Literature Synthesis:

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ABSTRACT

The interface of an Expert system determines the level of usability of the system. A user interface which is consistent and easy to use will lead to an improved user experience and task performance [5]. This paper discusses the various approaches used to interact with Expert systems and issues found to exist when taking into consideration human limitations such as low literacy or motor skill disabilities. The discussed interface is that of a medical expert system that helps advice patients or physicians about Diabetes. The purpose of this paper is to find an effective approach to a user interface that'll take into consideration human limitations using methods which are scientifically proven to assist in human-computer interaction. A general overview of expert systems is discussed to aid in understanding how the interface corresponds with the other modules of expert systems architecture.

Keywords: Expert System, Diabetes Advisor, Medical Advisor System, Human-interaction Design

1. INTRODUCTION

Expert systems require an exhaustive knowledge base and a functional user-friendly human computer interaction interface in order to be effective [7], the latter however, is often not given enough attention [7, 8]. In this paper, information visualisation on a web based graphical user interface and speech-based input is proposed in order to avoid simplified texted-based interfaces for Expert systems which have been found to be deficient [7]. Many factors such as the thinking process of an individual influence the design of a user interface [5]. An expert system should cater for different human mental models as one individual may feel the system is effective and another may feel otherwise. Explanations should be clear and concise whilst maintaining a usable interface. Problems encountered in expert system user interfaces are due to designing the interface using user requirements rather than user's thinking process as well as HCI lacking in some of the most widely used development methodologies such as the Agile method [8]. An interface for a Diabetes Advisor Expert system in particular will be the focus of this paper as it has to cater for patients that may be illiterate mentally or functionally.

2. EXPERT SYSTEMS

Expert systems are a branch of artificial intelligence and thus use domain specific knowledge in order to explain, resolve and conclude a problem from the defined domain [2, 9]. Expert systems gather knowledge from human experts and attempt to use the acquired knowledge to solve real world problems relating to the human experts

domain [2]. Expert systems use the stored knowledge to make a decision and use rationing of an expert to give a specialized response.

There are four features that classify a program as an expert system: proficiency level is that of an expert, uses an inference mechanism to reach a conclusion, the knowledge in the knowledge based is capture from the expertise of a human, storing of data in a database acquired from the knowledge of an expert in a specific domain.

3. ARCHITECTURE OF EXPERT SYSTEM

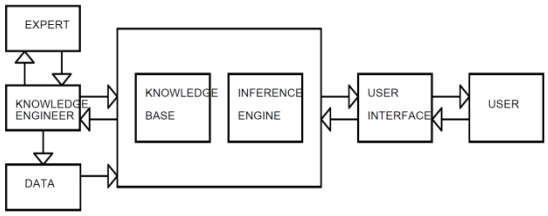

Figure 1- Basic structure of a knowledge based expert system [9]

The main modules of an expert system are [2]:

- **Knowledge base**
  Permanently stores the system's knowledge that has been gathered from an expert in a respective domain [2]. The knowledge is represented in the form of production rules [7] and facts which are organized in a way that facilitates inference [2]. In the case of a diabetes advisor expert system, the knowledge base can be divided into two parts [11]:
  - Static knowledge base
    Consists of rules that do not change when the system is modified.
  - Dynamic database
    Holds data which is created during run time relating to specific patient cases being tackled by the system at the time. The data is then removed once the system is done executing [11].

  An example of a rule that guides dosage combination:
  IF (patient is on regimen 4)
  AND (regimen long acting insulin is great)
  THEN (the dosage is of unusual proportions for the day)

  The format of the rules is in the following form: IF <conditions> AND <conditions> THEN <action list> ELSE <action list>

- **User Interface**
  Facilitates bi-directional communication between a user and the expert system [9]. It consists of questions in the form of text or speech [7]. Imagery and visual aids may also be used to communicate with the user. Input is provided by the user for each question the system presents and then the system outputs the appropriate dialog in response to the user's input.

- **Working memory**
  Can also be referred to as a dynamic database, due to its function in temporarily storing data and facts during program execution [12].

- **Inference Engine**
  Its responsible for the reasoning of an expert system as it uses the knowledge currently stored in the system to solve a problem by selecting rules to be applied using forward or backward chaining [7].

4. USER INTERFACE

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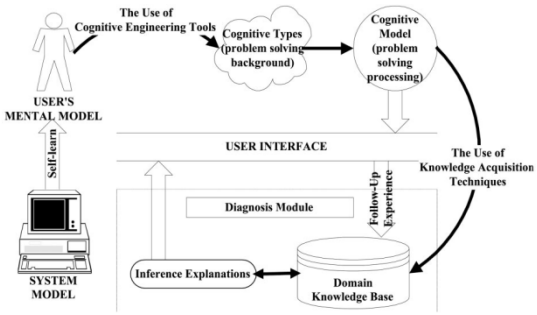

Figure 2 - Expert system interface developed model

The user interface collects facts entered by a user and saves the collected data into the fact base [12]. Furthermore, the interface can be used by knowledge engineers to gather knowledge which is required through a knowledge acquisition interface [12]. Two types of interface will be discussed: Web-based graphical user interface and speech-based user interface.

4.1 Web based graphical user interface

The web-based interface graphically represents the explanations of the process at hand and conclusions reached using output produced by the expert system in text form or visual graphics [12].

When designing an interface, the general issue that needs to be addressed is how to effectively establish a natural dialog between the user and the artificial intelligence, while at the same time, computationally efficient [7]. Furthermore, when the expert system is web-based, the response time becomes a critical factor in maintaining a natural and consistent dialog [9]. To achieve desirable performance from a web based expert system, a minimalistic yet useful interface is required to cut down on bandwidth setbacks whilst providing information using lightweight design principles. A good interface or dialog also assist in the decision making process about tasks and task performance [9].

There are various technologies that are used to manage dialog based on context, and in this paper the following technologies will be discussed: Natural Language Processing, context-based reasoning and dialog system design [7].

a. Natural Language Processing (NLP)
   In developing countries, especially in rural areas, literacy levels are low. NLP facilitates Human computer interactions (HCI) using the users' native language [7]. This allows for either a text-based interface for users who may be computer literate or speech-based interface for users who are not computer literate.
b. Context-based reasoning (CxBR)
   Context-based reasoning can be used to further enhance Natural Language Processing by providing resolution of semantic ambiguity through contextualisation techniques [7]. This technology however introduces issues ranging from speech recognition errors and limited dialogs between the users and the artificial intelligence [7]. Context can constrain a domain without being involved in that particular domain explicitly [13]. The main idea for context based reasoning is to allow for the adapting of solutions used to solve previous problems and use them to solve new problems [14].
c. Dialog system design
   Dialog system design can be used to further enhance Natural Language Processing by providing conversational dialogs which are more natural and dynamic [7].

The use of effective dialog design can improve the user interface of an expert system to a certain extent; however it does not cater for users who severe human limitations such as deafness or being mute. Some deaf people do not understand any form of native text-based languages and rely entirely on sign language as a form of communication. Thus, the use of metaphors should also be incorporated to the user interface on a medical expert system.

Metaphorical reasoning is another factor which is usually overlooked when dealing with user interfaces. Users of a system are more likely to make sense of something they're not familiar with by making comparison with what they know about something similar [9]. This gives rise to an opportunity to design an interface which is entirely based on imagery and visual aids to enable users to interact with the expert system using their intuition and metaphorical reasoning.

Finding a balance between dialog and visual interactivity can result in a user interface that can adapt to the user's preference by making explicit assumptions about the user and responding differently where necessarily [9].

4.2 Speech-based Interface

A speech-based interface is an interface layer that uses speech as input rather than text or interactivity with visual objects [7]. This interface would allow for a more natural conversation with the artificial intelligence without the delay of typing out a response or performing an action in order to receive output from the expert system. The technologies used for dialog design are more significant when dealing with speech based interaction.

5. INTERFACES in MEDICAL EXPERT SYSTEM

In medical expert systems, the interface is tasked with giving advice, making therapy recommendations and performing diagnosis using the given input by a physician or patient [4]. To facilitate these tasks, the interface should be easy to use by the appropriate people as well as easy to learn to use by the same people [10].

An interface that is easy to use does not mean that it should be limited in functionality which may introduce complexities if implemented. For example, a patient simply wishing to receive medical advice from the expert system may prefer a minimalistic and simple interface whereas an inexperienced physician will need access to a certain amount of expert knowledge in a more detail manner [10]. The interface should meet the balance between simple and complex design.

6. SUMMARY

The user interface is a significant component of an Expert system. The system may contain all the knowledge required in its specific domain but if the interface is deficient, the knowledge of the system is not well represented. Most expert systems utilize a text based user interface which is not appropriate for users who are illiterate or suffer from motor disabilities.

7. CONCLUSION

This paper discusses the importance of user interfaces in expert systems. Interface designers have overlook significant aspects of user interface designs due to the development methodologies they use [7]. Users are not involved enough in the process of development and thus some vital factors such as the mental models of individuals as well as the individuals' mental capacity.

Furthermore, the user interface should be designed paying careful attention to minimalism and simplicity whilst using visual imagery and visual aids to spark metaphorical reasoning in users as well as intuitive responses to the system. The discussed approaches include using speech-based interfaces or web-based graphical user interfaces both integrating technologies such as Natural language processing, diagnosis system design and context-based or case-based reasoning in order to achieve a natural dialog between the user and the expert system [7].

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