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Comparative Analysis on Software's used in Expert System with Special Reference to Agriculture

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Abstract—The expert system developed by various experts clearly indicate that different software's were used to develop computer based expert system for different applications. There are two ways of building expert system: one is to develop from scratch i.e. to code the expert system as a normal computer programme for each domain using programming languages like CLIPS, PROLOG, LISP, VB 6.0, VB.Net, ASP.Net, PHP etc as front end, MS Access, MySQL, ORACLE etc as back end and the other is to use an expert system shell i.e. to build an expert system with the help of specially designed programmes that are commercially available which may be used for a particular domain. The shell enables the user to build their own expert system with or without the help from knowledge engineers. Thus shells can make considerable saving on programming time. Because of this, building expert system can be faster and more commercial. This paper discuss about different softwares used for the development of expert system.

Index Terms— Agriculture, Expert System, Software, Information and Farmers

I. INTRODUCTION

The information need of farmers on new crops, pesticides, farm machines and farming techniques is keep increasing over the years. In order to make accurate decisions, farm managers, extension workers/farmers need speedy access to advice on agricultural problems which could be timely, reliable and consistent. Hence, they have to resort on the subject matter specialists like agronomist, entomologist, plant pathologist, soil scientists, horticulturist, farm scientist etc. Though the subject matter specialists extend a willful service, the availability of resource persons, affordability of information in time and accessibility, all that matters a lot. It is in this juncture the hall mark in use of telecommunications and computer based information technology in the era of globalization probably would be the best alternative and rather means for sea exchange in extension. Factors involved in choosing a shell or other software tool for an expert system project are:

1. The characteristics of the knowledge and the style of inference used by the domain expert.
2. The time and money available for the project.
3. The programming capabilities available in-house (what languages do the programmers know? Is it feasible to retrain them?).
4. The hardware available for development.
5. The required performance of the system.

II. DIFFERENT SOFTWARES USED IN THE EXPERT SYSTEM

In the recently developed expert system, many programming languages are used. The Schematic representation for the languages used in expert system is given as below

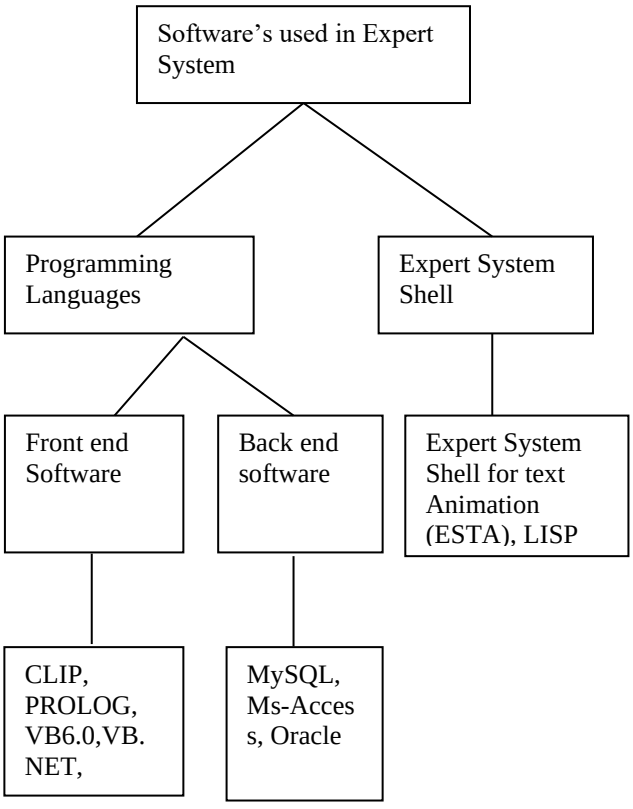

Fig 1 : Schematic Representation of Languages in Expert System

Table1.Expert systems in Agriculture

S.NO	AUTHORS	UTILITY	SOFTWARE /SHELL USED
1	PALMER [9]	SOYBEAN CROP VARIETY SELECTION	PROLOG

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2	BENNETT AND SNEED [10]	PLANNING, DESIGN AND EVALUATION OF IRRIGATION SYSTEMS	PASCAL
3	FOLRIS, SIMON AND SIMON[11]	REAL-TIME OPERATION; REAL-TIME METEOROLOGICAL DATA HANDLING	PASCAL
4	GETFORTH AND MACVICER [12]	OPERATION OF CONTROL STRUCTURES; REAL –TIME METEOROLOGICAL DATA HANDLING	PASCAL
5	HAIE AND IRWIN [13]	DRAINAGE DIAGNOSIS	PASCAL
6	STONE AND TOMAN [14]	COTTON CROP MANAGEMENT ; COUPLED WITH SOYGRO MODEL	PASCAL
7	BACHELOR, WETZSTEIN AND MC CLENDON [15]	SOYBEAN CROP MANAGEMENT	INSIGHT 2+
8	MCCLENDON, BACHELOR AND HOOK[16]	SOYBEAN IRRIGATION	INSIGHT 2+
9	HART, EKHOLT AND KIM [17]	IRRIGATION SYSTEM SELECTION	LISP
10	HERSHAEUR, KARIM, OWENS AND PHILIPAKIS [18]	CANAL WATER DISTRIBUTION; CANAL NETWORK INCORPORATED	LISP
11	BHATTY [19]	RESERVOIR OPERATION ;DP MODEL INTEGRATED	PROLOG
12	MCGREGOR AND THORNTON [20]	WHEAT CROP VARIETY SELECTION	CRYSTAL
13	OSWALD [21]	TANK SYSTEMS DIAGNOSTIC ANALYSIS	PROLOG
14	HASBINI, BUCHLEITER AND DUKE [22]	OPERATIONAL GUIDELINES FOR CENTER PIVOT SYSTEMS	PASCAL
15	KING, BRONER, CROISSANT AND BASHAM [23]	FERTILIZER AND IRRIGATION APPLICATIONS	TURBO C
16	SRINIVASAN, ENGEL AND PANDYAL [24]	DELIVERY SYSTEM OPERATIONAL; CANAL NETWORK INCORPORATED	EXSYS
17	CLARKE, TAN AND STONE [25]	IRRIGATION SCHEDULING ;ET METHOD SELECTION	PC PLUS
18	PLANT, HORROCKS, GRIMES AND ZELINSKI [26]	COTTON IRRIGATION SCHEDULING	CALEX
19	RAMAN, MOHAN AND RANGACHARYA [27]	CROP PLANNING UNDER DROUGHTS; LP MODEL INFERENCING	INSIGHT 2+
20	NEVO, OAD AND PADMORE [28]	OPTIMAL CROP PLANNING ; LP MODEL INTEGRATED	PROLOG
21	PATIL, DHANDRA , ANGADI , SHANKAR. AND JOSHI [1]	MICRONUTRIENT DEFICIENCIES IN CROPS	SERVCLIPS
22	PRASAD, RANJAN AND SINHA [3]	DISORDERS IN INDIAN MANGO	SHELL FOR TEXT ANIMATION
23	SARMA, SINGH AND SINGH [4]	DIAGNOSIS OF RICE DISEASES	EXPERT SYSTEM SHELL FOR TEXT ANIMATION
24	BALASUBRAMANI [6]	DIAGNOSIS OF RUBBER PLANT DISEASES	VB 6.0
25	KUMAR, LEHRI, SHARMA, MEENA AND KUMAR [7]	RAPESEED-MUSTARD DISEASE EXPERT SYSTEM	VB 6.0
26	BABU, MURTY AND NARAYANA [8]	DIAGNOSIS OF TOMATO CROP DISEASES	JSP

2.1 C Language Integrated Production Systems (Clips)

A web based expert system was developed for diagnosis of micro nutrients' deficiencies in crops [1]. This virtual diagnosis framework was developed using the ServCLIPS tool to support the building and running of the expert system by web. The ServCLIPS uses the inference engine and the programming language of the CLIPS to develop the expert system [2]. It is a productive development and delivery expert system tool which provides a complete environment for the construction of rule and/or object based expert systems. Created in 1985, CLIPS is now widely used throughout the government, industry and academics. Its key features are:

- Knowledge Representation: It provides a cohesive tool for handling a wide variety of knowledge with support for three different programming paradigms: rule-based, object-oriented and procedural. Rule-based programming allows knowledge to be represented as heuristics or "rules of thumb," which specify a set of actions to be performed for a given situation. Object-oriented programming allows complex systems to be modeled as modular components. The procedural programming capabilities provided by CLIPS are similar to capabilities found in languages such as C, Java, Ada, and LISP.
- Portability: It is written in C for portability and speed and has been installed on many different operating systems without code changes. Operating systems on which CLIPS has been tested include Windows XP, Mac OS and UNIX. It can be ported to any system which has an ANSI compliant C or C++ compiler. It comes with all source code which can be modified or tailored to meet a user's specific needs.
- Integration/Extensibility: It can be embedded within procedural code called as a subroutine and integrated with languages such as C, Java, FORTRAN and ADA. It can be easily extended by a user through the use of several well-defined protocols.

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- Interactive Development: The standard version of CLIPS provides an interactive, text oriented development environment including debugging aids, on-line help and an integrated editor. Interfaces providing features such as pull down menus, integrated editors and multiple windows have been developed for the MacOS and Windows XP.
- Verification/Validation: It includes a number of features to support the verification and validation of expert systems including support for modular design and partitioning of a knowledge base, static and dynamic constraint checking of slot values, function arguments and semantic analysis of rule patterns to determine if inconsistencies could prevent a rule from firing or generate an error.
- Fully Documented: It comes with extensive documentation including a Reference Manual and a User's Guide.
- Low Cost: It is maintained as public domain software.

2.2 Expert System Shell for Text Animation

Expert system shell is a collection of software packages and tools used to design, develop, implement and maintain expert systems. An expert system *viz.*, AMRAPALIKA was formulated for diagnosing 14 different pests including eight diseases and six insects in Indian mango variety using Expert system Shell for Text Animations [3]. An expert system was designed in order to diagnose and manage the diseases occurring in rice crop using Expert system Shell for Text animations (ESTA) [4]. The ESTA programme has some advantages compared to other available expert system programmes such as the CLIPS. It is easy to use, fast and requires no programming experience.

According to Prolog Development Center, there are two major knowledge representations in ESTA [5]. They are called "Sections" and "Parameters". Sections are the highest level of knowledge representation in ESTA. The first section must be called "start". Parameters determine the flow of control between the sections. A parameter may be any of four types: Boolean, Text, Number and Category. Any parameter may obtain a value through answering a question, as a result of applying some rules or an assignment resulting from an assigned action. The Boolean or logical parameter is used for evaluating whether the answer to a specific question is "true", "false", or "unknown". This is possible when the answer to the question is either "Yes", "No" or "Unknown." The text parameter is used for text objects such as the name of a tree, a forest region, etc. The number parameter may be used to represent real values, such as diameter of trees, height or volume per hectare. The category parameter is used when the parameter is known to take one of a predefined set of values.

In transferring this knowledge-based into the text-based rules of ESTA, one should determine the type of parameter. If the parameter type is Boolean, a value will be assigned to each question. One (1) for an expected answers towards sustainability and Zero (0) for an unexpected answers. It may be concluded that building knowledge based rules is the major part of the work. This includes collecting the knowledge, analyzing and organizing it in a structured way and then testing it. Feeding the ESTA programme with the knowledge base is a relatively small part of the total project.

2.3 Visual Basic 6.0

Visual Basic 6.0 is the programming language used for developing the expert system on rubber [6]. The main advantage of Visual Basic is that it is a rapid application development tool. An image based rapeseed-mustard disease expert system was developed in India with Visual Basic 6.0 as front end and MS-Access 2000 as back end [7].

It is the third-generation event–driven programming language and Integrated Development Environment (IDE) from Microsoft for its Component Object Model (COM) programming model. Language features like the BASIC programming language, Visual Basic was designed to be easily learned and used by beginner programmers. The language not only allows programmers to create simple GUI applications, but can also develop complex applications. Programming in VB is a combination of visually arranging components or controls on a form, specifying attributes and actions of those components, and writing additional lines of code for more functionality. Since default attributes and actions are defined for the components, a simple program can be created without the programmer having to write many lines of code. Performance problems were experienced by earlier versions, but with faster computers and native code compilation this has become less of an issue.

Forms are created using drag-and-drop techniques. A tool is used to place controls (e.g., text boxes, buttons, etc.) on the form (window). Controls have attributes and event handlers associated with them. Default values are provided when the control is created, but may be changed by the programmer. Many attribute values can be modified during run time based on user actions or changes in the environment, providing a dynamic application. For example, code can be inserted into the form resize event handler to reposition a control so that it remains centered on the form, expands to fill up the form, etc. By inserting code into the event handler for a key press in a text box, the program can automatically translate the case of the text being entered, or even prevent certain characters from being inserted.

Visual Basic can create executables (EXE files), ActiveX controls, or DLL files, but is primarily used to develop Windows applications and to interface database systems. Dialog boxes with less functionality can be used to provide pop-up capabilities. Controls provide the basic functionality of the application, while programmers can insert additional logic within the appropriate event handlers. For example, a drop-down combination box will automatically display its list and allow the user to select any element. An event handler is called when an item is selected, which can then execute additional code created by the programmer to perform some action based on which element was selected, such as populating a related list. Alternatively, a Visual Basic component can have no user interface, and instead provide ActiveX objects to other programs via Component Object Model (COM). This allows for server-side processing or an add-in module. The Visual Basic compiler is shared with other Visual Studio languages (C, C++), but restrictions in the IDE do not allow the creation of some targets (Windows model DLLs) and threading models.

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2.4 Ms-Access

Microsoft Access is used to design the databases. When reviewing Microsoft Access in the real world, it should be understood how it is used with other products. An all-Access solution may have Microsoft Access Forms and Reports managing Microsoft Access tables. However, Microsoft Access may be used only as the 'front-end', using another product for the 'back-end' tables, such as Microsoft SQL Server and non-Microsoft products such as Oracle and Sybase. Similarly, some applications will only use the Microsoft Access tables and use another product as a front-end, such as Visual Basic or ASP.NET. Microsoft Access may be only part of the solution in more complex applications, where it may be integrated with other technologies such as Microsoft Excel, Microsoft Outlook or ActiveX Data Objects.

Access tables support a variety of standard field types, indices, and referential integrity. Access also includes a query interface, forms to display and enter data, and reports for printing. The underlying Jet database, which contains these objects, is multiuser-aware and handles record-locking and referential integrity including cascading updates and deletes. Repetitive tasks can be automated through macros with point-and-click options. Microsoft Access is popular among non-programmers and professional developers alike. Non-programmers can create visually pleasing and relatively advanced solutions with very little or no code. It is also easy to place a database on a network and have multiple users share and update data without overwriting each other's work. Data is locked at the record level which is significantly different from Excel which locks the entire spreadsheet.

Microsoft offers a wide range of template databases within the program and for download from their website. These options are available upon starting access and allow users to enhance a database with pre-defined tables, queries, forms, reports, and macros. Popular templates include tracking contacts, assets, issues, events, projects, and tasks. Templates do not include VBA code. Microsoft Access also offers the ability for programmers to create solutions using the programming language Visual Basic for Applications (VBA), which is similar to Visual Basic 6.0 (VB 6.0) and used throughout the Microsoft Office programs such as Excel, Word, Outlook and PowerPoint. Most VB6.0 code including the use of Windows API calls, can be used in VBA. Power users and developers can extend basic end-user solutions to a professional solution with advanced automation, data validation, error trapping, and multi-user support.

2.5 Java Server Pages

A Web based tomato crop expert information system was developed with java server pages (JSP) as the front end and MySQL as the backend [8]. Java Server Pages (JSP) technology is the Java platform technology for delivering dynamic content to web clients in a portable, secure and well-defined way. Java Server Pages (JSP) technology is the Java platform technology for delivering dynamic content to web clients in a portable, secure and well-defined way. The JSP specification extends the Java Servlet API to provide web application developers with a robust framework for creating dynamic web content on the server using HTML, and XML templates, and Java code, which is secure, fast, and independent of server platforms. JSP has been built on top of the Servlet API and utilizes Servlet semantics. JSP has become the preferred request handler and response mechanism. Although JSP technology is going to be a powerful successor to basic Servlets, they have an evolutionary relationship and can be used in a cooperative and complementary manner.

Servlets are powerful and sometimes they are a bit cumbersome when it comes to generating complex HTML. Most servlets contain a little code that handles application logic and a lot more code that handles output formatting. This can make it difficult to separate and reuse portions of the code when a different output format is needed. For these reasons, web application developers turn towards JSP as their preferred servlet environment.

JSP technology is blessed with a number of exciting benefits, which are chronicled as follows:

1. The JSP technology is platform independent, in its dynamic web pages, its web servers and its underlying server components. That is, JSP pages perform perfectly without any hassle on any platform, run on any web server and web-enabled application server. The JSP pages can be accessed from any web server.
2. The JSP technology emphasizes the use of reusable components. These components can be combined or manipulated towards developing more purposeful components and page design. JSPs are very different from Servlets; however, they are precompiled into Servlets at run time and executed by a JSP engine which is installed on a Web-enabled application server such as BEA Web Logic and IBM Web Sphere.

2.6 MySQL

SQL (Structured Query Language) is a database computer language designed for the retrieval and management of data in relational database management systems (RDBMS), database schema creation and modification and database object access control management. SQL is a programming language for querying and modifying data and managing databases. Most database management systems implement a majority of one of these standards and add their proprietary extensions. SQL allows the retrieval, insertion, updating and deletion of data.

A database management system also includes management and administrative functions. The first version of SQL was developed at IBM by Donald D. Chamberlin and Raymond F. Boyce in the early 1970s. This version, initially called SEQUEL, was designed to manipulate and retrieve data stored in IBM's original relational database product, System R. IBM patented their version of SQL in 1985, while the SQL language was not formally standardized until 1986, by the American National Standards Institute (ANSI) as SQL-86. Subsequent versions of the SQL standard have been released by ANSI and as International Organization for Standardization (ISO) standards.

2.7 CRYSTAL

It is a quantum chemistry ab initio program, designed primarily for calculations on crystals (3 dimensions), slabs (2 dimensions) and polymers (1 dimension) using translational symmetry, but it can also be used for single molecules.

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2.8 TurboC

It is an Integrated Development Environment and compiler for the C programming language from Borland. First introduced in 1987, it was noted for its integrated development environment, small size, fast compile speed, comprehensive manuals and low price. Turbo C built on the strengths of previous programming languages, such as Pascal, to take things to the next level for coders for PC programs. It's strengths were notable in graphics delivery, which allowed programmers to do more to showcase their skills in the 16 bit display environment that was dominant at that time. It was a bit complex for novice users. This was intentional, since Turbo C was designed to be a professional coding language for experienced coders and software developers.

The main facets of Turbo C were an integrated development environment, editor, and compiler. It was designed to run in MS-DOS. The integrated development environment (IDE) was a carry over from previous Borland offerings, and much more basic than the advanced user interfaces and WYSIWYG formats that replaced it. The compiler, however, was very fast for its day and capable of handling large programming projects. This won it numerous fans in the coding community, to the point that users re-wrote popular tunes such as The Beatles 'Let it be' to be tribute pieces such as 'Write in C.'

There were three total versions of Turbo C put on the market. Version 1.0 was the original 1987 version, Version 1.5 was released in 1988, and Version 2.0 came out in 1989. After Version 2.0, Borland released Turbo C++ and the name Turbo C was dropped from Borland's marketing and the Turbo C elements were built into the later programming platforms.

III. CONCLUSION

The different softwares used in the development of expert systems are studied and discussed in this paper. The rapid development of internet technology has changed the way of expert system development. It is easy to access the expert system via the internet. The expert system do not replace people, but serve as intelligent assistant, improve the quality and productivity of decision-making in farmers field.

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