database schema. To store this metadata it makes connection with the database.

The database system used in this thesis was SQL server. When metadata extractor extracts metadata of files, it stores those metadata into the database. In the following table 2 we see the schema of the database.

Table 2: Database schema of our prototype

File Name	Download Time	Downloaded Date	URL path	URL	Resource Name

The above database schema includes extracted metadata such as file name, file download time, date, URL path of the file, URL´s of the downloaded file, resource name. The file name represents the name of the downloaded file. The time and date represents the timing and date when the file was downloaded. URL represents the location from where the file has been downloaded and the resource name represents the name of that URL. In this implementation time, date and resource name to present relevant information to the users has been used.

5.2.1.2.Information manger

While metadata extractor is running at the background, the information manager checks the metadata from the database and creates a new annotation of the resource name, which is extracted from URL by the metadata extractor. A new annotation is created by information manger, only if that annotation does not exist. By doing this it avoids the duplication of annotation. After creating new annotation it makes association of all files which are downloaded from that resource name. This information manger also checks for the time, date context for the making of the association of files according to their downloaded time and date. Whenever the user downloads similar file for the second time from URL, this information manager does not consider that file. This function is useful to avoid redundancy of information file. The information manger is also used to provide a list of related file to the users.

In the above discussion the metadata extractor and the information manager were described. Further we will see how the process flows from these components. Process flow of these components is explained in figure 11.

.

In the figure 11.The users download files from the internet is seen. The metadata extractor stores these file into the download folders and extracts metadata of these files. After extracting metadata of the files it stores the metadata into the database. At the same time the information manager creates an association of some metadata, this association was presented into the xml file format, and provides list of related file to the users by using GUI form.

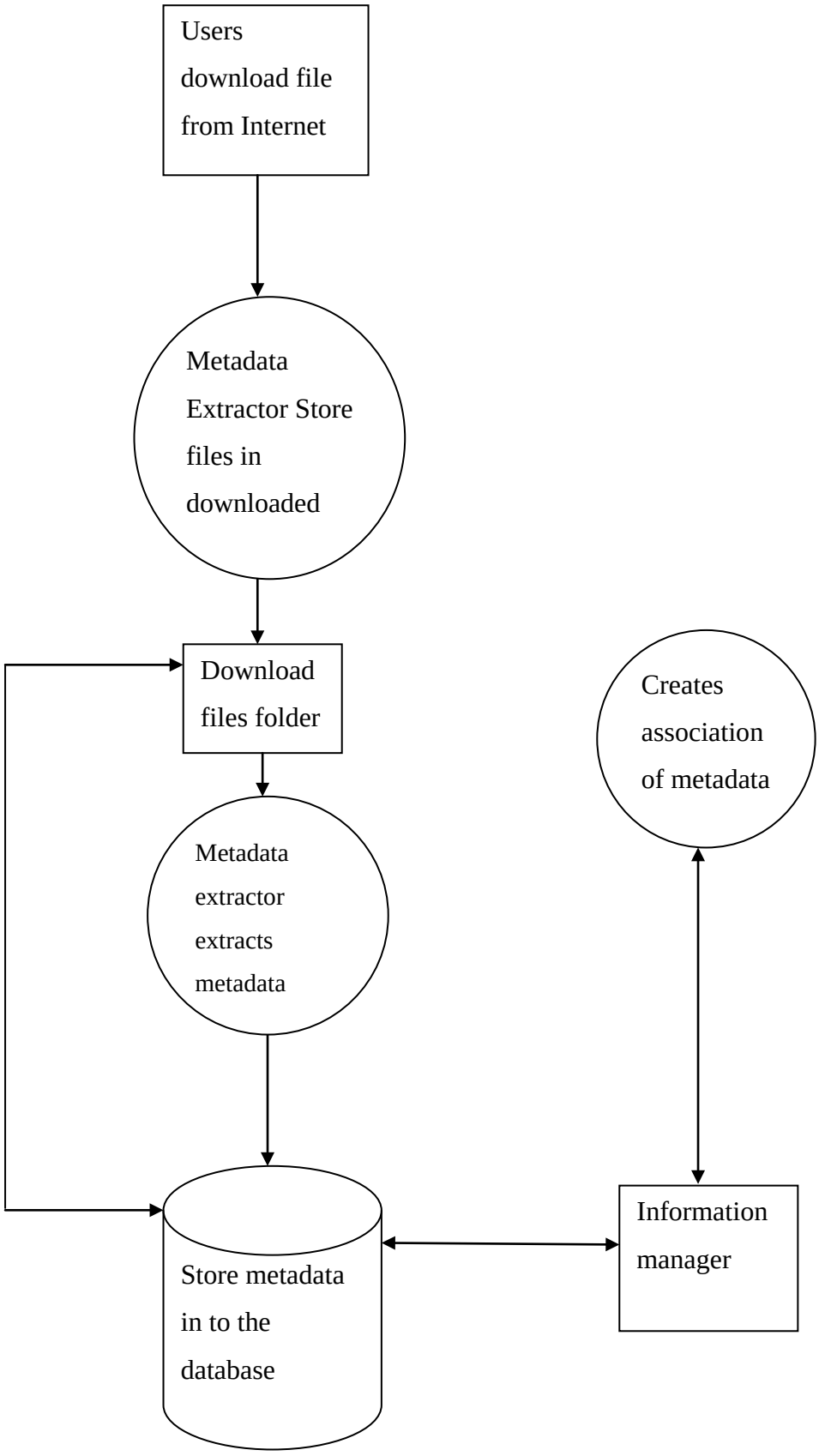


Figure 11: Process flow of metadata extractor and information manger

The details of controller and user interface components are described below.

5.2.1.3. Controller

The controller is used to display files to the users from user interface. The controller is connected to the database. When user selects file from the related files suggested by the information manager, the controller fetches that selected file from database and display it to the user.

5.2.1.4. User Interface

This is used as web page to provide file list to the users. This GUI form has combo box, from where user selects one file and according to that selected files, the information manager provides related file to the user. This GUI form is connected to the controller. The user chooses one of the suggested related file and the controller fetches that file for user.

The figure.12, show the process flow of Controller and GUI process. In this figure 12, the user selects file name from GUI form, this GUI form selects the file name from database. When user selects the file name the information manager suggest related file names to the users. The users selects file which has to open. The controller is connected to the database and database is connected to the download file folders. The database fetches the file for controller from download folder and controller display selected file in a new window.

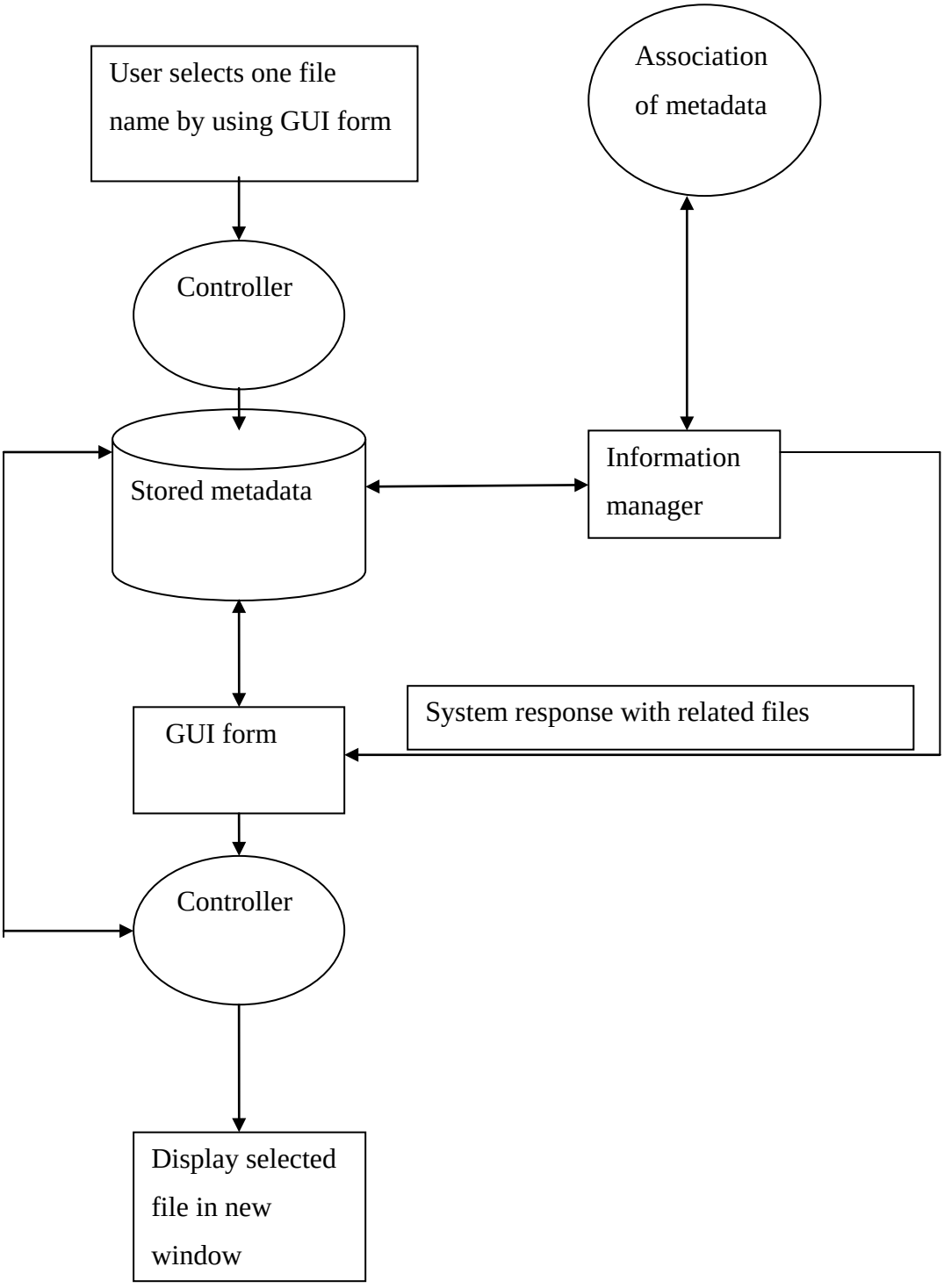


Figure 12: Process flow of controller and user interface

The above discussion was about the process flow of the four components. The programming details of these modules are described in the next chapter.

5.3. Summary

This chapter was about design of the prototype. In that overview of our prototype was described. Most importantly prototype architecture and descriptions of each component was given. The components that were used here are metadata extractor, information manager, controller and user interface. The task of the metadata extractor was to automatically store file and extract context of those file. It was also seen, how this metadata extractor stores context in to the database.

The information manager was used to make association of the context and to provide related files to the users through GUI form. Further, the process flows of the metadata extractor, information manager; controller and user interface was also described in this chapter. The programming details of the implemented prototype are described in the next chapter.

CHAPTER: 6

6. Implementation

In above discussion design and architecture of the prototype was seen. In the next part we will see the implementation part of our prototype.

To develop prototype some development tools were used as follow.

Hardware

RAM : 512 MB

Hard Disk : 40 GB

Processor : Pentium IV and Above

Secondary Storage : 700 MB CD Disk

Software

Operating System : Windows XP

Language Used : Visual Studio 2008 C#.Net

Database : MS SQL Server 2000

The implementation and programming technique of each component is discussed in following part.

1. The first component was metadata extractor. This component was developed for an automatic file storing into the downloaded folders. Further, this component extracted metadata and stores that metadata in to the database. For developing this module number of Built in Classes, DLL's, Controls, Methods, properties were used.

The programming detail of metadata extractor components is as follows:

6.1. Metadata extractor

First we executed our implementation and started downloading files from an internet explores in to the download folder. The metadata extractor automatically extracts context of files, such as file name and downloading date, time of the downloaded files. Also, it automatically extracts URL of the file from internet explores history. To do this the metadata extractor uses Shell Windows class, internet explorer's class of ShDocvw.dll and stores that URL in to the database. The metadata extractor also extracts the resource name from those URL´s. To extract resource name from those URL´s, It read all URL´s of open document of internet explorer and stored into Array list. Array list is a class used for collection of strings. Then metadata extractor used some string functions to extract exact resource name from that URL. This string functions called **Slit ():,** by using this function we are splitting URL string by "/".

Metadata extractor also extracts time and date context from downloaded files. To extract time and date metadata, Datetime class was used. This information manager reads the metadata from the database and makes association of those metadata. The information manager create one XML files named with associationXML.xml file, this association xml.xml file contains all related files association in it.

To develop this metadata extractor component, we used number of build-in and user defined classes, DLL, and controllers, methods, and properties. The programming technique of this module is described into the following discussion.

6.1.1. Timer controller

This controller was used to execute our code after specific time of interval. In this application, we set 1000 milliseconds time interval. This allowed metadata extractor to execute automatically after one second.

6.1.2. ShDocvw.Dll

This was dynamic link library provided by windows system. It contained number of classes to access internet explorer and its functionality. This library has two classes: one is Shell windows class, and another one is Internet explores class. The details of these two classes are discussed into the following section:

6.1.2.1. Shell windows class

Object of this class was to represents the collections of open windows that belong to Shell method. The association with this object can control and execute commands within Shell and obtains other Shell related objects.

6.1.2.2. Internet explorer class

Object of this class control was to remote instance of Microsoft internet explorers through automation. Here in our implementation, Internet explorer and Shell windows class were used to read all URL of the open web pages on internet explores. Further, these URLs were extracted and stored into the ´array List´ and resource name were extracted from those URLs.

6.1.3. Directory info class

This class was used for creating directory to store the downloaded file from internet, if it does not exist.

6.1.4. FileInfo class

This class provided instance methods for the creation, copying, deletion, moving, and opening of files. Further, it aided in the creation of File Stream objects. We used 'GetFiles ()' method for getting all files, which were stored in the Download directory and added into FileInfo object array.

6.1.5. DateTime class:

This class was used for the extraction of date and time of the file and stored it into the database. This class has some properties. In implementation creation time properties was used, where we get creation time of the file and we store it in to the Datetime object. If a date property is used, then downloaded date of the file can be extracted. If a time property is used, then downloaded time of the file can be extracted.

6.1.6. Connect.cs

This class was written to establish a connection with Database. It contains the "getConnection()" method. This method developed the connection with database by using "Configuration Manager" class. This configuration Manager requires connection string to exatablish connection with database. For this Configuration Manager Class gets connection string from "App.config" file. Then Configuration Manager Class gives this string to "getconnection ()" and the connection gets established with database.

6.1.6.1. OleDbConnection class

This class represents an open connection to a data source. This class checks weather the connection is establish with database or not. Using object of this class, we called the "Connect.cs" class to establish connection with database. When the connection is established, this class use "Open ()" method to open connection with database and it also close connection by using "Close () method.

6.1.6.2. OleDbCommand Class

When we established and open connection with database, we need some commands to read or execute data from the database. This class is used to execute those needed commands.

6.2. Information manager

To extract the file name, downloaded time of file, file URL, resource name of file the logic or code were written by using above mentioned classes. The information managers make association of metadata and create one AssociationXML.xml file. The WriteXML () method was used to create automatically XML file and to create association of all related files. In this method, XmlDocument class, XmlNode class, XmlNodeList class, XmlElement classes were used to write this "AssociationXML.xml" file.

The information manager creates association of the relevant files, for this the following method were used.

6.2.1. WriteXml () method

This is user defined method and it used to write xml file, which contains association of the related files. In this method, following classes were used.

6.2.2. XmlDocument class

This class represents the XML document and enables the navigation and editing of the document. This class provided number of methods & properties. In this implementation Load () method of XmlDocument Class was used for loading "AssociationXML.xml" file to navigate and create a new association in xml file.

6.2.3. XmlTextWriter class

This class provided methods and properties to write new xml file and navigate into xml file. In our implementation we used this class to write "AssociationXml.xml" file.

6.2.4. XmlNode class

This class represented a single node in the XML document. This class has some properties by using objects of this class it can reach to the node. This class checks or read existing nodes.

6.2.5. XmlNodeList class

This class represented an ordered collection of nodes. This class is used to check list of the existing nodes. It also creates new nodes if that node dose not exists in XmlNodeList class.

6.2.6. XmlElement class

This class represented Xml Element. This class provided methods and properties to create an element of xml and write into Xml file. By using this class we can create, delete elements or nodes.

6.3. Code snippet used to create “AssociationXML.xml” file

```
void WriteXML(string ResourceName, string DownFileName,string date,string time)
        {
            try
            {
                //pick whatever filename with .xml extension
                string filename = "AssociationXML.xml";

                bool flag = false;
                XmlDocument xmlDoc = new XmlDocument();
                try
                {
                    xmlDoc.Load(filename);
                }
                catch (System.IO.FileNotFoundException)
                {
                    //if file is not found, create a new xml file
                    XmlTextWriter xmlWriter = new XmlTextWriter(filename, System.Text.Encoding.UTF8);
                    xmlWriter.Formatting = Formatting.Indented;
                    xmlWriter.WriteProcessingInstruction("xml", "version='1.0' encoding='UTF-8'");
                    xmlWriter.WriteStartElement("Association");
                    xmlWriter.Close();
                    xmlDoc.Load(filename);
                }
                XmlNode root = xmlDoc.DocumentElement;
                XmlNodeList objXmlNodeList = root.ChildNodes;
                for (int Count1 = 0; Count1 < objXmlNodeList.Count; Count1++)
                {
                    if (objXmlNodeList.Item(Count1).Name.ToString().Trim() == ResourceName.Trim())
                    {
                        XmlElement objXmlEle = xmlDoc.CreateElement(DownFileName);
```

```
                    objXmlEle.SetAttribute("Date", date);
                    objXmlEle.SetAttribute("Time", time);
                    objXmlNodeList.Item(Count1).AppendChild(objXmlEle);
                    flag = true;
                    break;
                }
            }
            if (!flag)
            {
                XmlElement                objXmlEle2                =
xmlDoc.CreateElement(ResourceName);
                root.AppendChild(objXmlEle2);
                XmlElement                objXmlEle3                =
xmlDoc.CreateElement(DownFileName);
               // objXmlEle3.SetAttribute("Name", "Value");
                objXmlEle3.SetAttribute("Date", date);
                objXmlEle3.SetAttribute("Time", time);

                root.LastChild.AppendChild(objXmlEle3);
            }
            xmlDoc.Save(filename);
            if (File.Exists(@"C:\\Program Files\Download\" + filename))
            {
                File.Delete(@"C:\\Program Files\Download\" + filename);
                File.Copy(filename,  @"C:\\Program  Files\Download\"  +
filename);
            }
            else
            {
                File.Copy(filename,  @"C:\\Program  Files\Download\"  +
filename);
            }
        }
        catch (Exception ex)
        {
            // WriteError(ex.ToString());
        }
    }
```

Snippet 1: AssociationXML.xml

6.4. User Interface

In this section the details of user interface component for the user side interface can be seen. By using GUI (Graphical User Interface), user can select the desired file, which he/she wants to open with the help of Combo Box Control. When user clicks on Open button, one message box is displayed, if these files have some related files in "AssociationXML.Xml". It also displays two Buttons "Yes" & "No". When user clicks on "Yes" button, it displays one panel containing List of Related files in "RadioButtonList" Control. Then user can easily select the file name that he/she wants to open. By clicking on the "Open" button, the selected file gets displayed in a new window.

In the next part the programming details of the controller and user interface components are described.

6.4.1. Combo box controller

This controller is used to display all file names contained in the "AssociationXML.xml" file.

6.4.2. Panel controller

This panel contained message and two buttons for displaying message to the user.

6.4.3. RadioButtonList controller

This controller displayed a list of all related files. Using this controller user selects the required file, which needs to open.

6.4.4. PDF Viewer control

We implemented this controller to displays the PDF file into web page when user selects PDF file name from RadioButtonList control.

6.4.5. Image controller

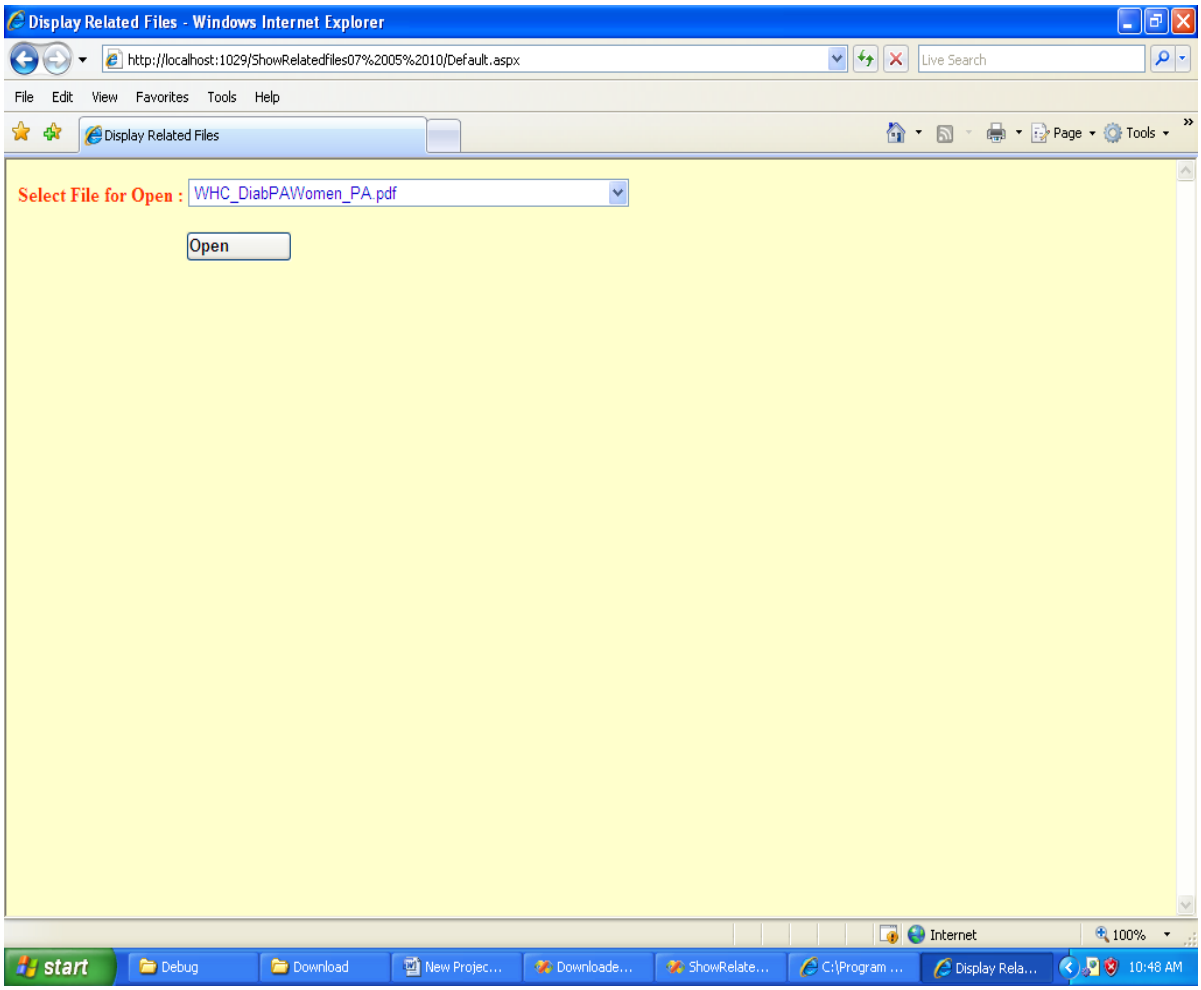
This controller displayed the image file into web page when user selects image file name from RadioButtonList control.

6.4.6. Calendar controller

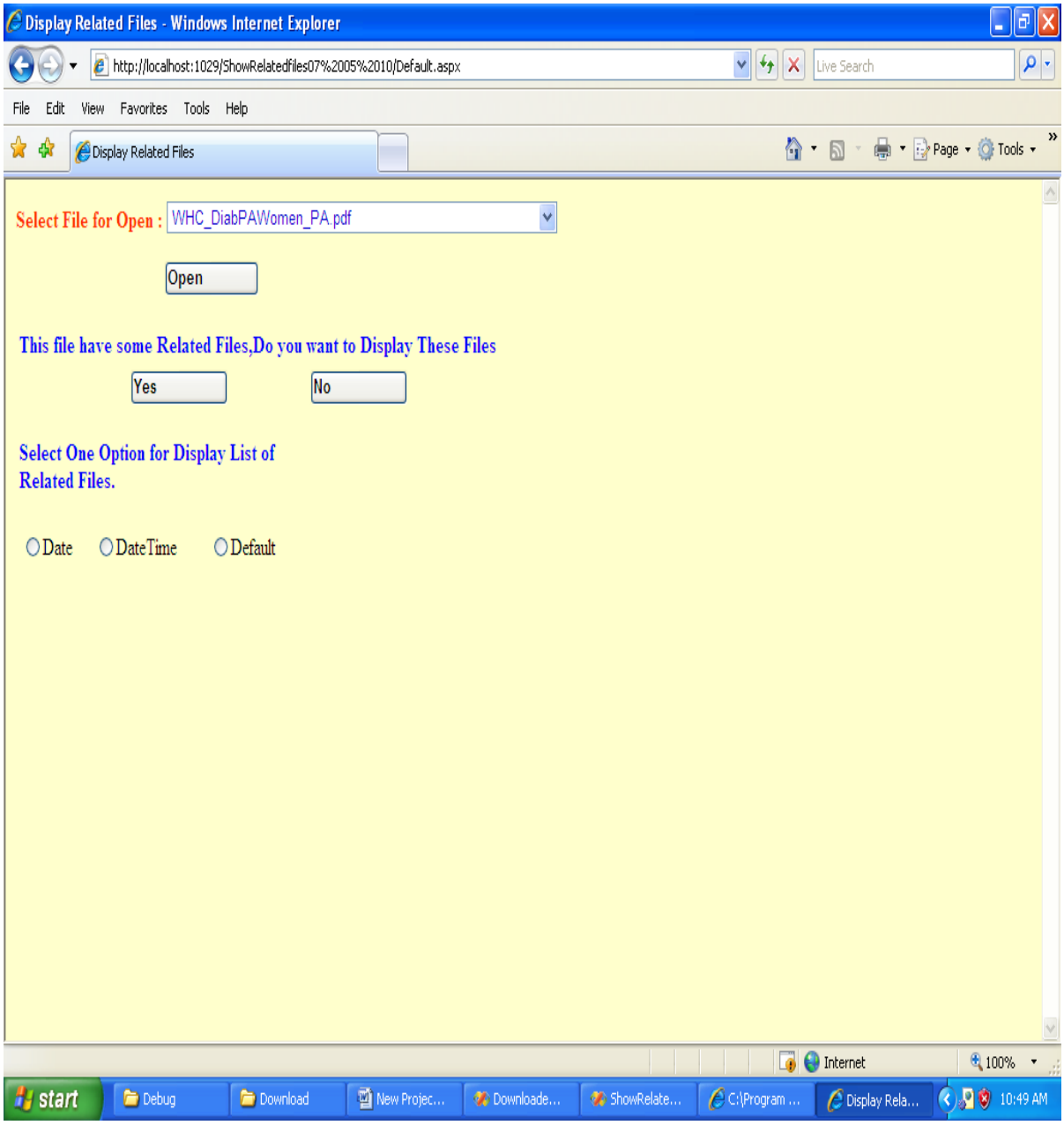
This controller is web controller. By using this controller the user could select date very easily instead of typing it.

6.5. Working of the prototype

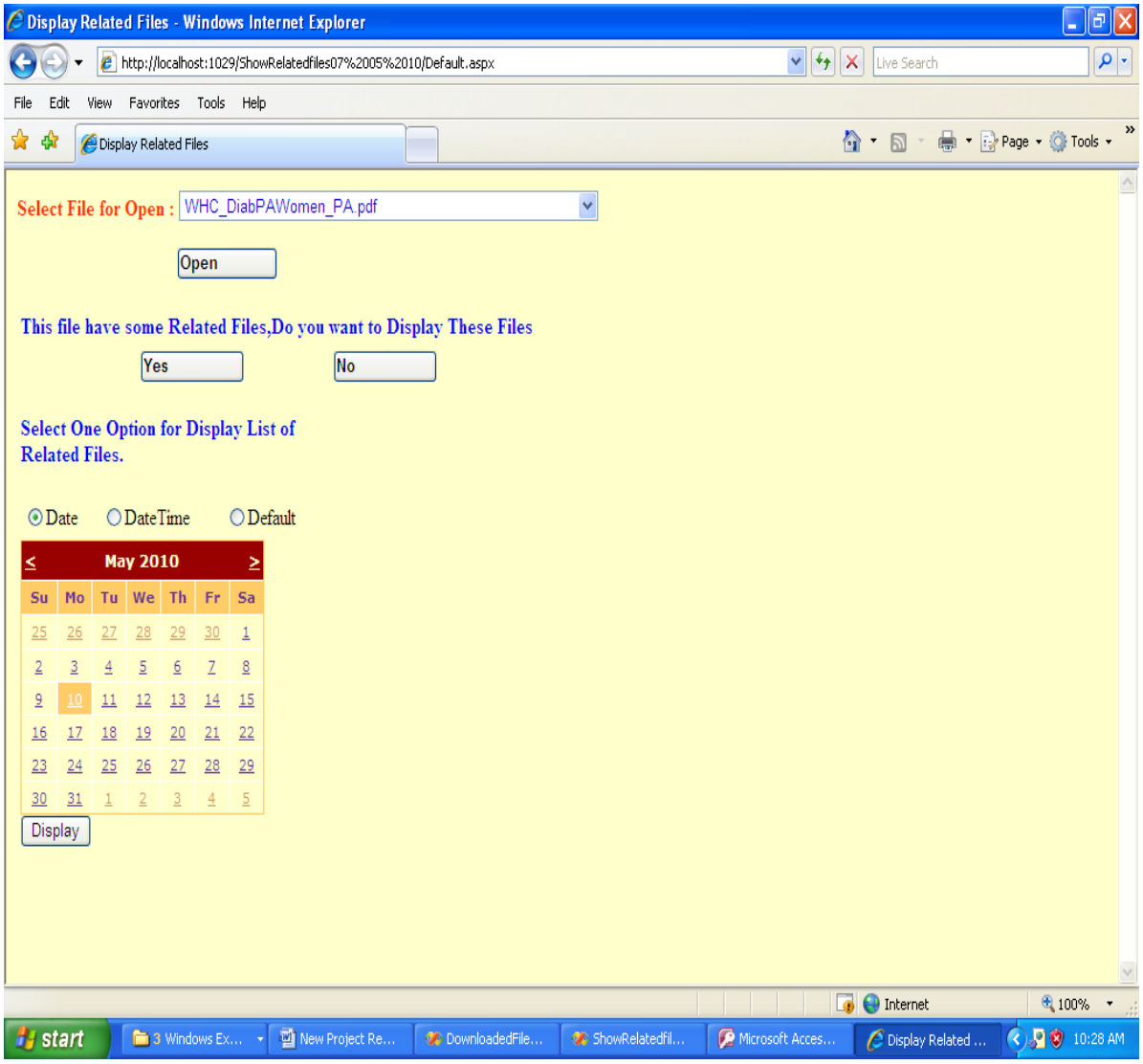
In this section the work of the prototype can be seen. The following section includes screen shots of the prototype.



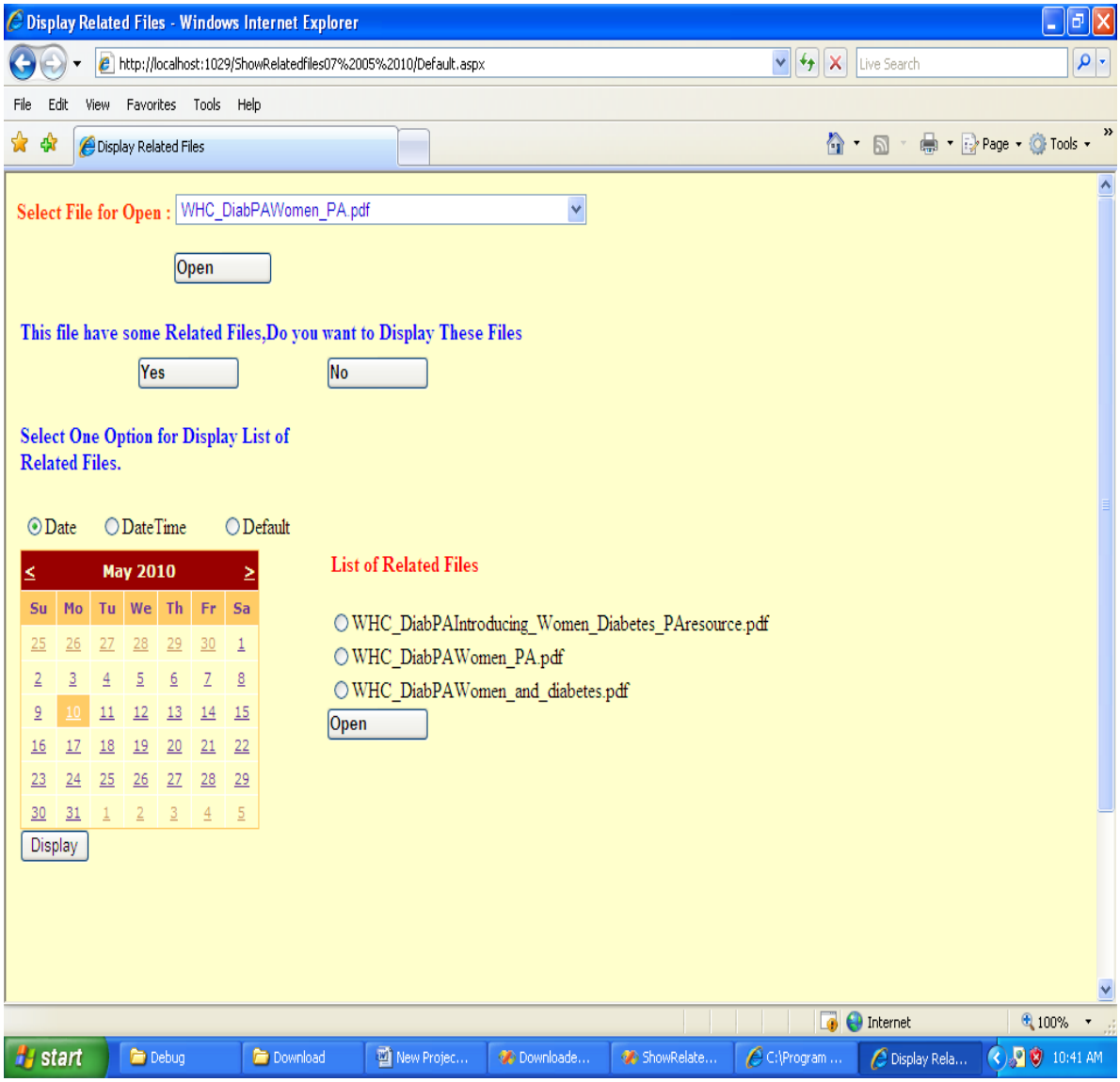
Here, we can see combo box from which user selects file to be open. By using open button user can see selected file.



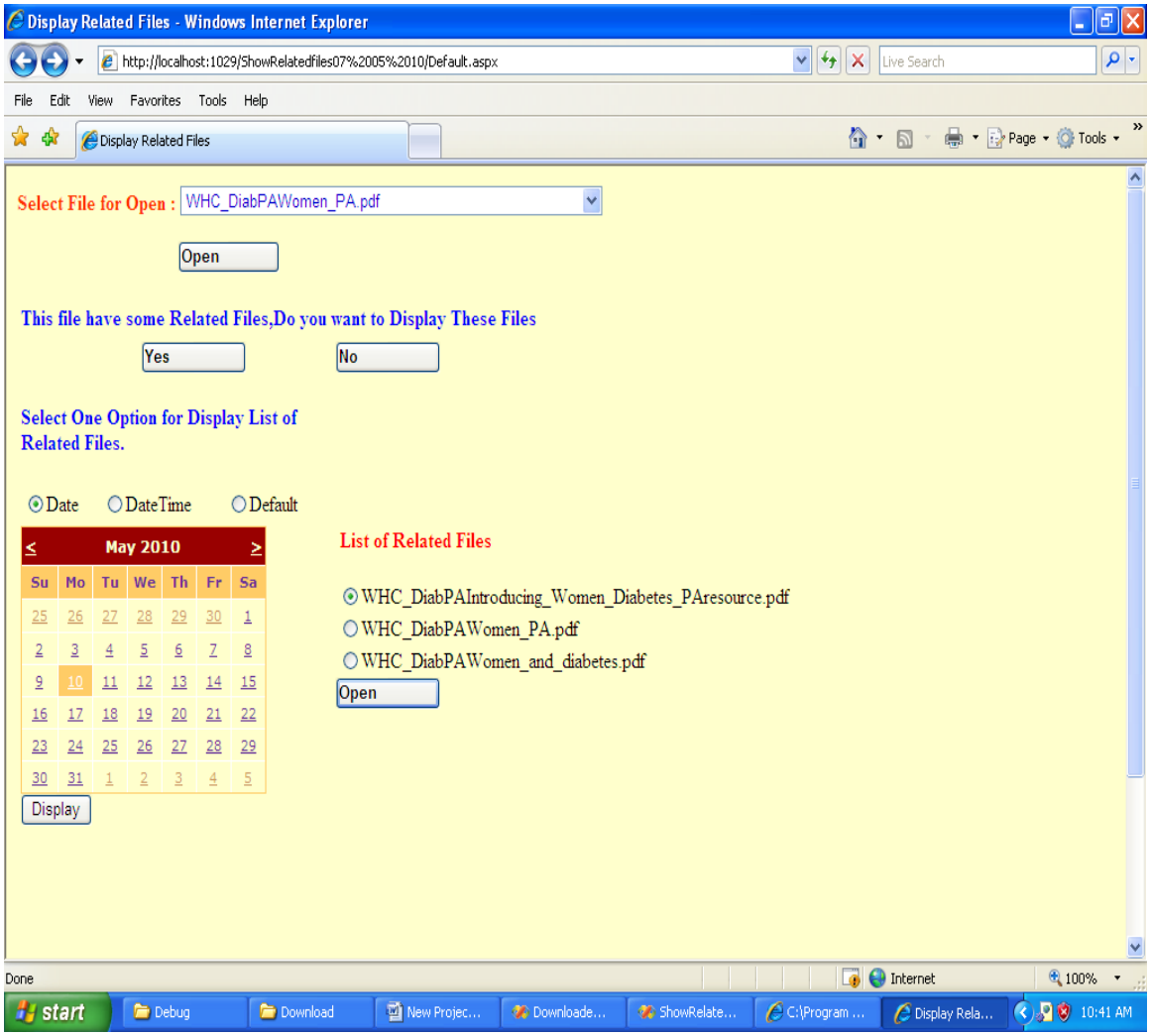
When user select file to open the prototype ask to user for related files. If user select no then prototype will not show related files. Then by clicking on open button user can see only selected file. If user choose yes button, then the prototype ask user to choose one option according to user's preference. Here, we see three options given to users, by choosing one of these option user give preference to open related file.



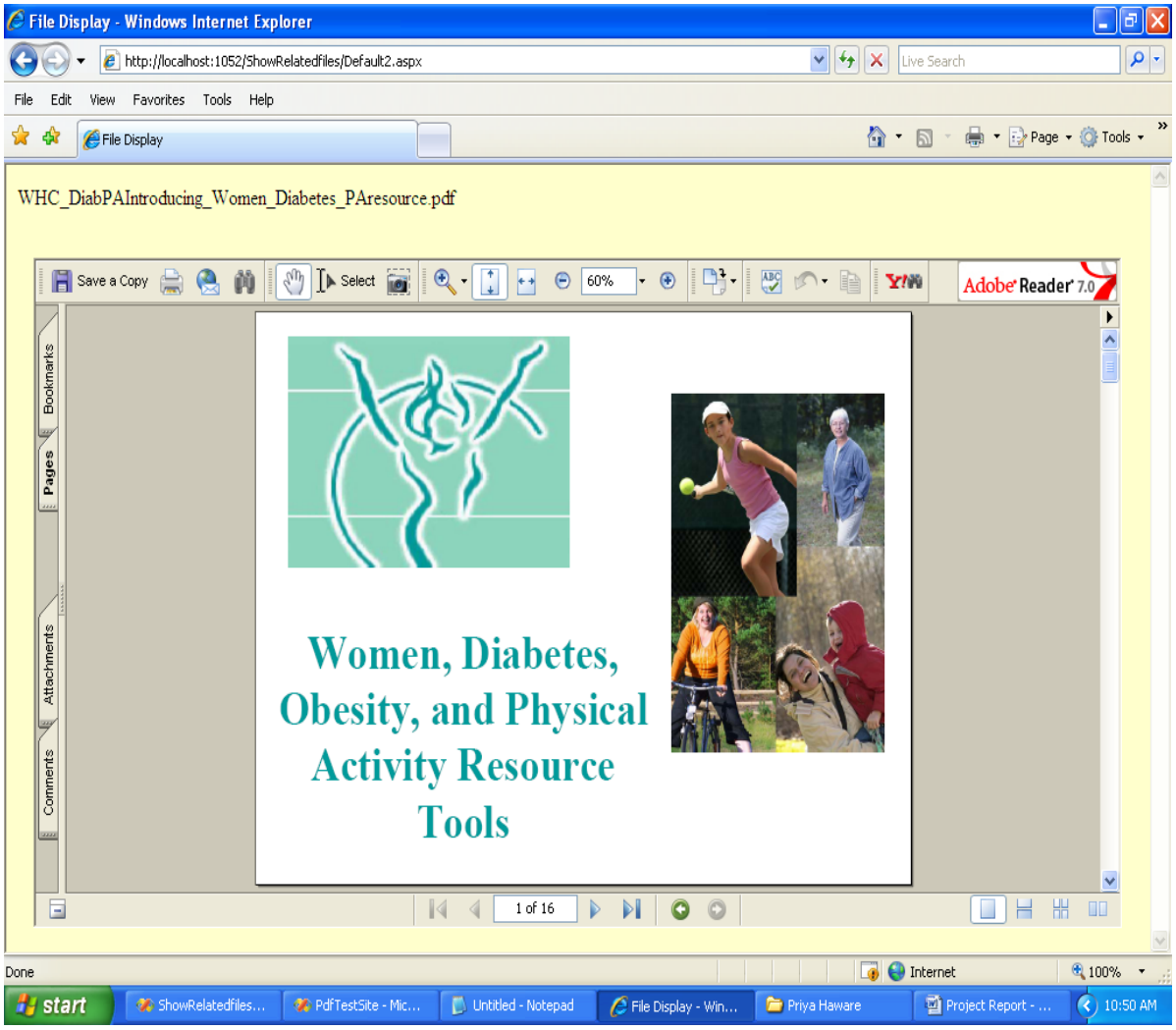
When user selects Date, the relevant/related files are display by refereeing to the Date and Resource name of that file. In this screen shot the user chooses Date option and click on display button to have look on the related files.



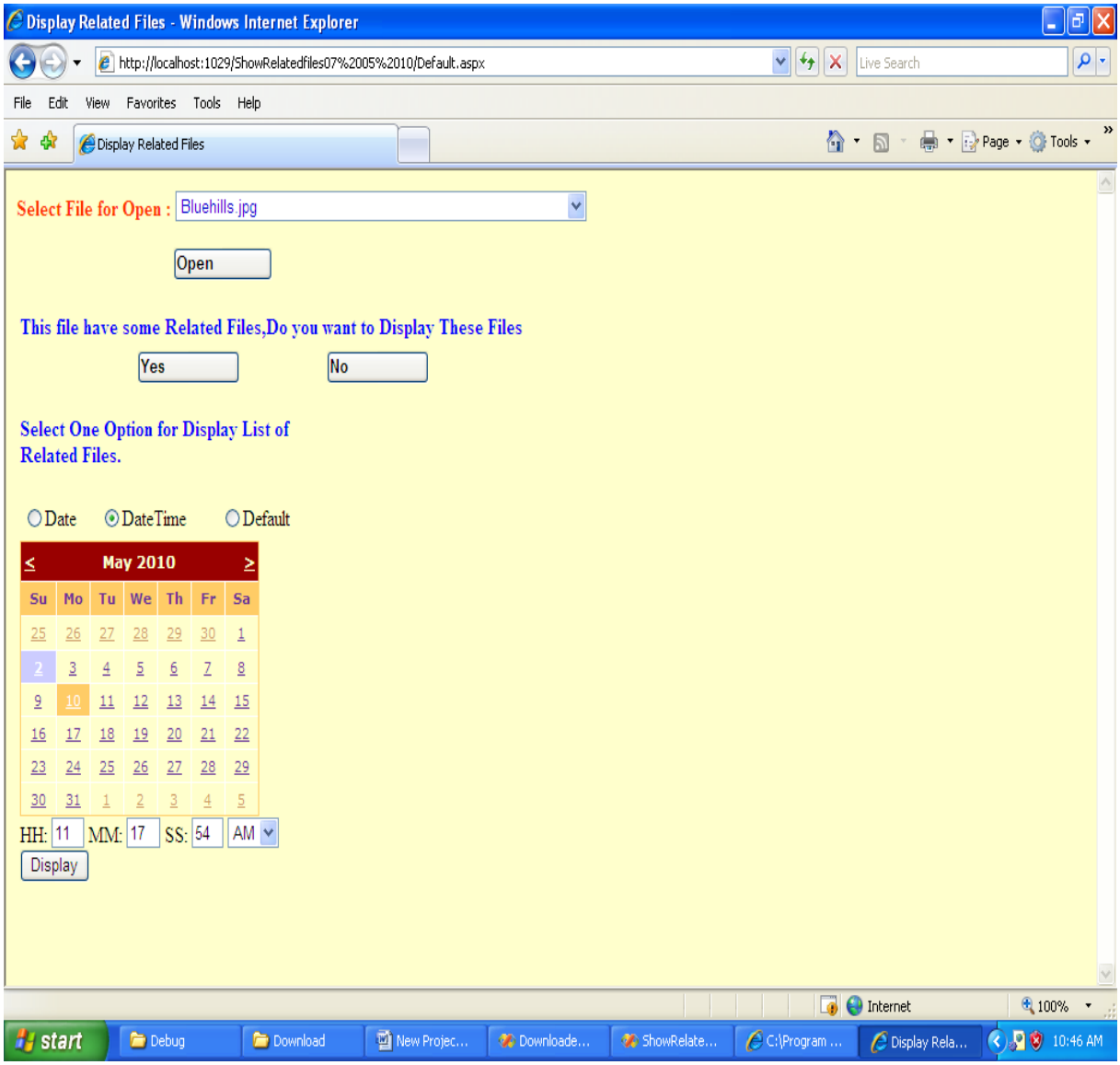
Here, we can see the prototype shows relevant files according to the user context. User choose one desire files he want to open it and clicks on open button to have look on that file.



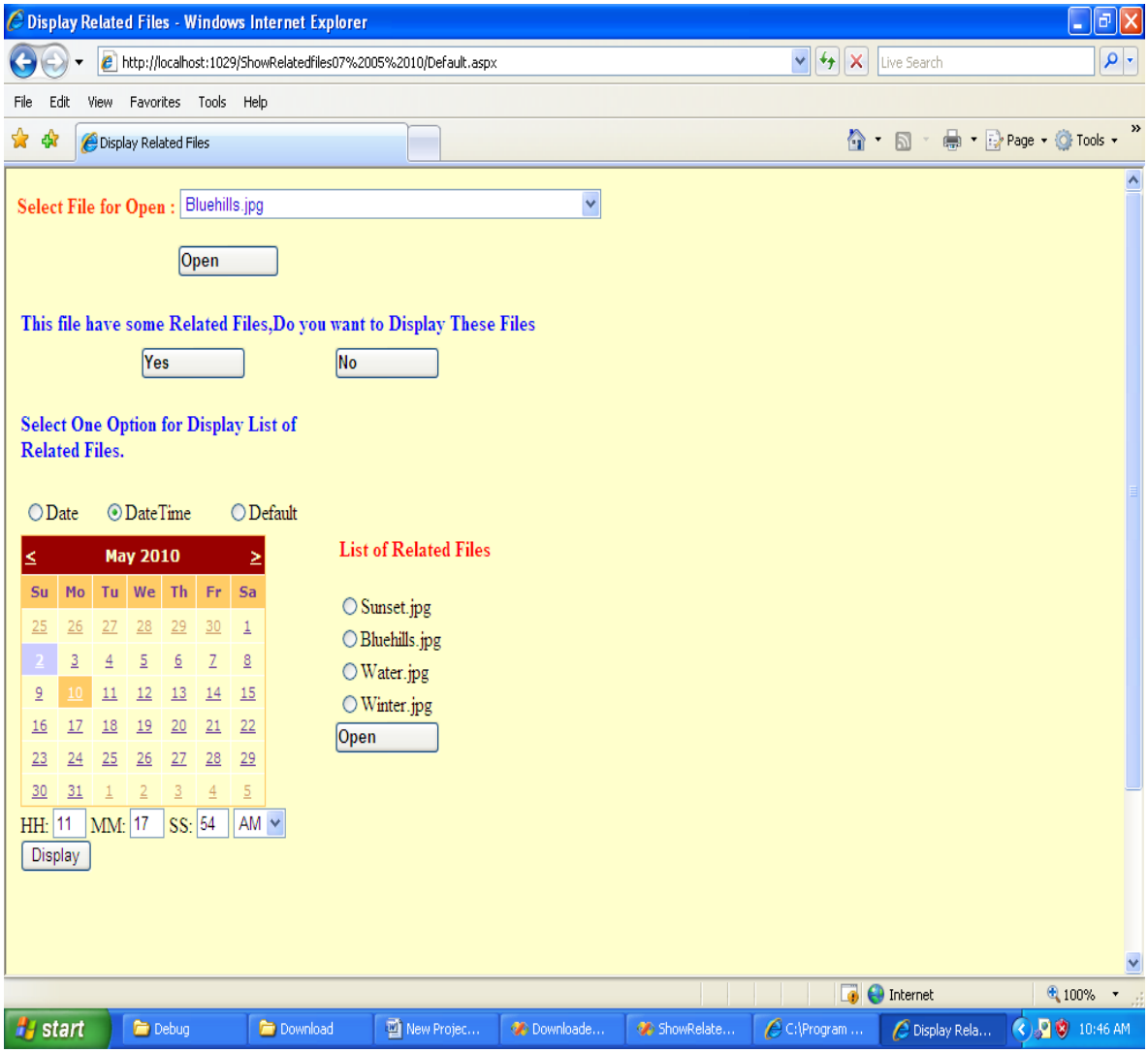
Here user selects one file to open it and click on open button.



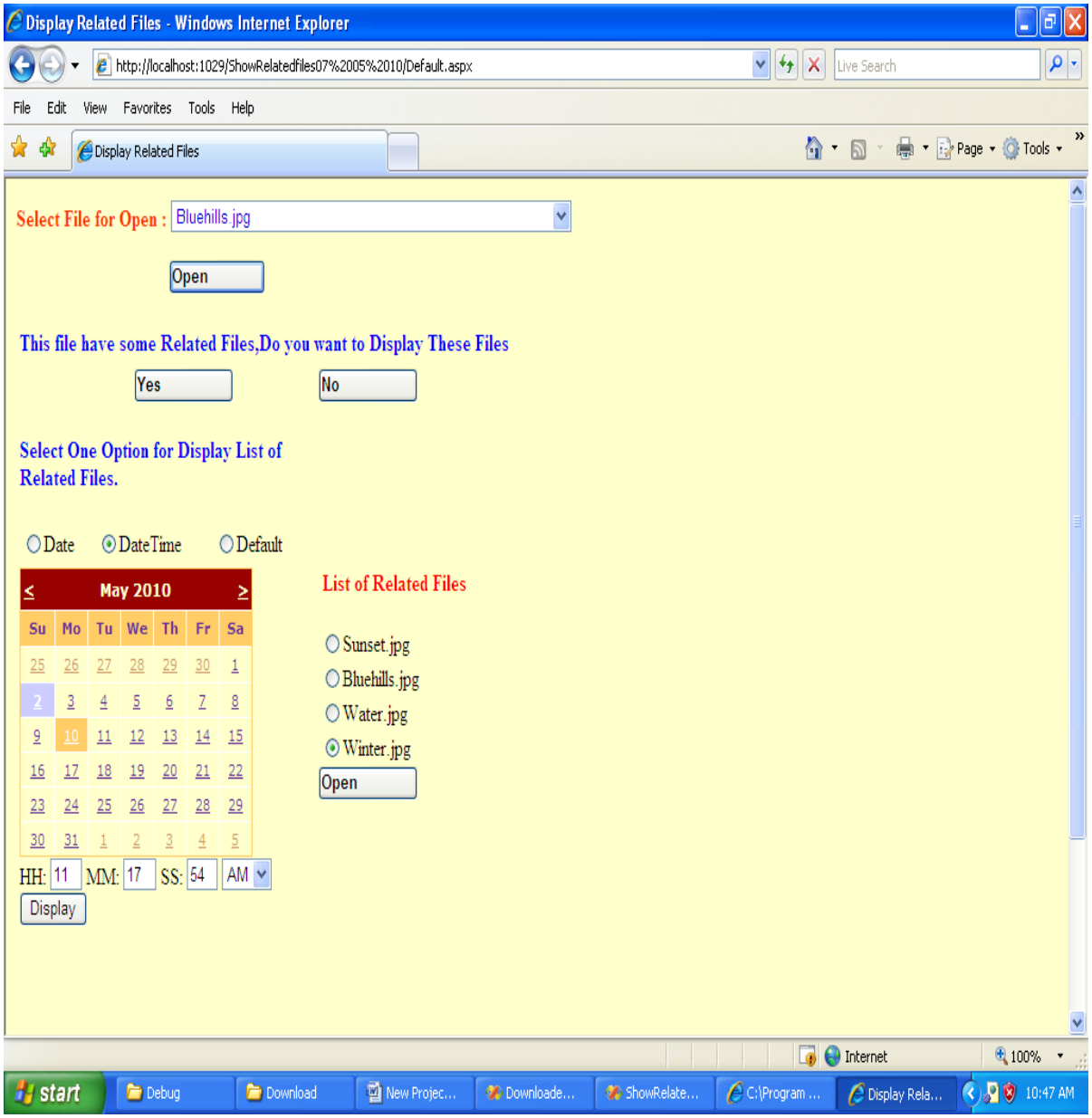
The selected file gets open for user in new window. We gave new window to open selected file to provide more convenience of the users.



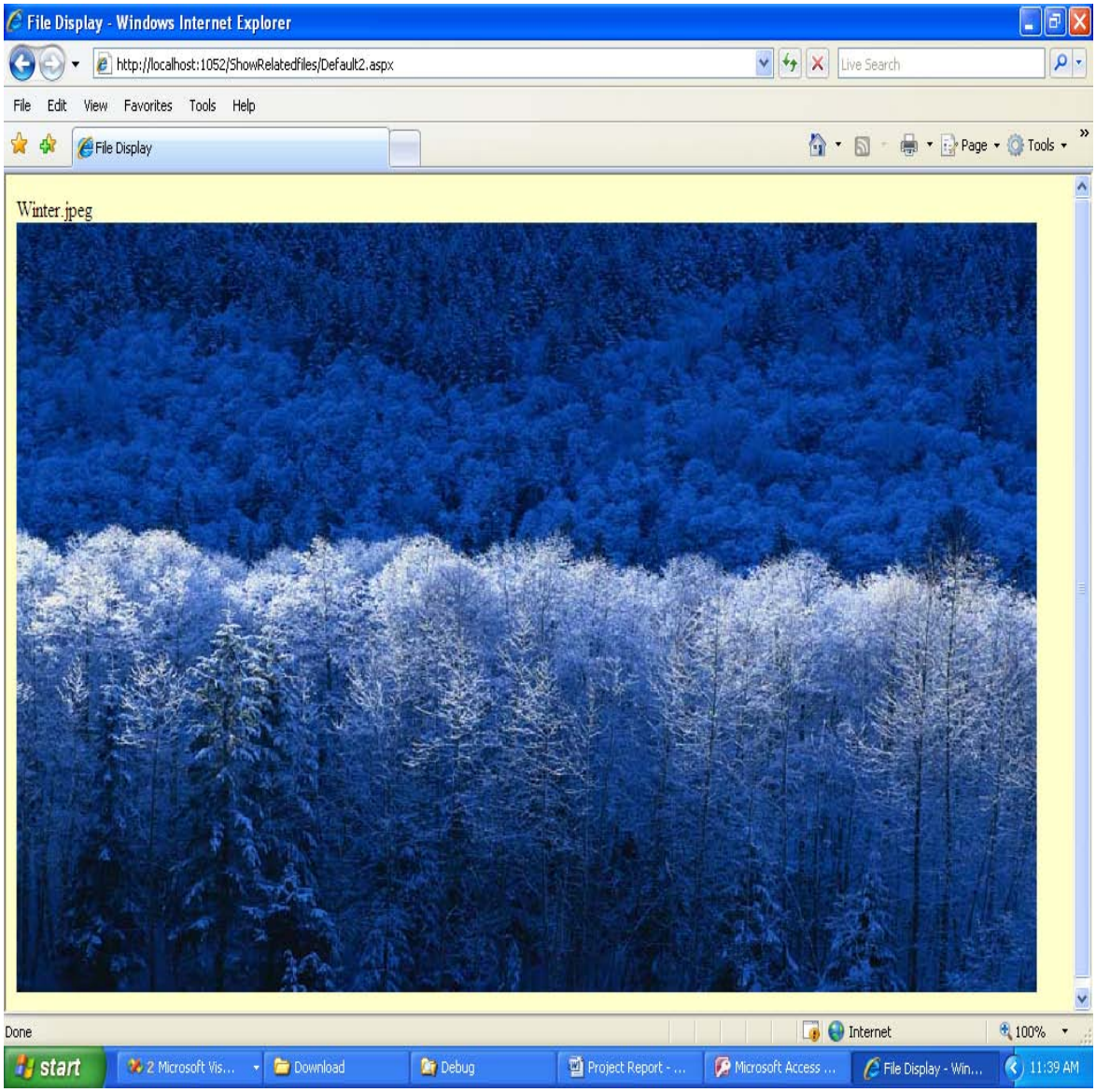
The user select date and time option, then the prototype will display related files by refrying to the date, time and resource name of chosen file. Here users do not have to specify minute and second to get related files. The prototype suggests those related files which were user downloaded at 11.00am to 12.00am.



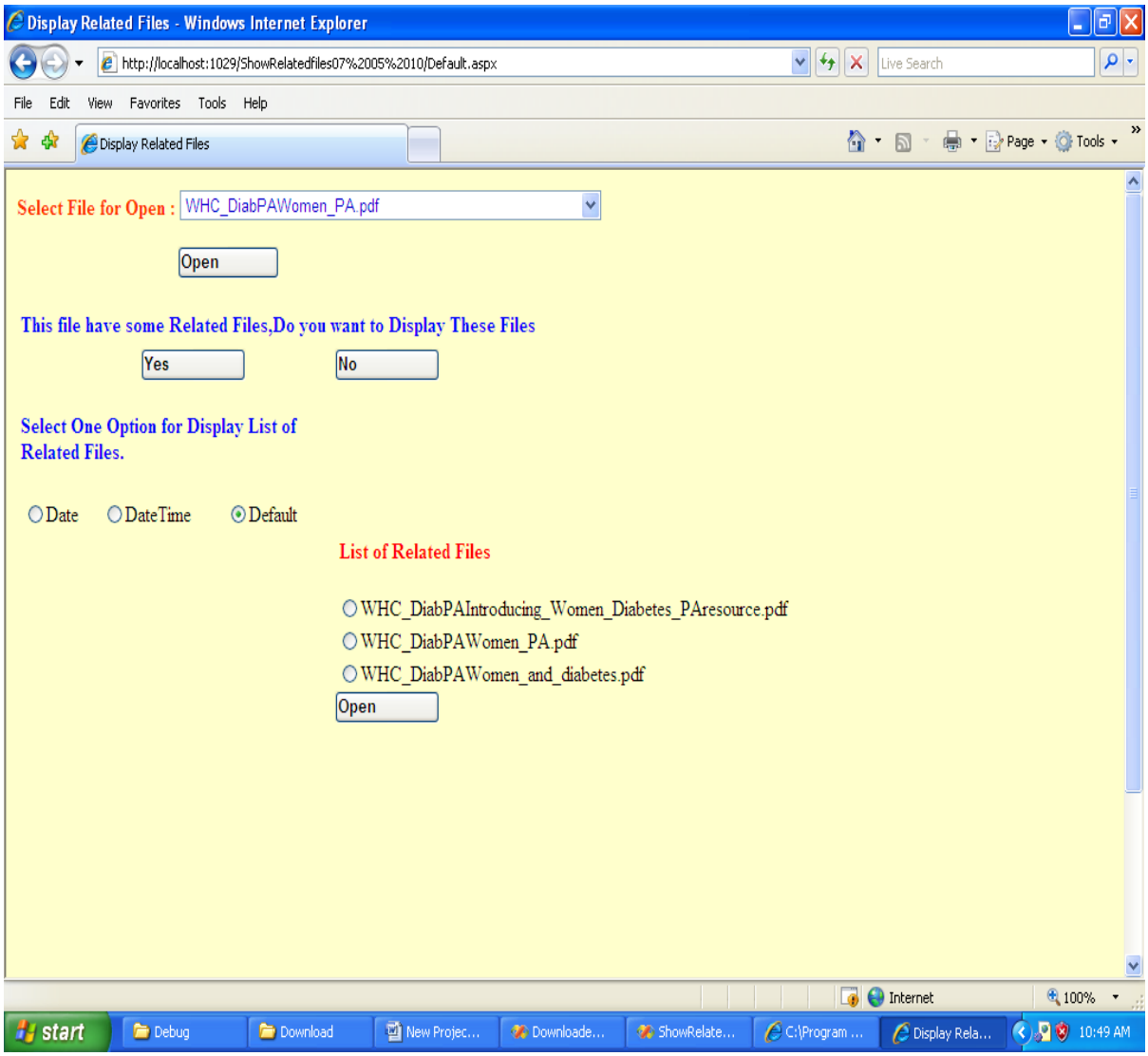
The lists of relevant files get display to the users. If user asks for date and time then the prototype shows relevant file according to the date, time and resource name.



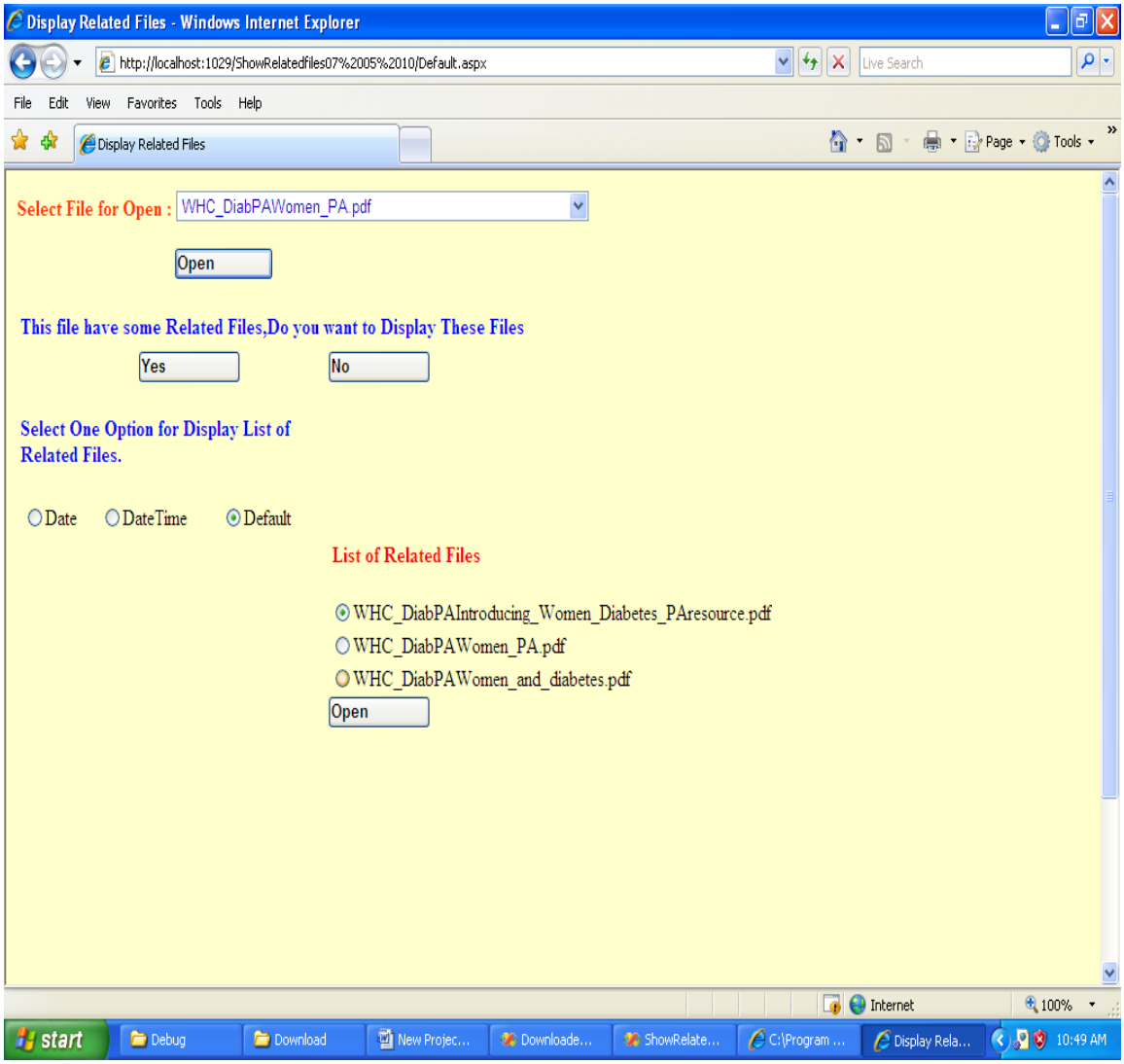
User follows the same procedure according the above; user clicks on display button and related files are displayed to users. From these suggested related file, user's selects one file to open.



The selected file get display in new window. Here, we have given the example of images.



When user selects default option, then prototype simply show relevant file according to the similar resource name of files.



User selects one of the related file and clicks on open button to open selected file. Then the selected file gets open in to the new window, same as above.

6.6. Summary

This chapter was about implementation part of the prototype. The details of what programming techniques were used for each component are discussed in this chapter. The chapter gave total information about function and classes that were used in the implementation. The screen shots describe the exact function of the prototype and how it works. After the discussion of implementation part, in the next chapter testing and evaluation part of the prototype will be seen.

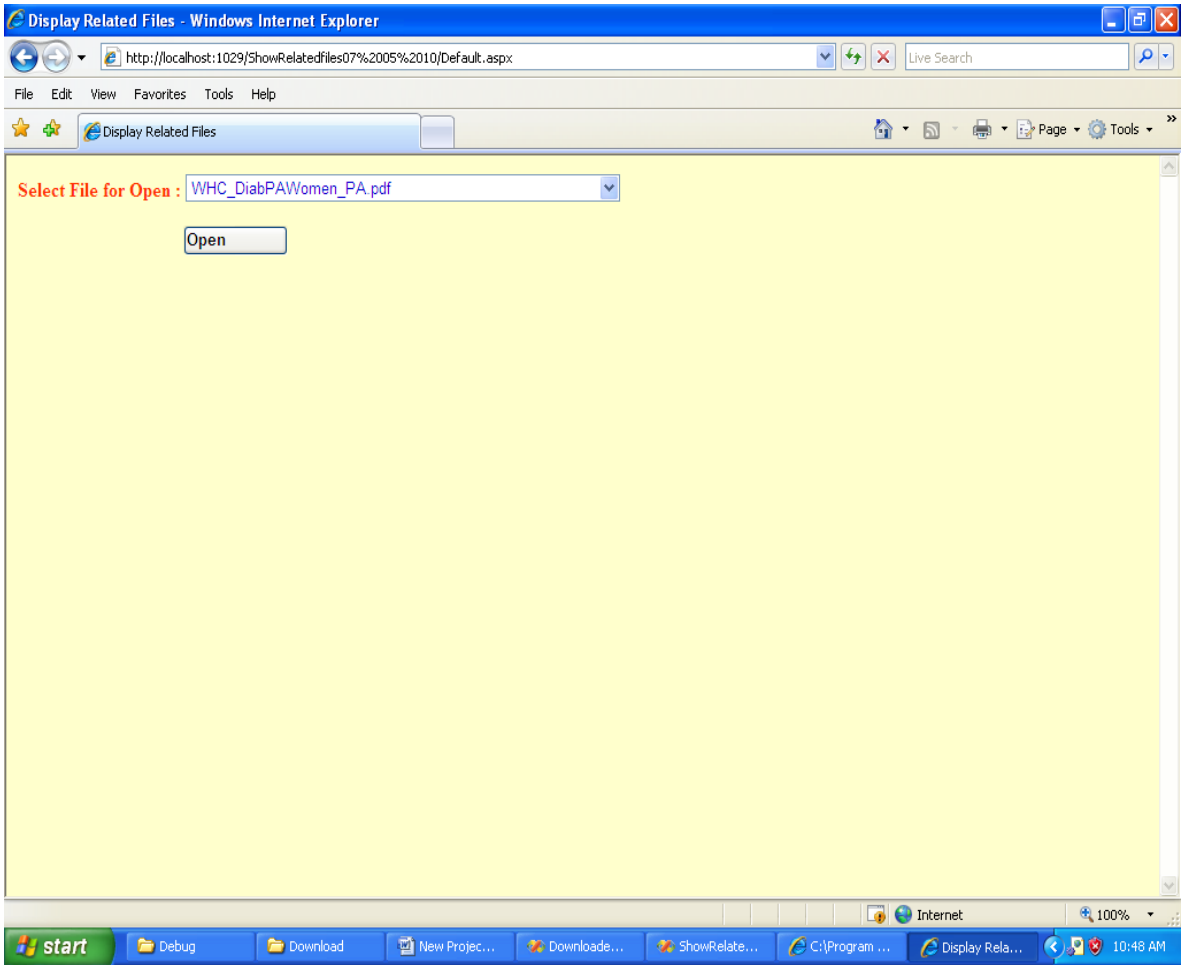
CHAPTER: 7

7. Testing and evaluation

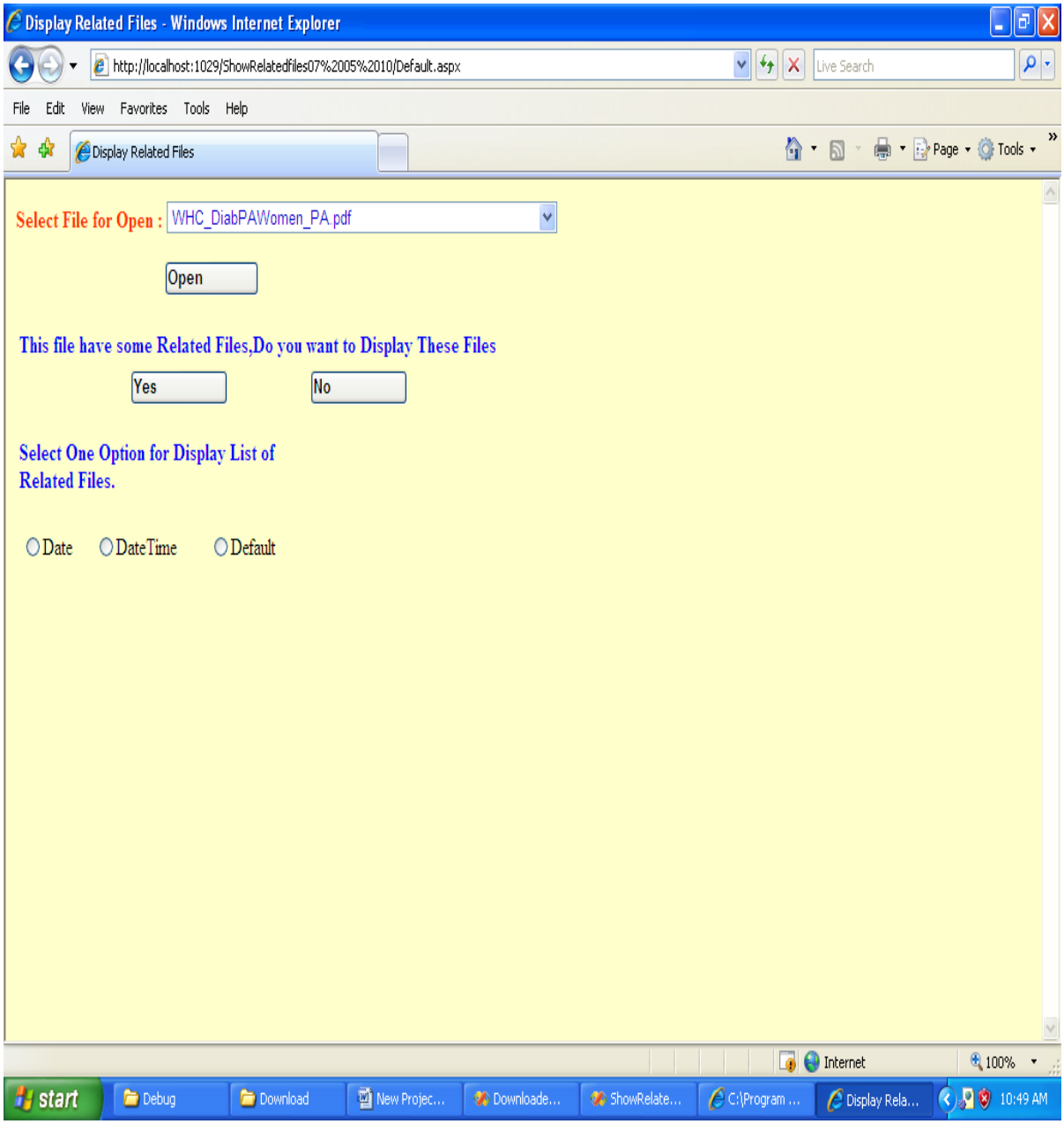
7.1. Testing

In the next sections testing on the implemented prototype are discussed. During testing it was tested whether or not the prototype provides relevant information to users. In general it was observed that the prototype was able to provide the related information to user. The implemented prototype included 30 files, among those 3 files were of diabetes, 5 were images files, 7 of chronic disease and, remaining 8 files were about sports. The testing was done with almost all the 30 downloaded files. According to the testing, it showed that the prototype was able to suggest related files of selected file. In following screen shots testing results of diabetes files can be seen.

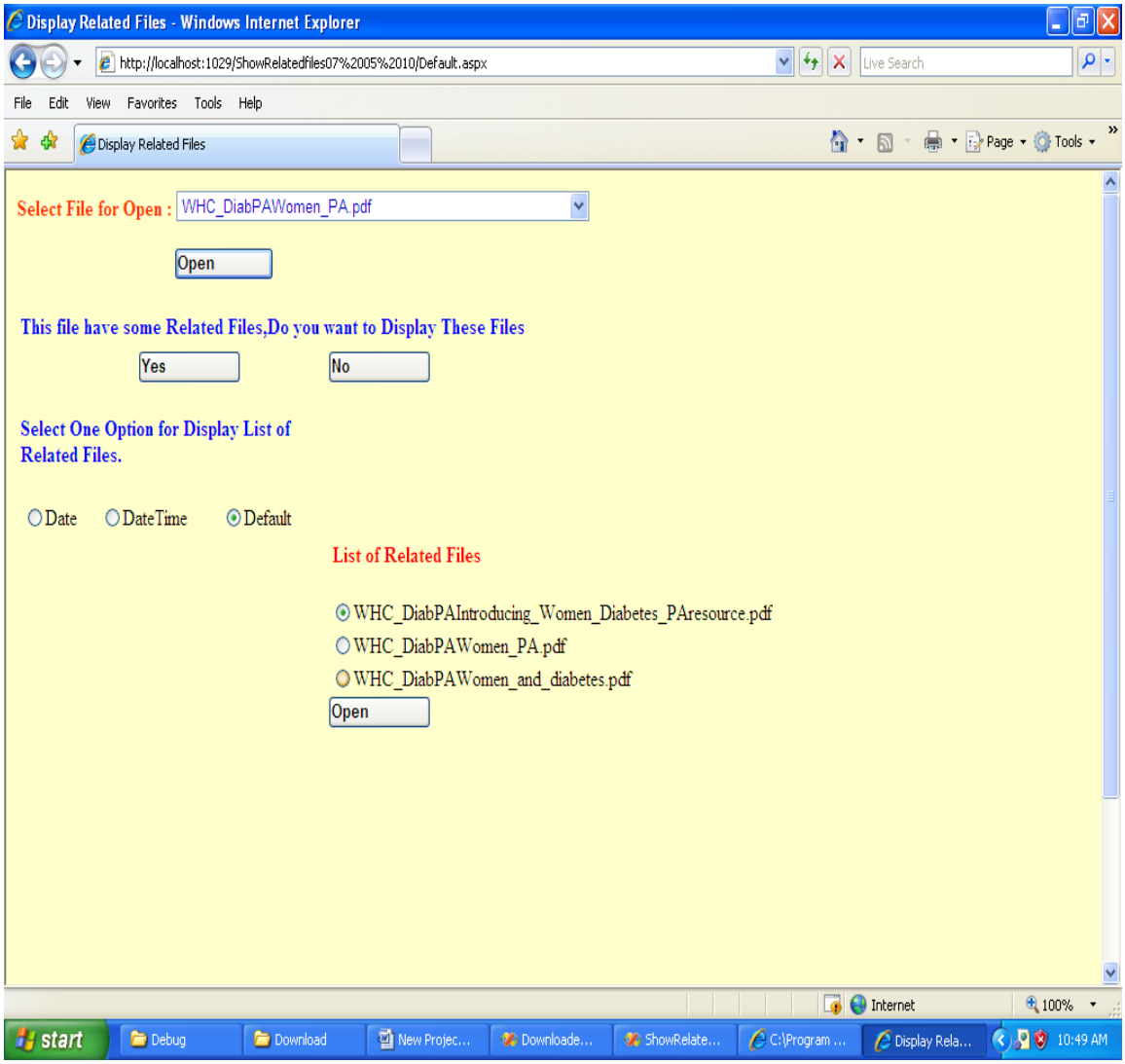
In the first screen shots the user selects one file about diabetes, by clicking on open file, user can open that file.



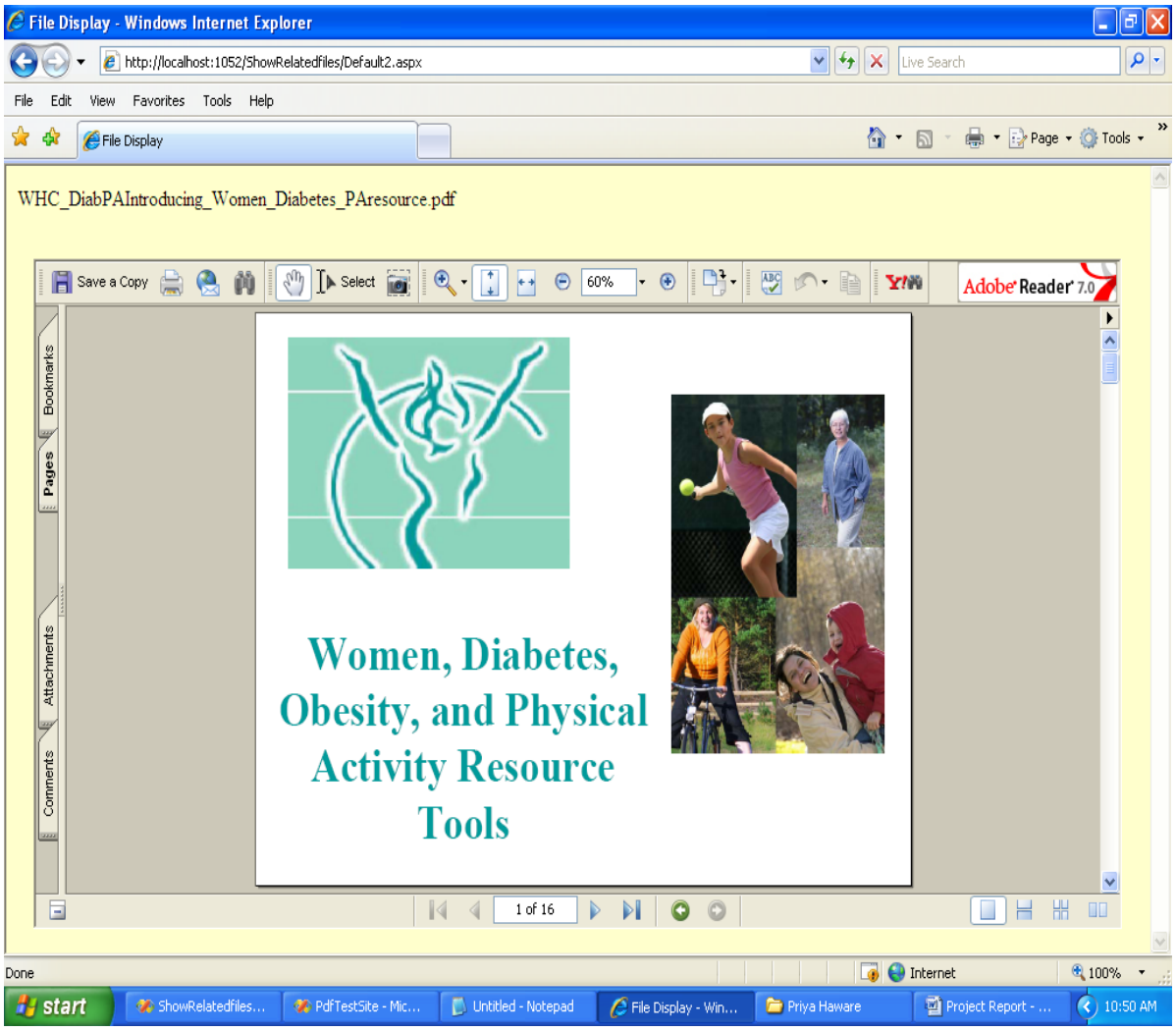
In the second screen shot the prototype asks the user if he/she wants to see the related file of WHC_diabPAwomen_PA.pdf. If the user says yes, then again the prototype asks user to select one given option.



If the user chooses time and date option then prototype suggests related files by referring to the date, time and resource name context of file. And if user selects default option then it suggests some related file by referring resource name. In the following screen shot it can be seen that the prototype suggested three files to the user. By choosing one file the user can click on open button and the chosen file gets open in new window.



In the following screen shots the selected file opens which is related to diabetes and it gives information to the users according to their need. This following file provides related information to the user.



Even though the prototype provides related files to the user, the relevancy of information depends on the user's point of view. Each user of the prototype might have different point of view for the relevancy of information. These views might be the subjective or situational [20-21] and are based on the user's current need. Human might have different intentions, emotions, dislikes, phobias, perceptions and interpretations. Third aspect is depending on the user's perspective and behaviors, which is cognitive [20-21].

The next testing updated information into the database was tested. The information manager was able to catch every new downloaded file and also checked for the existence of the downloaded file and resource in the database. If the file and resource name already existed then the information manager did not take the new file into consideration and did not use that file to make association. This helps to avoid the redundancy of the data.

The functionality of the prototype was tested. When the user selects one file to open, the prototype provides suggestions for the related files. The prototype has some different options for the users, such as choosing option date, time and default option. When the user selects date and time option to get the related files, the prototype provides related files to the users according to selected date and time. If the user selects default option the prototype provides related files to the users according to the resource name of the file. This functionality allows user to get related files according to their choice or need.

The developed prototype also needs to have user friendly interface. Also one of the issues was about the prototypes functionality for search technique, its usefulness and easy use. It would have been possible to test the user friendliness of the prototype and get inputs from users on this implementation. This could be done by providing the user with of questionnaire. With the help of such questionnaire, the likeness and usefulness of the developed prototype could be known. But due to limited time period the developed prototype was never tested with the users.

For the system to run successfully the system should be very fast. If the system is too slow then the users might change their interest. So, the system should respond very fast to avoid this problem. When the testing was done the developed prototype responded very quickly and this must be one of the reasonable service provided by prototype and will be useful to the users. While testing this prototype there were around 30 files and associated information to these files in to the database. But if there are more than 30 files then the prototype may or may not take longer time. The developed prototype contains very small amount of data in database, so comparing the prototype speed with other existing systems speeds was not the right approach. Therefore the prototype speed was not tested with other existing systems.

7.2. Evaluation

In our prototype implementation we have used time, date and resources name context of the information. Thought these contexts are related with each other but the content of the file may not be similar according to the user need. So the related information provided by the prototype may not satisfy the user need.

To avoid this problem more contexts or different parameters can be used in this prototype. One the parameter could be the keyword context. The keywords from the textual documents can be used to provide related information to user. For example if the file content is related to the diabetes, then by using diabetes as the keywords the prototype can find out that, this information is about diabetes. By using this approach it is possible to provide more relevant files to the users, which may satisfy the users need.

From the above testing it was seen, that the developed prototype provided the related information to the users. It always checks for the time, date, and resource name to make association between related information. But it was seen that it did not relate two different resource information for e.g. if the user has two resources, one is glucose meter and another one can be step counter, the information within these two resource is related with each other. But our prototype does not relate one resource information with other resource information. By improving these limitations the performance of the prototype can be enhanced.

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7.3. Advantages of the our prototype

The issue discussed earlier regarding the management of information can be solved with the help of our developed prototype. In this section, the advantages of the prototype in the management of information based on the context awareness are discussed. The advantages are as follows:

- Our prototype provides an automatic search technique for searching the related information, it does not use the keyword based search. As a result, user does not need to know the specific keyword for searching the desired information.
- The prototype always avoids duplication of files, and therefore overload of information and redundancy can be avoided
- The prototype always stores updated files and their association in the database. Thus, it helps users to access the updated information. .
- The users always have choice to choose or deny the relevant files either by accepting or denying the suggested relevant files.
- The prototype can be useful in case of an emergency situation to get the relevant information about the particular patient.
- This developed prototype provides the right information at the right time based on the information context.

7.4. Summary

This chapter describes the testing and evaluation of the prototype. The main testing was whether the prototype provides related information to the users or not. Based on testing it was proved that the prototype provides related files to the users. The next testing was about to test if prototype takes updated files or not and how it avoids the redundancy of files. The information manager always checks new downloaded files and avoids overload of information by avoiding redundancy of files by using xml file.

The speed of the prototype was fast when it had 30 files in to its database, the file quantity was not so sufficient to compare with other existing systems. It was seen that the prototype provided different types of useful functionality to the users, than other existing systems.

Along with these advantages the developed prototype has some drawbacks. The prototype was not able to associate downloaded files from different resources, which need to be improved. The prototype used only time, date, and location of file context. There are more contexts which could have been used while developing the prototype in order to improve the performance of the prototype.

CHAPTER: 8

8. Conclusions and future work

8.1. Conclusions

The implemented prototype has shown that using the context of information is useful to provide the relevant information to the users. We used context of the information to achieve our goal. The information is stored by the users on their system, that stored information has metadata. Some metadata of the information describes context of the information, such as time, date, location, name of file, author of that file and so on. We used metadata that describes context of the information. The contexts that were used here are: time, date and resource name and by using these context the relevant information is provided to the users.

While designing the prototype we implemented four components, such as metadata extractor, information manager, controller and user interface. Each of these components has different functions. The metadata extractor was used for extraction of the metadata of the downloaded file by the users. The information manager was used for association of metadata. The controller was used to fetch related files from database to the users, and the last user interface component was used to interact with our developed prototype and display related files to the users.

The prototype was tested to see whether it provides related files to the user or not, also the testing was done with the response time of the prototype. The prototype can store updated information into the database was also tested.

We can also conclude that the approach of adding a context to the search might be applied for the search of other domains than the health information. The information on the database could be replaced by other information, which defines the person's interests or context. Subsequently, this information can be used to retrieve the related results, in which person might be interesting on their daily searches.

8.2. Future work

8.2.1. Making association of different resource information

As it was seen that the prototype was not able make association of different resource information. In the future making association of different resource information can be one task of our implementation. Because the information from different resources may be related with each other, and the prototype also need to consider that related information even thought it was stored from different resource.

8.2.2. Testing prototype with large amount of data, and providing backup for stored information

The prototype was not tested with the very large amount of the data in the database, so it is difficult to say about the prototypes reaction time, speed requirements for handling the large amount of information. Testing of prototype with huge amount of data will be the one task to do in the near future. Beside this important future works, providing backup in order to avoid the loss of this valuable information would one of the important future work.

8.2.3. Using semantic web technology approach

Different strategies or different approach can be used in this prototype development, such as semantic web technology. In semantic web the meaning of the data can understood, read, and find by people and computer also. The performance of the context aware system is depends on its interpretation of the provided knowledge; if it can interpret the exact knowledge the system will give better performance. In contrast, if system interprets the wrong meaning of a

given data, it will become complicated for the users. Perhaps semantic approach and different context could be used while developing the information management systems for the health related information.

8.2.4. Adding more functionalities

The implemented prototype was about the personal health related information management. The personal health information management system is not just about providing the relevant information to the user but it's more than that. If the users of this prototype are patients who always want to keep control on the information by them. Then they may want to share this information with their relatives or with clinicians for their quality care. So in future, it is necessary to provide an authorization to select the people with whom participants wanted to share their information.

By adding some of these functionality the personal information management system can provide more usefulness in to the patient daily life.

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Appendix

CD-ROM

All source code can be found on the included CD-ROM.

Thank you!