An Expert System for Early Warning to Husky 307 Air Operated Diaphragm Pump

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Abstract

Expert systems have been recognized as a powerful toolkit to assist the non-expert user in finding the root and solve the related problem within a short time. With the help from visual appearances in the expert system, all necessary information will be more understandable to user. The combination between expert system with visual from the artificial intelligence branch will definitely serve more application. Although the application of an expert system is only based on information stored in the computer program, the effectiveness on information transferred is capable to imitate the on-line system which is quicker in notifying fault information to user. In this project, the development of an expert system is to develop an early warning system for a related pump problem using graphical user interface. The type of pump used in this project is Acetal Husky 307 Air Operated Diaphragm Pump. Thus this system will able to give an early warning for any disturbances or damage in the pump with complete pictures of all necessary parts needed to be change. In fact, the technical cause of problem will be viewed as to show why it is happening. In overall, the benefit of developing this expert system is for easy to detect and solve the Acetal Husky 307 Air Operated Diaphragm Pump problem. The expert system can assist the lecture to explain students how to maintain a pump. Other expert system can be developed in the same way to other problem.

Keyword: Pump, expert system, graphical user interface

Introduction

David W. Rolston in his book "Principles of Artificial Intelligence and Expert Systems Development" defines an expert system as follows: 'An expert system is a computer application that solves complicated problems that would otherwise require extensive human expertise [1]. To do so, it simulates the human reasoning process by applying specific knowledge and inferences'. Expert system are used to perform a variety of extremely complicated tasks that in the past could be performed by only a limited number of highly trained human experts. Through the application of artificial intelligence techniques, expert system captures the basics of knowledge that allows a human to act as an expert system when dealing with complicated problems. Another important feature of an expert system is that it has the facility to explain or justify the methods it used to provide the information. The above definition clearly identified what an expert system does. The element of an expert system is how the information or knowledge base is gathered, kept and manipulated so that the system could perform its function and to assist the user with the knowledge the expert system has. Expert system can be developed to monitor the quality of the oil on line [2], to monitor the operation of the fluid power system [3] or to monitor the fault analysis of the fluid power system [4]. This paper shows the development of an expert system of the Husky 307 Air Operated Diaphragm pump. This expert system is intended to assist the user to let know the existed fault, cause and solution

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of the fault of the pump. It is hoped that the expert system can be used to be a condition monitoring system.

The process of developing the expert system

The expert system is developed with the help of the manual book of the pump [5] and gathered to be an expert system using graphical user interface (GUI). The design of GUI using Visual Basic can be studied through books [6] and [7], [8], [9], [10]. Figure 1 shows the process of designing an expert system using GUI. The previous data of the expert system using flex prolog 4400 will be modified to be GUI. In this expert system, the scope of specification is only based on the Husky 307 Air Operated Diaphragm pump manual. All data from the pump manual are transferred into the expert system using Visual Basic software. The replacement parts are also drawn using AutoCAD in 3 Dimensional drawing. After all necessary data needed to construct the expert system such as all the parts drawing and pump technical data is gathered, it is all combined into the visual basic software to create the expert system. In the end, an execution file is compiled and the results are the Acetal Husky 307 Air Operated Diaphragm Pump expert system.

The major components of GUIs are windows, icons and hotspots. Brief descriptions of each are as follows:

- *Windows* - A windows is an area of the computer screen that behaves as if it was an independent terminal. It may contain text, graphics, motion pictures or other windows. It can also overlap each other and are associated with devices such as scrollers, which allow the user to move the content of a window.
- *Icons* – An icon is a small picture that represents a window, which is currently not shown (closed). However, the user knows what the window is. When working with GUI, the user can see many icons on the screen. Clicking on an icon activates the related window, expanding it to full size. Windows are temporarily shrunk to an icon when the user does not want to follow a particular thread of dialog.
- *Hot spots* – These are object on a window that contain additional information. When a point cursor “touches” a hot spot, a text, a picture or other presentations are activated.

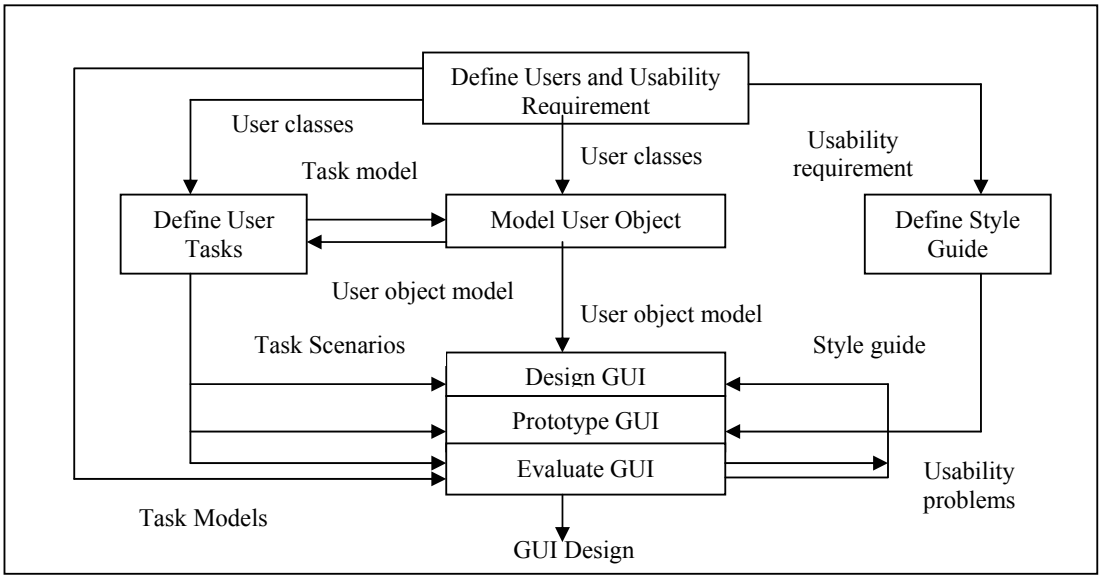

Figure 1: Overview of GUI Design Process

The expert system considers the target type of the user for example beginner; intermediate and expert (figure 2).

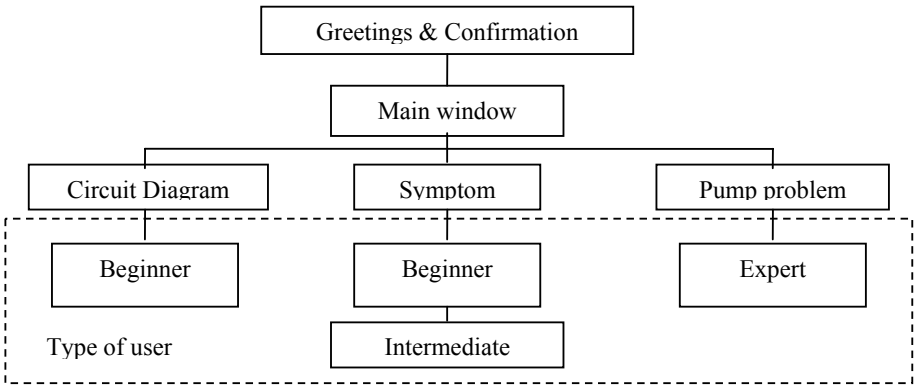

Figure 2: Target type of user

With this target, the expert system is designed as follows:

Circuit's diagram - Data inserted in this option is mainly about introducing user that does not familiar with the system. Under this option, user can see several basic data as a step to know the pump. For an example, the data includes the type of installation used in the system, the circuit's diagram, all the assembly drawing for the pump and many more.

Symptom option - Data inserted in this option is design to target the beginners and intermediate user. In this option also, it is filled with related graph and technical data so that the

user who select this option will know the cause and problem the pump facing. This option will also show user the remedies including pictures of separated parts for any problem.

Pump problem - Design to fulfill the pump expert needs. This option will only give a straight answer of any problem selected and known by user. Although it will not give any explanation of why any of related problems happen, it is recommended for user that is already familiar with the system and just using the system to revise the pump knowledge.

In the expert system, the following are included:

I. Knowledge-based for Air Operated Diaphragm Pump troubleshooting

II. Control mechanism or inference engine to control the program hierarchy

III. Graphical User Interface design

IV. Complete details on every parts and components for remedies

V. Able to display the specific corrective parts picture based on their related pump problem

VI. Separate option on one single menu for many target type of use

The structure of the expert system is shown in Figure 3.

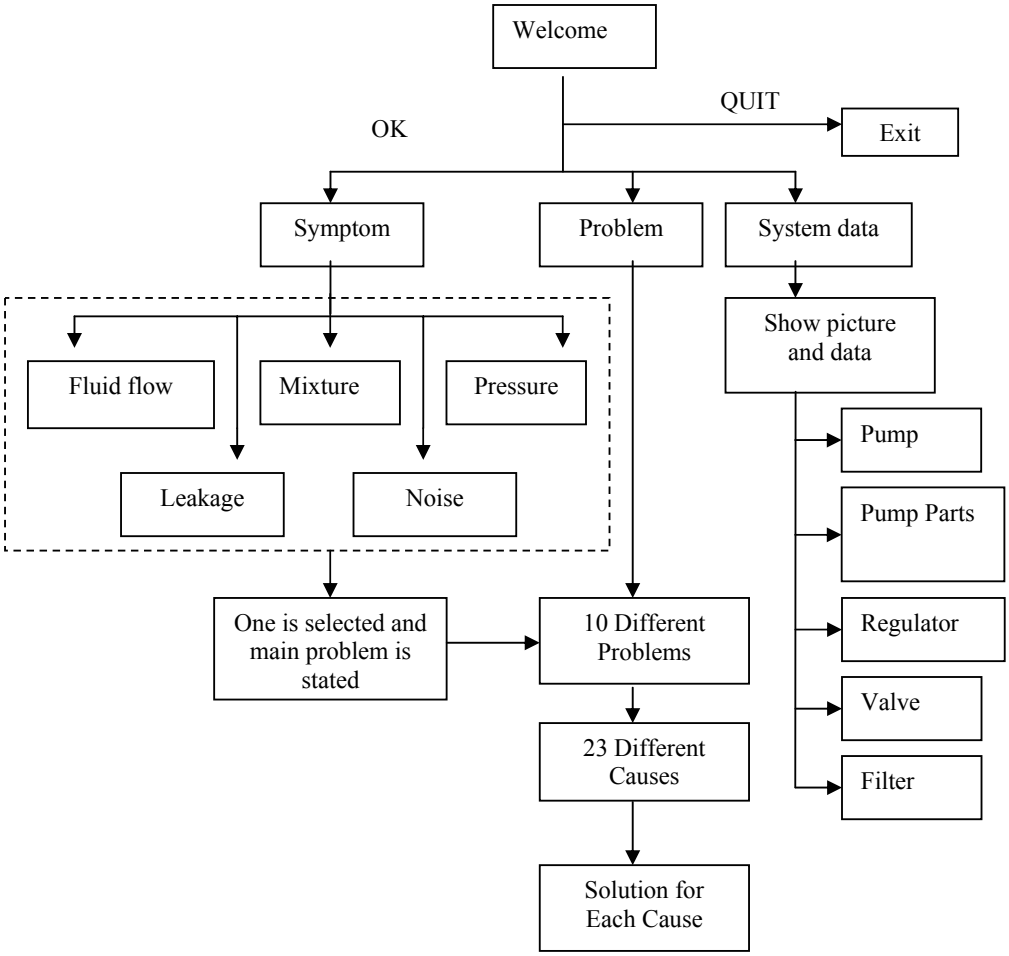

Figure 3: Expert system structure

The main window is marked with dashed box with each of selection given. The parameter of symptom includes fluid flow, leakage, mixture, noise and pressure. There are 10 problems, 23 different causes and its solutions. The expert system is designed based on the parameter of the pump and covers the drawing of the pump, component of the pump, valve and strainer.

Examples of developing the expert system on fluid flow option

Fluid flow option is constructed for any problem related to pump with fluid flow symptom. The symptom is basically seen or after inspecting the pump condition manually or based on the specification data of pump. Figure 4 is Graph Pump Air Consumption and Air Pressure at a Specific Fluid Delivery and Discharge Head which defines the structure of system related to the fluid flow option.

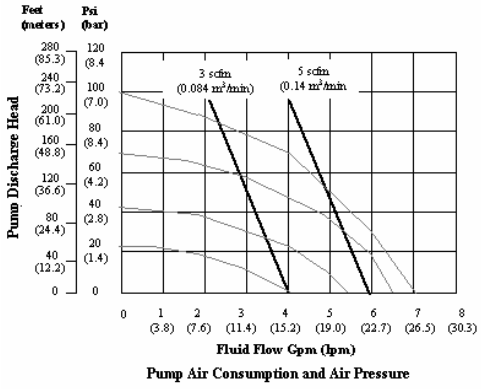

Figure 4: Pump Air Consumption and Air Pressure

Figure 5 shows the structure of system related to the fluid flow option. The main window is marked with dashed box with each of selection given. After inserted the current pump condition in this window, the value will be applied to the graph above and inform user whether the value inserted is ok to the system or not. If the condition is not good, the system will gives an early warning to user that there is a problem with the pump current condition. In the end, all the cause and possible solution is stated to user in attention to solve the problem immediately. The structure of the fluid power (figure 5) is translated to the window of fluid flow option (figure 6). For example the design condition of the pump is not fulfilled. Referring to figure 4 and figure 5, with the current condition, if the Discharge Head Pressure (scfm) is not suitable with the fluid flow (Lpm), this expert system will notify user that there is fault in the system. As we can see from the main fluid flow window, there is 7.6gpm, 11.4 gpm and 15.2 gpm taken as an option from the pump air consumption, air pressure graph, and the value of 3 scfm and 5 scfm as their air consumption values. These values are taken for determining the pump current condition. The cause of the fault condition of the pump can be traced.

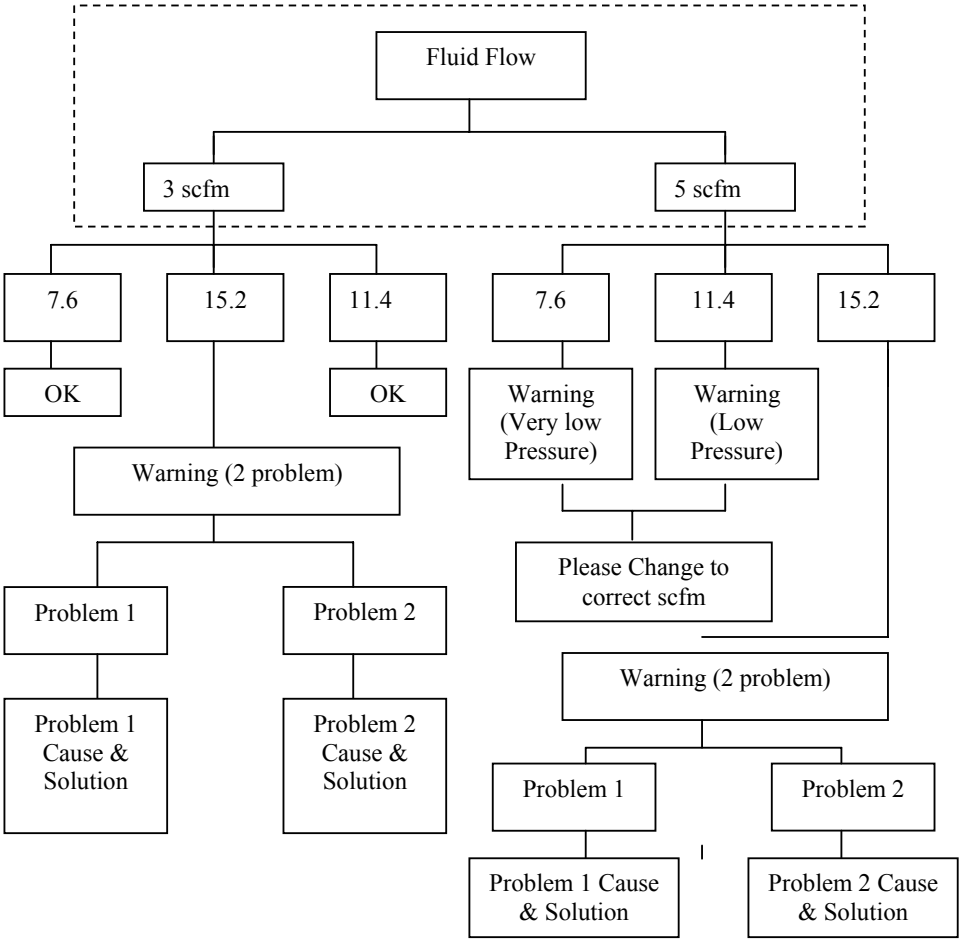

Figure 5: Structures of Fluid Flow option

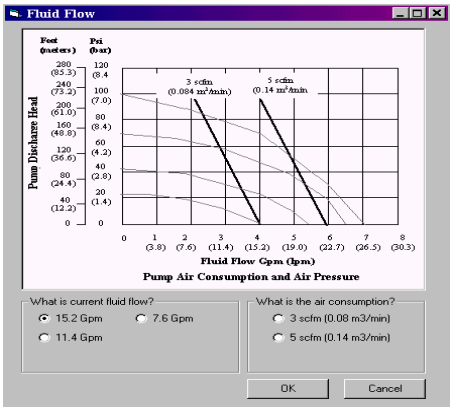

Figure 6: Fluid Flow option main menu

The maximum air consumption of the pump is 5.5 scfm. In order not to exceed the maximum value, the value of 3 scfm is taken as it is below 5.5 scfm and it is considered as the safe range for pump. In addition to that, the 3 scfm value is more likely to reach the 7.6 gpm, 11.4 gpm and 15.2 gpm. From the figure 5, if the value of 19 gpm is taken as one of the option, the air