International Journal of Mechanical, Industrial and Aerospace Sciences
ISSN: 2517-9950
Vol:9, No:8, 2015

A New Internal Architecture Based on Feature Selection for Holonic Manufacturing System

Jihan Abdulazeez Ahmed, Adnan Mohsin Abdulazeez Brifcani

***Abstract*—**This paper suggests a new internal architecture of holon based on feature selection model using the combination of Bees Algorithm (BA) and Artificial Neural Network (ANN). BA is used to generate features while ANN is used as a classifier to evaluate the produced features. Proposed system is applied on the Wine dataset, the statistical result proves that the proposed system is effective and has the ability to choose informative features with high accuracy.

***Keywords*—**Artificial Neural Networks, Holonic Approach, Feature Selection, Bee Algorithm.

I. Introduction

AT the beginning of 21st century manufacturing system has faced many challenges and rapid change in economic and technical manufacturing environments [1]. The increase of competitiveness is expressed in more flexibility, with more qualities, more agility, and more productivity and with better adaptation to the unexpected disturbances which is crucial for an enterprise staying in the business [2], [3]. The new manufacturing system has to cope with the above developments and to realize the demand of the customers. There are two emerging technologies that are coping with the increasing complexity of manufacturing; these are the holonic approach which is based on the event-driven control strategy, usually aimed at modular control systems that are directly physically linked with the manufacturing hardware equipment. The other is the multi-agent approach which is developed in the area of distributed information processing [4].

In the middle of sixties, Arthur Koestler proposed the word “holon” to describe a basic unit of organization in biological and social systems [1]. The word "holon" is a combination from the Greek holos means “whole” with the suffix “on” which as in proton or neutron. Holon is an autonomous and co-operative entity of a manufacturing system includes operational features, skills and knowledge, and individual goals, it can represent a physical or logical activity, such as a machine, an order, a Flexible Manufacturing System (FMS), or even a human operator [5]. Holonic Manufacturing System (HMS) defined as an intelligent manufacturing paradigm, used to control manufacturing activities, and organize them in order to meet the agile, scalable and fault tolerant requirements [6], [7]. HMS deals with the overall of manufacturing system such as products, parts, factories, operators, workers (user), machine, equipments, control, and so on. All these elements are modeled as ‘holon’ having autonomous and cooperative properties. In 1994, Christensen at First European Conference on HMS wrote down some key properties of a HMS [8]:

- Autonomy: the capability of a manufacturing unit to create and control the execution of its own plans and/or strategies (and to maintain its own functions).
- Co-operation: the process whereby a set of manufacturing units develop mutually acceptable plans and execute them.
- Self-organization: the ability of manufacturing units to collect and arrange themselves in order to achieve a production goal.
- Reconfigurability: the ability of a function of a manufacturing unit to be simply altered in a timely and cost effective manner.

Katholieke Universities Leuven (KULeuven) developed a new architecture for manufacturing system based on holonic reference architecture. This architecture works as a template for organizing the distributed planning and control system; it describes three types of basic holons: order agents (internal logistics), product agents (process plans), and resource agents (resource handling) [8]-[10]. Another example of HMS architecture defines four classes of manufacturing holon according to their functions and objectives, product holon (PH), task holon (TH), operational holon (OH) and supervisor holon (SH). The resulting architecture of this work has a degree of self-organization of manufacturing holons, which reduces the complexity to integrate new components, allows balancing the control between different control structures, and enables easy reconfiguration of the system [2], [10], [11].

Aggregation in HMS in 2008 has been introduced Focusing on the problems and complexity of the interaction between holons, and used the aggregation tools such as genetic algorithm between the groups of holons inside HMS [12]. Design of complex evolvable system based on holonic rationale and self-organization was introduced in 2009, this design tried to enhance the emergent requirements imposed on the manufacturing domain. By using the holonic design combined with swarm intelligence and self-organization [13].

The holonic manufacturing concepts require a set of properties, or strategies that must be present by the manufacturing control system. The holon needs algorithms, methods, techniques and tools to facilitate its process. This paper suggests a new feature selection model base on the combination of BA and ANN. BA is used to produce feature while ANN is used to evaluate the produced features.

F. A. Jihan Abdulazeez Ahmed is with the Computer Science Department, Faculty of Science, Duhok University, Duhok City, KRG-Iraq (phone: 00964-7504613591, e-mail: drjihanrasool@gmail.com , sarah_jihana@yahoo.com).
S. B. Adnan Mohsin Abdulazeez Brifcani is with Department of IT, Duhok Technical Institute, Duhok Polytechnic University, Duhok City, KRG-Iraq (phone: 00964- 7504611970, e-mail: presidentdpu@gmail.com).

International Journal of Mechanical, Industrial and Aerospace Sciences
ISSN: 2517-9950
Vol:9, No:8, 2015

The rest of the paper is organized as follows: Section I, II presents a brief description of BA, and ANN. The proposed design and architecture base on the proposed feature selection model is presented in Section III. Numerical result and experiment is discussed in Section IV. Finally, conclusion is given in Section V.

II. Bees Algorithm

Bees Algorithm is a swarm-based search approach produced in 2005 [17]. It imitates the food foraging behavior of honeybees to found the optimal solution [14]. There are two type of bees named: Recruits: "the bee that wait in the hive and follow dance when she notices it and then forages", and the Scout: "the bee that starts the forage process and finds new food sources and dances" [15]–[18]. The main steps of the basic BA are:

1. Initialize population with random solutions.
2. Evaluate fitness of the population.
3. While (stopping criterion not met) //Forming new population.
4. Select sites for neighborhood search.
5. Recruit bees for selected sites (more bees for best e sites) and evaluate fitness.
6. Select the fittest bee from each patch.
7. Assign remaining bees to search randomly and evaluate their fitness.
8. End While.

III. Artificial Neural Networks (ANNs)

An ANNs is an information processing system that is inspired by the way biological nervous systems, such as the brain, process information. It is composed of a large number of highly interconnected processing elements working with each other to solve specific problems. Each processing element is basically a summing element followed by an activation function. The output of each neuron (after applying the weight parameter associated with the connection) is fed as the input to all neurons in the next layer. The learning process is essentially an optimization process in which the parameters of the best set of connection coefficients (weighs) for solving a problem are found and include the following basic steps [19], [20]:

- Present the NN with a number of inputs (vectors each representing a pattern)
- Check how closely the actual output generated for a specific input matches the desired output.

IV. Proposed Internal Architecture Design

The basic internal architecture holon shown in Fig. 1 consist of three main parts, coordination module, internal data base and control unit. In the proposed design two agents were used. The first one is used as a feature selection model based on the combination of BA and ANN in order to generate an optimal subset of features using internal database. While the next agent, is used as a decision making on the generated features using ANN classifier. The proposed design is described in Fig. 2.

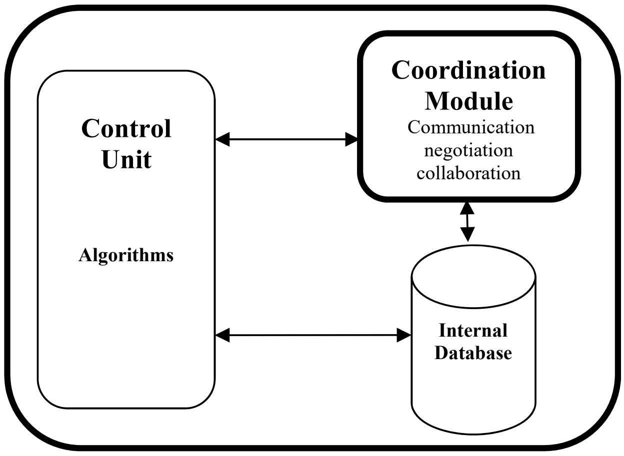

Fig. 1 Internal Architecture of the Basic Holon

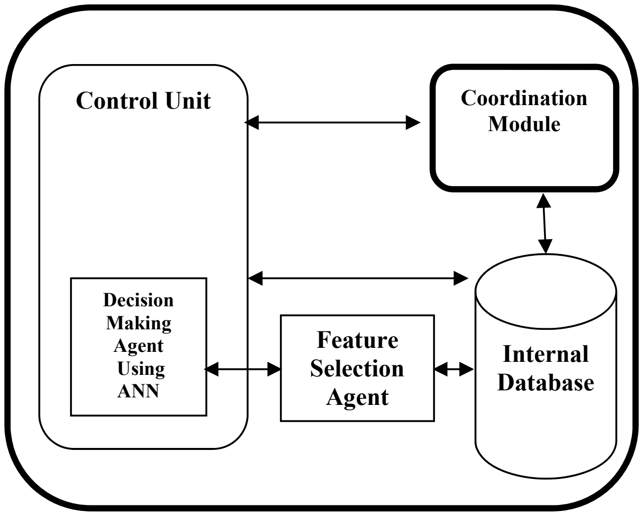

Fig. 2 Internal Architecture of the Proposed Holon

A. Proposed Feature Selection Agent

The proposed Feature Selection (FS) model starts with a population S of N initial solution generated randomly, S = {s1, s2, s3, ..., sN}. Each si is associated with two subsets: generatedFeatures (the features with highest accuracy) and remainderFeatrures. The value 1 shown in (Table I) indicates that the corresponding feature is generated randomly and it will be added to the generatedFeatures subset. While the value 0 indicates that this feature is not selected and it will be added to the remainderFeatrures subset. Each generatedFeatures will be evaluated using NN classifier, based on the quality of each subset. The population S will be sorted in descending order and as a neighborhood search, a simple random exchange method between generatedFeatures and remainderFeatrures is proposed. In Fig. 3 is the flowchart that describes the general principle of the proposed FS model, while the Fig. 4 illustrates clearly the proposed exchange method.

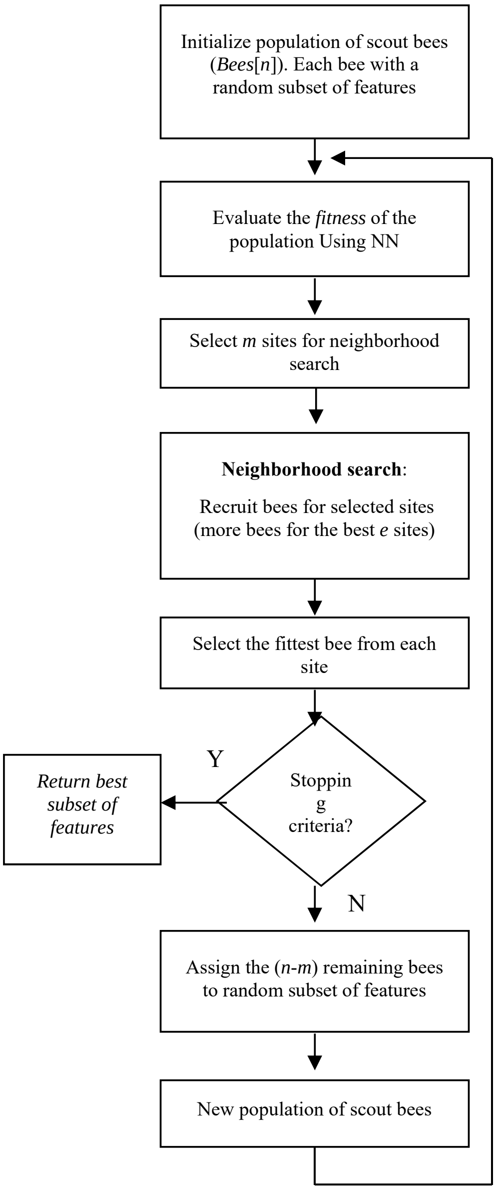

Fig. 3 The general principle of the proposed FS model

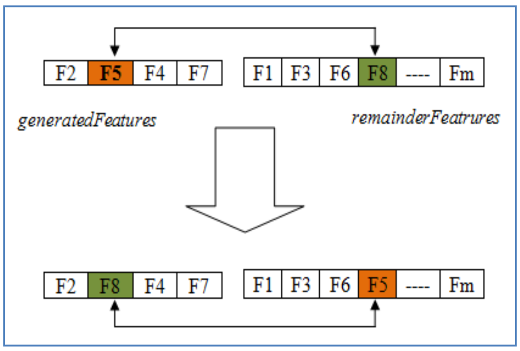

Fig. 4 A simple random exchange operator between generatedFeatures and remainderFeatures

TABLE I
RANDOM GENERATED FEATURE IS INDICATED BY 1, WHILE THE REMAINDER FEATURES ARE INDICATED BY 0

F1	F2		F4	…..	…..	F m
0	1	1	0	…	…..	…

V. EXPERIMENTS AND RESULTS

The proposed model is evaluated based on the Accuracy Rate (AR) as defined in (1):

$$AR = \frac{No.of\ correctly\ classified\ instance}{total\ No.of\ instance\ in\ the\ test\ data} \quad (1)$$

The validation and the quality of each subset of features are supported by the NN classifier. NN will advice which subset of features is better according to their AR. In our experiments we used the Wine dataset available on the website UCI [21]. This dataset contain 178 instances each instance consist of 13 continuous attributes, the name of the features are Alcohol , Malic acid, Ash, Alcalinity of ash, Magnesium, Total phenols, Flavanoids, Nonflavanoid phenols, Proanthocyanins, Color intensity, Hue, OD280/OD315 of diluted wines and Proline. The first column contains three classes: class 1, class 2 and class 3. In order to evaluate our model, the Wine dataset is partitioned into two subsets: the train dataset and the test dataset. The number of train data set is equal to 70% of the entire dataset while the number of the test dataset is equal 30%. The parameters of BA are assumed as follows through the experiments: n = 50, m = 5, e = 2, nsp = 15, and nep = 20. For NN the number of neurons in the input layer is equal to the number of selected features produced by BA, while the number of neurons in output layer is equal to the number of class = 3. The momentum is fixed to (0.5) after many experiments where this parameter varied over the interval (0.2, 0.9). The learning rate is fixed to (0.6) after varying it over the interval (0.1, 0.8). However, the weights values of the different Connections in the whole network are randomly initialized in the interval [-0.5, 0.5]. For each subset the NN will be trained for 1000 epoch using Back Propagation (BP) learning algorithm.

The Simulation of the proposed architecture based on the proposed feature selection model have been carried out using C# on a Pentium CORE 2 Duo CPU 2.20 GHz laptop, 3 GB RAM. The obtained result shown in (Table II) and Fig. 5 are the average of ten independent runs in term of number of features and AR. The results show that even if using only 3 features are produced better result when compared with the result using the whole 12 features. The highest result is obtained when number of features is equal to 7, 8 and 9 with AR approximately equal to 100%.

VI. CONCLUSION

In this study, we have investigated the combination model of BA and ANN for feature selection for designing a new internal architecture for holon and it evaluated based on the Wine dataset. The BA is used to generate subset of features while ANN is used as measure on generated features. Empirical results show that when using only 3 features the proposed model is performed better result when compared with the result using the whole 12 features. In addition, the best result is obtained when number of features is equal to 7, 8, and 9. The combination of BA with other classification techniques is an open issue.

TABLE II
PERFORMANCE OF THE PROPOSED FEATURE SELECTION MODEL IN TERM OF NO. OF FEATURES AND AR

No. of selected features	AR
3	0.96726
5	0.97569
7	0.99131
8	0.99375
9	0.99242
10	0.97916
12	0.95833

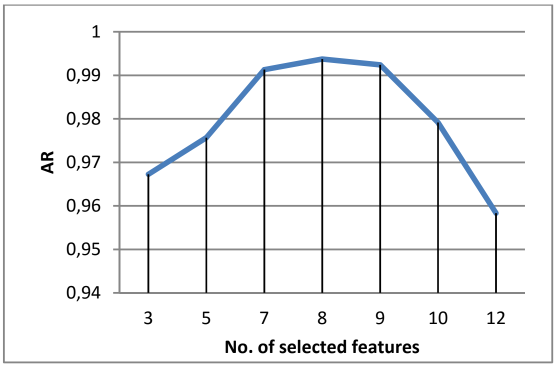

Fig. 5 No. of feature with corresponding AR

REFERENCES

[1] A. Koestler, “The Ghost in the Machine”. London: Arkana Books; 1971.
[2] L. Paulo and R. Francisco, “ADACOR: A holonic architecture for agile and adaptive manufacturing”, Computers in Industry, Vol. 57, No 2, 2006, pp. 121-130.
[3] L. Paulo, "Holonic Rationale and Self-organization on Design of Complex Evolvable Systems, Holonic and Multi-Agent Systems for Manufacturing", Lecture Notes in Artificial Intelligence, Vol. 5696, Springer-Verlag, 2009, pp. 11–23.
[4] L. Paulo and R. Francisco, “Towards autonomy, self-organization and learning in holonic manufacturing”, Multi-Agent Systems and Applications III, Lecture Notes in Artificial Intelligence, Vol. 2691, Springer, 2003, pp. 544–553.
[5] L. Bongaerts, “Integration of Scheduling and Control in Holonic Manufacturing Systems”, PhD Thesis, Production and Automation Division, Katholieke Universiteit Leuven, Leuven, Belgium, 1998.
[6] S. Weiming, J. Hyun, H. Douglas, “Application of agent-based systems in intelligent manufacturing: An updated review”, Advanced Engineering Informatics, ELSEVIR, 2006, P. 415–431.
[7] B. Vicente and G. Adriana, A Multi-agent Methodology for Holonic Manufacturing Systems, PhD thesis, 2008.
[8] J. Christensen, “Holonic Manufacturing Systems: Initial Architecture and Standards Directions”, In: Proceedings of First European Conference on Holonic Manufacturing Systems, European HMS Consortium. Hanover; 1994. – P. 1–20.
[9] J. Christensen, “HMS/FB Architecture and its Implementation, Agent Based Manufacturing: Advances in the Holonic Approach”. Berlin: Springer, 2003. – P. 53–87.
[10] B. Van, W. Jo, Paul V., B. Luc, “Reference architecture for Holonic manufacturing systems: PROSA”, Computers in Industry - Special Issue on Intelligent Manufacturing Systems, 1998, pp. 255–276.
[11] L. Paulo and Francisco R., “An Agile and Adaptive Holonic Architecture for Manufacturing Contro", scientific area of Industrial Automation, PhD thesis, 2004.
[12] L. Qing, L. Dongbo, and H. Dao, “Methods to Support Holon Aggregation in Holonic Manufacturing System”, International Symposium on Computational Intelligence and Design, 2008.
[13] L. Paulo, "Holonic Rationale and Self-organization on Design of Complex Evolvable Systems, Holonic and Multi-Agent Systems for Manufacturing", Lecture Notes in Artificial Intelligence, Vol. 5696, Springer-Verlag, 2009, pp. 11–23.
[14] D. Pham and A. Ghanbarzadeh, E. Koc, S. Otri, S. Rahim, M. Zaidi., “The bees algorithm, a novel tool for complex optimization problems”, In: Proc. of the 2nd international virtual conference on intelligent production machines and systems, Cardiff, UK, pp. 454-459, 2006.
[15] D. Pham and A. Ghanbarzadeh, “Multi-objective optimization is using the bees algorithm”, In: proceedings of the 3rd international virtual conference on intelligent production machines and systems, Scotland, 2007.
[16] A. Fahmy., “Using the Bees Algorithm to select the optimal speed parameters for wind turbine generators”, Journal of King Saud University – Computer and Information Sciences (2012) 24, 17–26.
[17] D. Pham, “The Bees Algorithm. Technical Note”, Manufacturing Engineering Centre, Cardiff University, UK, 2005.
[18] A. Siti, “A Study of Search Neighbourhood in the Bees Algorithm”, PhD Thesis, Manufacturing Engineering Centre, School of Engineering, Cardiff University, United Kingdom, 2012.
[19] S. Mohammad, and S. Shima, “A Hybrid Approach for Effective Feature Selection using Neural Networks and Artificial Bee Colony Optimization”, International Conference on Machine Vision, ICMV ,2010.
[20] J. Zurada, “Introduction to Artificial Neural Systems”, Prentice Hall International, Inc, 1996.
[21] The UCI machine learning repository, http://archive.ics.uci.edu/ml.