5.0 INTRODUCTION

The need of expert system arises due to the limit that is generated by decision making and conventional programming in manufacturing environment. Expert system has the capabilities of the human being and the computers that can be incorporated to overcome a lot of limits by decision making tools. The expert system have expertise about the product that are necessary to solve, domain related problems. The decision making capabilities and manipulation of knowledge / data can be done by conventional programming.

Expert system program capture the knowledge of one or more experts. Expert system has the components inference engine, database, knowledge base and user interface. It also contains data, facts and relationship. All these data are used to solve a problem. Where non experts can ask a question to expert system for problem and make the correct decision. The important thing is that there are no need of human expert is needed.

5.1 NEURO FUZZY

Neuro fuzzy as a fuzzy system that was built on the basis of a learning algorithm which is achieved or stimulated by the concept of neural network that determines the fuzzy rules and sets by dispensation sample of data.

It was usually represented as special multilayer feed forward neural networks [10]. However, fuzzy logic which was applied by other neural network architectures is also considered. In those neuro fuzzy networks connection weights, activation functions and propagation are different from common neural networks. Whereas there are a number of various approaches, where we generally use the term neuro fuzzy system for approaches which have various features as follows:
• Neuro fuzzy system is a fuzzy system based system which is achieved from a learning algorithm whereas learning algorithm which is resulting from neural network concept. It based on local data that locally modifies the fundamentals of fuzzy system.

• Another way to view a neuro fuzzy system is a forward neural network that is a three layer based system, where the first layer consist of the input variables, the second layer is a hidden layer that represents third layer and fuzzy rules represents output variable. In Fuzzy logic the fuzzy connection weights. Interpretations can be made in neuro fuzzy system as a system of fuzzy rules whether before, during and after learning. It is also generate the system out of the training data from scrape by initializing it with previous knowledge in the type of fuzzy rules.

• The semantic property of the fuzzy system is taken by a neuro fuzzy system for gaining knowledge, which outcome in constraint on the feasible alteration which is applicable to the system parameters.

• It takes an approximation of n-dimensional function, may be unknown that is not completely defineds by training information. The rules are defined inside the fuzzy system that can be seen as prototype of the training data.

• The combination of fuzzy logic and artificial neural networks is Neuro Fuzzy System, this logic is proposed by Jang. Hybrid intelligent system is a combination of two techniques, the human reasoning style of fuzzy systems with the connection and learning structure of neural networks. The human reasoning style of fuzzy systems is included in Neuro fuzzy systems using linguistic model and fuzzy sets which consists set of fuzzy rules IF THEN. They act as a universal approximates having the capability to interpreted IF THEN rules. Accuracy versus Interpretability is the strong point of neuro fuzzy that includes two opposing necessities in fuzzy modeling. In fuzzy modeling, research Neuro fuzzy can be classified into two types, one is mamdani model and linguistic fuzzy modeling that focuses on interpretability, secondly the Takagi Sugeno Kang model which is exact fuzzy modeling that focuses on accuracy.
Techniques implied by Neuro-fuzzy logic. Neuro fuzzy takes a reference of the combination of neural fuzzy networks and set theory with the advantages of both [12]:

- Handles various kinds of information either linguistic, numeric, logical etc.
- Manages partial, imprecise and imperfect information.
- Resolves conflications by cooperation as well as aggregation.
- Capabilities like self tuning, Self learning and self organizing
- Prior knowledge of relationships data was not needed
- Can easily imitate human conclusion process
- By using fuzzy in number of operations by which computation was fast

Applicability of Neuro fuzzy Technology

- Widely used in Business rule extraction and explanation process
- Personal preferences were very well incorporated
- Mostly used in model building
- Numeric data and linguistic information fusion was utilized

5.2 KNOWLEDGE BASE

Knowledge base is not concerned with the database. The heart of the concerned system is the inference engine and the knowledge base. The knowledge engineer accordance with the problem scenario created the module and translates actual knowledge into strategies and rules [14]. Knowledge can be presented through predicate calculus, lists, facts, rules, scripts, frame, intuitions and semantic nets that can be used by human expert for expert system for a particular domain. Production rules also effective method to represent knowledge for the expert system. For modifications and additions production rules are also effective. After rule generation the rule keeps in the computer memory and by the help of the inference engine the rule become search in knowledge base.

Knowledge based news computing emphasis on the use and representation of knowledge about any application. The powerful capability of Neuro-computing system helps in
modeling knowledge using Neuro-Fuzzy approach. This paper deals with theoretical models of computation which has learning capabilities of recurrent network models. It also focuses on various business patterns where we can use knowledge base one of the tool to analyze. There has been number of applications where we can represent Fuzzy finite automata as a tool to solve business decisions. In context of Neural Network learning, prior learning knowledge is designated to any information concerning the task domain or the target function. The knowledge can have different sources: it can be derived from human expert or accumulated by the system from the previous experience.

Prior knowledge can be used in Neuro Fuzzy Approach as a tool for training and design. The customer followed the methodologies that requires the technologies, that excludes a quantification of these relations, conventionally qualitative, which is genuine base of an financial and economic analysis that entrepreneur can understand the resources that will leave out in an surrounds where the technology aspect and joint marketing totally must be obviously grasped. We can find the solution to this problem by four ways.

The model of expert system provides information about how modifying resources influence their value and the process of creating, when the value has been changed who was responsible for the resources and when.

The expert system should imprison the fundamentals of the user business and filter out those user requirements that are likely to be change.

5.3 KNOWLEDGE ACQUISITION

In knowledge acquisition it is the procedure of creating a knowledge base to estimate the issues that is concerned with industrial Control System. For this the collection of data ensured that the collected data or information is accurate.

5.4 KNOWLDEGE BASE DEVELOPMENT
After the knowledge base has been developed and it should be understood by the expert system inference engine so that it can convert the pecking order of the data or information taken from the decision tree into a exacting language. This process is carried out throughout the course of development of parameters and rules. Thus every parameter should have the characteristic of an industrial control system.

5.5 EXPERT SYSTEM

sacts to solve difficult decision making problems, based on knowledge which is acquired by expert.

5.6 EXPERTS INTEGRATION: DOMAIN OR RANGE TRANSFORMATION DILEMMA

A classification problem can be described as identification of an appropriate mapping from a given domain to a range of categories. For example, a classification problem that takes a pattern composed of n real numbers as input and tries to classify it as belonging to one of two classes, defined as “0” or “1” can be seen as a mapping.

\[ R_n \rightarrow \{0, 1\} \]

Where \( R_n \) is the domain of the mapping and \( \{0, 1\} \) represents its range.

When integrating prior knowledge sources, the classification problem is hopefully simplified by transforming its corresponding mapping. This can be achieved by modifying either it is in the problem domain or its range.

5.6.1 Domain Transformation

When using the outputs of several experts as inputs to a new classifier (Called a combiner), the original input space is transformed to an entirely new one, its dimensionality being defined by the number of used experts and their output representation. Suppose “K” experts are to be combined to solve an n-input, m-class classification problem. Assuming that each expert uses m outputs, the combining classifier will have mK inputs, thus transforming the problem domain from n dimensions onto mK dimensions. Fig 5.1 shows schematically how this process works.
When transforming the problem domain, it will be easier to identify an appropriate mapping using the new problem domain. This can be the result of one or more of the following reasons.

**5.6.2 Reduced domain dimensionality**

This results in models with less parameter, which due to the curse of dimensionality can be a significant advantage when designing a model from a limited data set.

**5.6.3 Input preprocessing**

The domain transformation can be regarded as a feature extraction process. This can help eliminate the effect of irrelevant or noisy input variables.

**5.6.4 Simpler decision regions**
Even if the original dimensionality is not significantly reduced through a transformation, classed in the new domain may be easier to separate due to more favorable clustering of the patterns.

It is important to observe that information can be lost when transforming the domain, resulting in a poor classifier. This is especially true for experts with low resolution output representation e.g. one bit representation for each output dimension. Illustrate in fig 5.2 where two experts, whose outputs are one bit numbers, are to be combined. In this figure 5.2 class 0 and class 1 pattern are represented as circles and crosses respectively. The domain is partitioned into regions according to the expert’s outputs shown as pairs \((a, b)\) for each region. Each pair \((a, b)\) represents an input vector for the combiner. In this example, the transformed domain is not faithful in any of the regions, meaning that for each region there are examples that belong to different classes and that are mapped to the same input vector for the combiner. This information loss makes it impossible for a combiner to resolve the problem completely.

![Figure 5.1 Range Transformation](image)

In this case, a classifier is trained to integrate the various experts by partitioning the domain and assigning disjoint regions to individual experts. Here, the original
problem domain does not change but the integrating classifier has a different has a
different class range defined by the number of experts.

Suppose K experts are to be integrated in this manner. The problem is reduced to
assigning each expert exclusively to its “region of expertise”, i.e. a sub domain
where as given expert’s classification performance is superior to that of the other
experts. So, the original m-class problem is transformed into a new problem with
f(K) classes.

For K=2 the classifier could be trained to recognize the following potential:

Class 0 none of the local experts classify the illustration

Correctly

Class 1 Expert 1 alone classifies the illustration rightly

Class 2 Expert 2 alone classifies the illustration correctly

Class 3 Both local experts classifies the illustration correctly

Fig 5.3 (a) shows a schematic view of the Input space of δ 2-class problem and a
possible range transformation into a 4-class problem according to the method just
explained for K =2 experts. In this case the new decision regions are simpler in
the transformed problem the original one. This will be the case which depends on
the quality of the experts used and the characteristics of the problem.

This transformation leads to f (K) = 2^K so the amount of classes grow
exponentially with the number of experts used. A better alternative for this
example would be to use only 2 classes:

Class 1 Use expert 1 to classify the illustration

Class 2 Use Expert 2

So, the new problem here is that of assigning the patterns for which both experts
is correct (or incorrect) Fig 5.3 depicts two of the possible ways to distribute the
inputs space between the two experts. When both experts are correct then decision
boundary lying within the region.
Hybrid system relying on range transformation can provide various advantages over original classifiers, specially the following:

In domain transformation case, it is projected that the transformed problem will have simpler decision regions than the original one, thus being easier to solve and requiring a less complex classifier to do the job.

![Range Transformations](image)

**Figure 5.2 Range Transformations**

Restricted domain used for local training.

Assigning a portion of the domain to a specific classifier allows local training of machine learning based experts on the remaining region or regions.

### 5.6.5 Insensitivity to output representation

Range transformation works in the same wary regardless of the expert output representation. Indeed the technique can even work with experts whose output representation differs from one another. Figure 5.2 this time the range transformation produces two distinct and easily separable regions corresponding to the “areas of expertise” of each expert.

### 5.7 OUR MODEL

To provide assistance to the expert user in the assortment of an industrial control system, a knowledge base expert structure is developed and designed. This system does the
economic analysis and also specifies the parameters that are defined by the user. These systems take into account the parameter that are specified by the user and perform the economic analysis, if required. Payback period formulation has been used to carry out this analysis. The expert system is connected to the economic analysis software implemented for lot his task.

5.7.1 DOMAIN TRANSFORMATION IN EXPERT SYSTEM

The output of the domain transformation process in expert system is an economic resource that was business application want to confer and monitor where one of the outputs is a product, where as many conversion processes that produce another resources. In this situation business application are interested in monitoring, planning, and controlling the work in progress and intermediary resources.

The value chain model for creating a simple business procedure is represented in figure 5.4.

![Figure 5.3: Expert I/P Business Transformation Model](image)

It is important to observe that information can be lost when transform in the domain resulting in a poor classifier. The order to select the best possible combination of Port, Tool and Labour, Network selection criteria is used. The
detail model consists of various Export 1....... Export RV based on ontology based Pattern matching.

To properly decide on various resource quantities where every training model consists of an input vector and an ideal output response vector a tree is generated which finally detects the resource requirement at Assembly and Inspection.

![Workflow dynamics of Expert system](image)

**Figure. 5.4: Workflow dynamics of Expert system**

The algorithm which can describe the fuzzy control relation is given as:

**Step 1:** Find the desired transfer function of

\[ \Sigma y = \Sigma y (p) | \Sigma y (t) | \Sigma y (l) \]

**Step 2:** If \( \Sigma y (p) > \) Required Level switch to \( \Sigma y (t) \)

If \( \Sigma y (t) > \) required level switch to \( \Sigma y (e) \)

Else Return to \( \Sigma y (p) \)

**Step 3:** Train the Network for next Iteration.

**Step 4:** Generate a Rule Base and upgrade at each situation.

**Step 5:** Assign Judging and end the iteration.

The resources \( y (p) \), \( y (t) \) and \( y (l) \) are viewed as set of keywords by lemmatizing their significance weight age.
5.7.2 Indexing to create knowledgebase

Keywords correspond to a unique multiple value attribute. Let n total number of objects that are technical like \( y(p), y(t) \) and \( y(l) \) for making the product \( P \) where every basic technological object that is being represented in scalar form. We get the equation as:

\[
P = \{\Sigma y(p), \Sigma y(t), \Sigma y(t)\}
\]

Where

\[
[\Sigma y(p1), \Sigma y(p2)\ldots \Sigma y(l)]
\]

\[
(\Sigma y(t1), \Sigma y(t2), \ldots \ldots \Sigma y(tn)), (\Sigma y(l1), \Sigma y(l2)\ldots \ldots \Sigma y(ln))
\]

In creation of knowledge we will be taking the manufacturing advances at each and every process of plant given as:

\[
PK_i \in \{MA_1P, MA_2P, MA_3P, \ldots \ldots , MA_NP\}
\]

where \( PK_i \) = Knowledge Index Bar

\( PK_i \) can also be defined as Technology Vector, is the product view from resources and technologies.

We can develop a grid which represents as: \([PKI= \Sigma R0 \Sigma MA]\) where PKI is the Cartesian product function.
<table>
<thead>
<tr>
<th></th>
<th>Process P1</th>
<th>Process P2</th>
<th>Process P3</th>
<th>Process P4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Σy(p)</td>
<td>0.9</td>
<td>0.6</td>
<td>0.3</td>
<td>0.6</td>
</tr>
<tr>
<td>Σy(t)</td>
<td>0.6</td>
<td>0.4</td>
<td>0.3</td>
<td>0.9</td>
</tr>
<tr>
<td>Σy(l)</td>
<td>0.6</td>
<td>0.8</td>
<td>0.9</td>
<td>0.4</td>
</tr>
</tbody>
</table>

Figure 5.5: Matrix showing the Cartesian product of Resources and Manufacturing advances to create product during single iteration.

6.0 CONCLUSION

The method used in the development and design of the given expert system that includes the capability that are essential to give the solution of the specified problems related to the domain. Therefore the key strength that is present in the reality that is the presence of expert is not required. The knowledge base is different and should not to be perplexed with the database and the center of this system is knowledge base creation. Problem solving rules is fact; predicate calculus etc and it can be representing by knowledge base. These portray an extensive use of the IF - THEN rule.

To check against the most recent condition of the difficulty of the solution that is present in the database, where each and every new rule has to be examined. The methods that are used by rule interpreter are backward chaining and forward chaining.

Regularly a latest rule is checked, it is verified against the present status of the problem solution present in the database. Two remedies are generally utilized by the rule interpreter to explore for the answers that are backward chained and forward chained. The final element that we have used in generating a product is the user interface. It is an interface that allows a user can to give the primary information in the database.