
Manish Godse, Rajendra Sonar, T. I. Eldho, E. P. Rao
Indian Institute of Technology Bombay
{manishgodse, rm.sonar}@iitb.ac.in, {eldho, ceepria}@civil.iitb.ac.in

Abstract

Graphical User interface (GUI) is an integral part of any software system. It provides communication media between software program and human being. It usually consists of commands, menus, icons, images, graphs, tables, texts etc. The proper GUI presentation is influential in human-computer interaction. The present age commonly used GUIs are windows or web, which has improved usability compared to earlier text based UI.

The usual way of GUI development is based on use of GUI builders, which needs understanding, and knowledge of using them. IT professionals more commonly use them. For other professional who are developing algorithms in their own domain may have to spend more time on development of GUI rather than spending more on their domain algorithm work. The novel way of using expert systems for GUI development can reduce a GUI development efforts and time for other domain professionals. In this paper a rule-based expert system is presented for use of GUI development of integrated watershed model (IWM).

Keywords: Rule-based expert system, Graphical User interface (GUI), Procedural Programming

1. Introduction

User interface is a program that controls a display for the user and that allows the user to interact with the system [8]. The GUI plays important role in transferring information to user in a better way. The better-presented self-explanatory GUI gives better navigation and, helps in better understanding of information provided to the user. The GUI has changed since the computers were introduced from character based to interactive and self-explanatory graphics, which helps in efficient intuitive interaction with systems, and permits use of input devices such as mouse, touch screens, barcode scanners etc. These interfaces may be 2-D or 3-D depending on application types. Interfaces may also be provided with multimedia.

The GUI history starts with batch processing in which real time interaction with system was nil. Later introduced console command-line interfaces involving series of request-response transactions in textual commands. Though it changed user’s interaction but was not sufficient on ‘look and feel’ and quality of interaction with system. Then introduction of graphics changed user’s experience and expectations [2, 4].

Part of overall application coding involves writing code for GUI development. The results of Myers in 1995 showed that an average of 48% application code and 50% time was required for GUI development. This later reduced to 17% line of code for GUI and time to 50% because of use of GUI builder [1]. The simplified GUI development removes frustration of programmers and allows them to focus more on algorithm development rather than putting more time in GUI development. GUI development tool provide drag-drop controls for automatic generation of code. But developments of a GUI need working knowledge of GUI builders. The understanding of GUI builder is time consuming process.

There are three conventional approaches of programming: Console, client server and web. The console applications have textual user interface, while client sever (C/S) and web applications have graphical user interface. C/S applications have thick clients with part of the processing done at desktop. The clients are responsible for GUI presentation in C/S applications. GUI presentation in C/S is dependent of operating systems, programming languages, hardware etc. The web applications are thin clients using open standards using markup and scripting languages like Hyper Text Markup Language (HTML), JavaScript etc. and are browser independent. The interfaces in C/S or W/S are pre-programmed with multiple controls, information etc, which may reduce usability. Rule based expert system may be desktop or web based application, but
The major difference compared to conventional systems lies in the way interfaces are invoked or information is asked and displayed and shown to the user. The user interfaces of rule-based expert systems approach are not pre-programmed. They are accessed or invoked based on heuristics. The next input or interface is dependent on facts or inputs provided. During every state of consultation only required information is provided to user, which improves usability. The communication in expert system is kept very simple so that any novice user can use the system. [3]

The focus of this paper is on how rule based expert systems approach can be used to provide user interface for procedural programmed API (Application Programming Interface). A research case study related to this work is explained. This research project is carried at Civil Engineering Department of Indian Institute of Technology Bombay (IITB) [11]. It is development of integrated watershed model (IWM) for rainfall-runoff using FEM, GIS and Remote Sensing. APIs required for this model are programmed in C language.

1.1. Problem questions

A scenario is

- The civil engineering research group has team members’ having thorough understanding of their domain and is able to write programs in C.
- Team members are not familiar with any GUI development tool.

The problem was

- How to develop a web based GUI with fewer efforts?
- No addition and/or modification in existing code to add GUI.

The questions raised were

- Shall outside person’s help be asked to develop GUI from scratch?
- Is involvement of outsider going to increase the dependency on her/him?
- Shall team member learn GUI tool so that she/he can develop GUI for their work?
- What time shall be required to understand GUI builder and then develop GUI?
- Is there any other method to develop GUI, which will reduce learning and development time?

Based on questions raised it was decided that rather than learning GUI tool and developing system from scratch, find out other solutions which would help to develop system with lesser efforts and have complete control of research team on GUI development.

2. Cast study

A case study of IWM for GUI development is discussed in this section.

2.1. Background

Water resources management is all about to fulfill increasing water demand with available water resources. In a watershed perspective, spatial and temporal estimation of runoff for a fewer rainfall is important for the sustainable management of water resources. With the development of remote sensing and Geographical Information Systems (GIS), the hydrological models are getting more sophisticated and are being integrated with other process models [9].

In IWM research work, the objective was to develop Finite Element Method (FEM) based rainfall-runoff models using GIS and remotely sensed data. In the rainfall-runoff modeling, various hydrologic processes such as interception, infiltration, runoff, and interflow have been considered. Finally, an integrated model using FEM, GIS and Remote Sensing has been developed and applied for many watersheds. The IWM is programmed in C language.

Civil engineering scholars developed the integrated watershed development model using C programming language. The system developed was console based desktop application. Some of inputs/outputs were stored in text files and others were user fed at runtime. Then results were interpreted manually after looking into files or were converted manually into graphs using another graph generation tools. The developed system was satisfactory, but was lacking on usability. There were three major requirements in system:

- GU interfaces to accept user data and display textual as well as graphical output
- Web-based version
- Complete control on GUI development

2.2. Solution

We used iKen Studio for development of this application. iKen Studio is a web-based Integrated Development Environment (IDE) to develop, deploy, and run enterprise level applications which includes knowledge-based expert systems and decision support systems. The IDE is based on hybrid Artificial Intelligence techniques mainly expert system, case-based reasoning, neural network, genetic algorithm, and analytical methods [5]. The IDE include generic functions to generate graphs. It has inbuilt form and
report interfaces to develop HTML input forms and output reports.

iKen studio has capability to use external APIs through Dynamic-Link Libraries (DLL). DLL contains functions and data that can be used by another module in Windows environment (application or DLL) [7]. The code of IWM was written and compiled using turbo C. It was not possible to call this code directly in expert system hence, it was recompiled in Visual Studio 6.0 [6], and DLL was created. The created DLL is called in expert system to run the IWM. The more details of DLL generation are not provided here because it is not in scope of this paper.

The input data required for the system has two parts:

- Fixed set of values stored in text files
- Values that vary for different scenarios

The data stored in the text file is provided to the model by specifying the path of the files, using expert system input form. Form based interface is used to collect other required data from the user at run time. These interfaces are managed and controlled by expert system. This data is then transferred to the model. After processing the data, the model gives back the results to expert system. The outputs of model are in two forms: graph, and data stored in text files.

An example of the rule written in the system is shown in Table-1. This rule is as per syntax of expert system development tool. E.g. ASK() prompts the user to enter value of variable. As shown in Table-1, first line of rule asks the path of input files which are required for expert system. These rules have complete control on calling required user input forms; passing fixed as well user data to models; collecting output from models; displaying output, generation of required graphs etc. E.g. the runoff hydrograph is shown in Figure-5. At the end of session a session report is displayed (Figure-7).

### Table-1: Example of Rules

<table>
<thead>
<tr>
<th>Rule</th>
</tr>
</thead>
<tbody>
<tr>
<td>IF ASK(Integrated Watershed Model.PathForm)</td>
</tr>
<tr>
<td>AND Integrated Watershed Model.Select Model=Kinematic Wave Model</td>
</tr>
<tr>
<td>AND ASK(Integrated Watershed Model.Kinematic Wave Model)</td>
</tr>
<tr>
<td>AND Integrated Watershed Model.ChannelSection=Trapezoidal</td>
</tr>
<tr>
<td>AND Integrated Watershed Model.InterceptionModel=Yes</td>
</tr>
<tr>
<td>AND ASK(Integrated Watershed Model.Interception Model)</td>
</tr>
<tr>
<td>AND Integrated Watershed Model.InfiltrationModel=GAML model</td>
</tr>
<tr>
<td>AND ASK(Integrated Watershed Model.GAMLForm)</td>
</tr>
<tr>
<td>AND ASK(Integrated Watershed Model.FinishSession)</td>
</tr>
</tbody>
</table>
Model.KWM_TotalSimulationTime*60/Integrated Watershed Model.KWM_TimeStep)
AND Integrated Watershed
Model.Trend1 := C_TREND(CUSTOM_FUN(GetTime, C_TEXT(Integrated Watershed Model.Temp_Duration))))
AND Integrated Watershed
Model.Trend2 := C_TREND(CUSTOM_FUN(GetRunoff, C_TEXT(Integrated Watershed Model.Temp_Duration))))
AND Integrated Watershed
Model.TempMatrix := CREATE_MATRIX(Integrated Watershed Model.Temp_Duration, 1, 0)
AND CREATE_GRAPH(IWM, Integrated Watershed Model.TempMatrix)
AND SET_GRAPH_OPTION(IWM, Title, RUNOFF HYDROGRAPH)
AND ASK(Integrated Watershed Model.Graph)
AND ASK(Integrated Watershed Model.SessionReport)
THEN Integrated Watershed Model.Goal IS Complete

The few screen shots of systems are as following-

Figure 1: Input form for File and Directory path

Figure 2: Form for Selecting Model Type

Figure 3: Data Input form for Kinematic Wave Model

Figure 4: Result form - URL for input and output files

Figure 5: Output - Hydrograph
3. Discussion and conclusion

We have successfully implemented use of rule based expert systems to wrap procedural C code. Use of this approach improves usability as it shows only relevant and required information to user. Rule syntaxes are normally in routine English and are self explanatory, hence it reduces cognitive and learning efforts of programmer. The amount of training required is less compared to training on conventional programming. It also improves productivity and reduces time. Rule modification is very easier and takes less time compared to the conventional systems. The sequences of all operations are controlled by rules, hence modification and maintenance of system is very easy. This approach may also be suitable for using legacy systems in web environment. The role of experts system in this project is best depicted as host to control full application, and models acting as assistant.

4. Acknowledgement

This work is done as a part of WWM project. The WWM project is funded by ISRO-IITB Technology Cell to Civil Engineering Department of IIT Bombay.

10. References


