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THE APPLICATION OF EXPERT SYSTEM: A REVIEW OF RESEARCH AND APPLICATIONS

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ABSTRACT

The development of Artificial Intelligent (AI) technology system can be a wide scope; for an instant, there are rule-based expert system, frame-based expert system, fuzzy logic, neural network, genetic algorithm, etc. The remarkable achievement applications of AI has been reported in different disciplines including field of medicals, militaries, chemistry, engineering, manufacturing, management, and others. Its’ discoveries and contributions through of AI study since the early 1970s were be significant step to enhance better performance of human work activities and probably replaced by these technologies. Today, there a lot of intelligent machine is available in everywhere such as airport gate scanner, movie theater counter ticket, vending machine, ATM machine, washing machine, etc. Expert system has been used widely in many areas and industries. This paper is described the current research and development of expert system.

Keywords: artificial intelligence, expert system review.

INTRODUCTION

The discovery and development of expert systems recorded since in the early 1970s until today. The unique characteristic of the expert system is an explanation capability to review its own reasoning and explain its decisions (Hetem, 2000). It was built by extracting knowledge from human experts (Tan & Kher, 2012) as shown in Figure. 1 (Tan, 2007), to be applied in a computer program for knowledge processing so that it can deal with quantitative and qualitative data. Compared to other conventional program that require sequences of step prescribed called algorithm, expert system more intelligent as human being that allow inexact reasoning and can deal with incomplete data.

Figure-1. Simple diagram of expert system (Photo reprinted from (Tan, 2007).

Expert system programming can be categorized based of the particular subject area and it purpose of applications, as such type of diagnosis (Tan et al., 2012; Tan et al., 2013), repair, instruction, interpretation, prediction (Mookherjee and Bhattacharyya, 2001), design and planning, simulation (Ngevneitsvky, 2002), reengineering (Asgharizadeh et al., 2011), control, classification or identification and others many. Each type of expert system programming development would apply different rules, code, sequence of algorithm, interactive method between user and program etc. These categories are not rigid because some cases of application may exhibit characteristics of more than one category as refer to Table 1.

The main objective of the development of an expert fault diagnosis system is to achieve an integrated diagnostic procedure for air-conditioning development. The research was done in a subsidiary of the largest automotive parts manufacturing group in Malaysia. The developed system is to diagnose problems in the product development process in the vehicle air-conditioning manufacturing company. The developed ES will trace the error and defect in the various phases in the development processes. The developed ES is able to shorten the product development time and increase the efficiency in the decision making process.

RESEARCH ON EXPERT SYSTEM

An expert systems technology is to provide a mechanism for building the institutional or corporate memory of the firm. That is expert system are being used to preserve or document knowledge so that one’s knowledge and experiential learning would not be lost once that individual retires or leaves the firm (Liebowitz, 1995). Therefore, the application of expert system knowledge in different field of discipline has been done and experimentally success by quite a lot of researchers. There are a few hundred or maybe thousand studies and development of an expert system for various different fields like medicals, militaries, chemistry, engineering, manufacturing, management, etc. The statistic data for the subject research of AI from year 1996s until 2012s as can refer in Table-2 and Figure-2 shown that there are positively increment number of researches. This data prove that more researchers or academicians from worldwide countries have highly concerned and actively involved in the studying areas of the AI. The Malaysian
academicians and researcher collaboration with the industrial sectors for the current last 10 years indicates the improved of ranking and percentage of number of researches. Compared to the 140 countries, the Malaysia in year 2000 is only in the rank of 60 and the rank improves to 18 in the year 2012. The benefits and contributions from development of AI, especially the expert system development program in any discipline of study become significant. One of the reasons the application of expert system is to provide better alternative solutions and assist the companies to struggle among the world competitive market challenges. In terms of the optimization whole process activities for product development, its hope to prevent the losses or the wastes source of materials, producing times, labor, facilities and utilities invested by a company to manufacture a product. In addition, the company source of capital rolling can be enhanced therefore better profit will be generated. The researcher contribution in their journal, articles, conference papers and thesis writing, study field of expert system can be searched in various areas of study. This paper only discussed several numbers of an expert system study in seven disciplines; there are engineering, manufacturing, medicals, management, military, education & training.

Table-1. Category of an expert system and its application.

<table>
<thead>
<tr>
<th>No.</th>
<th>Category</th>
<th>Problem addressed</th>
<th>Applications Program (Examples)</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Diagnosis</td>
<td>Recommend remedies/treatment to illnesses, trouble shoot technical machine problem</td>
<td>SYNERGY-MYCIN: a legal expert system to diagnosis and treatment of meningitis and bacterial infections</td>
<td>O'Collaghan, 2003</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>ONCOCIN &amp; ONCOHELP – 1990s: diagnosis of the general cancer diseases</td>
<td>Saritas et al., 2013</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>DESE: Identifying the treatment accurately by diagnosing the diseases</td>
<td>Pota et al., 2010</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Diagnosis of industry piping manufacturing process</td>
<td>Tan and Kher, 2012</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Diagnosis of automatic wire bonding machine</td>
<td>Tan, 2007</td>
</tr>
<tr>
<td>2</td>
<td>Repair</td>
<td>Suggest the planning schedule structure to repair of item and maintenance works</td>
<td>ESFCRM: for personal computer repair and maintenance</td>
<td>Leng and Teng, 1992</td>
</tr>
<tr>
<td>3</td>
<td>Instruction</td>
<td>As training program that evaluate users ability with current knowledge base or monitor progress</td>
<td>HSPEXP: to assist less experienced modelers with calibration of a watershed model</td>
<td>Liebowitz, 1995</td>
</tr>
<tr>
<td>4</td>
<td>Interpretation</td>
<td>To analyze data input and determine its significance (compare with knowledge base)</td>
<td>Hepasert - 1989: To allows precise and exhaustive interpretations of hepatitis serology test results</td>
<td>Rudgier et al., 2010</td>
</tr>
<tr>
<td>5</td>
<td>Prediction</td>
<td>As method to guess or make assumption the possible outcome based data record.</td>
<td>DEREK: Predicts a variety of types of toxicology</td>
<td>Syed-Abdullah et al., 2011</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Recognition of CAD Feature</td>
<td>STAR: Predicts carcinogenicity</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Design of a Feature Recognition System for CAD/CAM Integration</td>
<td>Abrishami and Varahram, 2012</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Forecasting</td>
<td>Gas price forecasting</td>
<td>Integration of GMDH neural network with GA and Rile-based Expert System</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Design and planning</td>
<td>To develop and decide solution in shorten time, sometimes act as human experts</td>
<td>Cakes-ISTS: for planning an Internet-based stock trading system</td>
<td>Lee and Lee, 2012</td>
</tr>
<tr>
<td>8</td>
<td>Monitoring</td>
<td>Comparing observations to plan vulnerabilities</td>
<td>VES: To analyze vibration in condition monitoring of fixed plant</td>
<td>Ebersbach and Peng, 2008</td>
</tr>
<tr>
<td>9</td>
<td>Control</td>
<td>Interpreting, predicting, repairing, and monitoring system behaviors</td>
<td>KBESS: industrial applications of real-time knowledge based expert systems for process control</td>
<td>Stanley, 1991</td>
</tr>
<tr>
<td>10</td>
<td>Monitoring control</td>
<td>To monitor operations and control functions that particularly important in decision making</td>
<td>StructureWare Power Monitoring Expert 7: To collects and organizes data gathered from facility’s electrical network and presents it in comprehensive</td>
<td>Moridis et al., 2013</td>
</tr>
<tr>
<td>11</td>
<td>Classification/identification</td>
<td>To classify or identify the objectives in the system based on differences features or attributes</td>
<td>DEENDROID: to analyzing and classifying code-structures in Android malware families</td>
<td>Tangil et al., 2014</td>
</tr>
<tr>
<td>12</td>
<td>Discovery</td>
<td>To aid user getting to, setting up or otherwise exploring the system</td>
<td>SetES: to assist in the discovery and recovery of Unconventional Gas Resources (UGS)</td>
<td>Moridis et al., 2013</td>
</tr>
<tr>
<td>13</td>
<td>Debugging</td>
<td>To provide incremental solutions for complex problems</td>
<td>SIPDES: To simulate Program Debugger Using an Expert System</td>
<td>Doutidis and Paul, 1991</td>
</tr>
<tr>
<td>14</td>
<td>Selection</td>
<td>To select the suitable machining tool</td>
<td>To select the suitable carbide tool for CNC machine</td>
<td>Tan et al., 2012</td>
</tr>
</tbody>
</table>
especially in most developing countries like South of
diagnosis and treatment a certain high-risk diseases
enough expertise and experience to consult patients about
or doctor. Not many medical practitioners who have
diagnosis disease until the actual treatment by a specialist
as well as during pre-treatment of medical consultation,
Medical
for the company.
obtained from expert system that can prevent any losses
analysis of each engineering parts or process able to
critical and important tasks. Furthermore, accurate result
for operational workers during perform and deal the
and manufacturing process can provide greatest assistance
Therefore, an expert system implies into the engineering
processes, certain process, perhaps inefficient
machine for long distance, etc. Behind these product
travelling period, remote control enables us to operate the
comfortable, for the instant a vehicle that shortens our
everywhere make our life become much easier and
the current engineering industries as we can find in
Automotive, locomotive, chemical and others branch
could be a tough subject to be discussed. Products from
the current engineering industries as we can find in
everywhere make our life become much easier and
for the instant a vehicle that shortens our
travelling period, remote control enables us to operate the
machine for long distance, etc. Behind these product
engineering processes, certain process, perhaps inefficient
to be performed and handled by conventional way.
Therefore, an expert system implies into the engineering
and manufacturing process can provide greatest assistance
for operational workers during perform and deal the
critical and important tasks. Furthermore, accurate result
analysis of each engineering parts or process able to
obtained from expert system that can prevent any losses
for the company.

Medical
Technologies in medical treatment are important
as well as during pre-treatment of medical consultation,
diagnosis disease until the actual treatment by a specialist
or doctor. Not many medical practitioners who have
enough expertise and experience to consult patients about
diagnosis and treatment a certain high-risk diseases
especially in most developing countries like South of
Asian, African and third world countries. Furthermore,
patients need to wait in longer period before diseases has
been diagnosis by specialist and when the treatment is
stated, it may already late and patient could be suffered for
the whole life or in certain worse case mortality of patients
cannot be avoided. Computer technologies such as expert
system can solve the above problems with the aim to
counter the earlier diagnosis diseases for patients, identify
disease symptom and provide immediate accurate
response to save patient life (Cabrera and Edye, 2010). In
addition, the chance percentages to cure that disease turn
to positive which mean the current practice for patient to
consult specialist before treatment become more effective.

Management
Expert system build for the usage of different
application and different group of decision makers each
level in the organization, there are managers, accountant,
financial analysis, consultant, strategic planners etc. In
developing expert system, management teams might have
difficulties during strategic plan consist of sourcing expert
advisors, budget, time constraint, other management
support and contribution, skill etc. (Shariat et al., 2013).
Soufi et al. (2013) studied that expert system as
importance and provide accommodation to the
management to investigate the different aspect of
assumption and optimal solution even though in complex
case where the management problem normally solved by
expertise which took more longer time for solving. Due to
community demand and modern business culture
nowadays, development of expert system for the
application for data and information management in
organization become significant role. Furthermore,
company managers have an authority to access the
information should engaged with the technologies such as
expert system for them able to manage their management
resources which more systematic, improve accountability
and traceability of information system management. An
expert system as programmed to facilitate in decision
making in management and organization toward the high
performance, it program also show that the management in
its decision (Shariat et al., 2013)

Military
The technologies of artificial intelligence for the
most military program and hardware are wide and varied
which due to robustness, reliability and durability. It
showed the improvement to the military communication
security, operation, control and maintenance, training
areas etc. Liao (2008) studied that the expert system as
significant to facilitate decision support in the command
and control process ability by a military commander due to
expensive and complexity real situation in the military
program training. The potential of expert system can solve
many problems for the military and some AI application
had demonstrated their utility such as a device tool to find
bombs and mines, and search different radar. The AI
application in the military field which available in current
technology for instant the CALO (Cognitive Assistant that

Table-2. A ranking in the top five of a country founded
on the total research on AI topics (ScImago Lab, 2014).

<table>
<thead>
<tr>
<th>Rank</th>
<th>Country</th>
<th>Number of documents</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Year 1996-2012</td>
<td>Percentage (%)</td>
</tr>
<tr>
<td>1</td>
<td>United States</td>
<td>23,558</td>
</tr>
<tr>
<td>2</td>
<td>China</td>
<td>11,902</td>
</tr>
<tr>
<td>3</td>
<td>United Kingdom</td>
<td>9,030</td>
</tr>
<tr>
<td>4</td>
<td>Japan</td>
<td>6,341</td>
</tr>
<tr>
<td>5</td>
<td>Spain</td>
<td>6,104</td>
</tr>
</tbody>
</table>

Total countries = 140
Total documents = 131340

Figure-2. The total research of the AI from 2000-2012 for
the Malaysia country (ScImago Lab, 2014).

Engineering & Manufacturing
The impact of computer technologies application
of the engineering branch such as mechanical, electrical,
Automotive, locomotive, chemical and others branch
could be a tough subject to be discussed. Products from
the current engineering industries as we can find in
everywhere make our life become much easier and
comfortable, for the instant a vehicle that shortens our
travelling period, remote control enables us to operate the
machine for long distance, etc. Behind these product
engineering processes, certain process, perhaps inefficient
to be performed and handled by conventional way.
Therefore, an expert system implies into the engineering
and manufacturing process can provide greatest assistance
for operational workers during perform and deal the
critical and important tasks. Furthermore, accurate result
analysis of each engineering parts or process able to
obtained from expert system that can prevent any losses
for the company.

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**STATE OF THE ART EXPERT SYSTEM FRAMEWORK**

Selection of the expert system framework becomes the important factor for successful expert system project. Norton (1986) examined that the impact of particular framework on virtually every phase of an expert system project through the Bayesian Theory. Various characteristics need to be considered by system designers when evaluating an expert system framework. These are different aspects of knowledge acquisition, inference, knowledge representation, and explanation, knowledge engineering, and knowledge utilization depends on different tools applied. The impact of expert system technology by viewing of framework construction can be categories into six factors the technology itself; market realities; personal, organizational, and societal values; and policy choices (Chen, 2002). The framework of the successful implementation of each category of expert system is based on the influences both the user perceptions and the speed of its diffusion among the user group have been discussed by Bradley and Hauser (1995).

**CONCLUSIONS**

Modern businesses, academicians, scientists, engineers, manufacturers or individual were recommended to compile resources and expertise data which significantly will benefit other people. For companies, it could be the master storage the knowledge and operation expertise in keeping survival the operation of the company and eliminate a problem hiring or replacing human experts. The output of these researches will benefit any type of manufacturing industry by the optimization of product development in early stage design.

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