Wireless Sensor Network Based Real-Time Monitoring and Control for Factory Automation

Mohammed H. Al-Obaidi and Kasim M. Al-Aubidy
Intelligent & Embedded Systems Research Group,
Faculty of Engineering, Philadelphia University, Jordan
Email: kma@philadelphia.edu.jo

***Abstract*— The main objective of this research is to design and implement a real-time monitoring and control system for factory automation based on wireless sensor networks. A flexible manufacturing system with four load/unload stations for programmable machines, a manipulator, a conveyor belt, and a MATLAB Simulink model has been designed. Each unit in the proposed FMS is considered as a node in a wireless sensor network. A fuzzy-based algorithm has been developed as intelligent decision maker to obtain the destination load/unload station for the selected object. The obtained results from both real and simulated systems confirm that the implemented FMS perform the required tasks with acceptable accuracy and speed.**

Keywords: *Flexible manufacturing system, Real-time monitoring, Wireless sensor network, MATLAB Simulink, Fuzzy decision making.*

1. INTRODUCTION

Automation is the process of replacing the human resources by programmable machines controlled by computers[1,2]. The use of automation in factories has many advantages including; less employees cost, less human errors, low cost production, reducing production time, increasing production volume, and more. Wireless sensor networks add several features to the factory automation, these include; minimizing the use of wires, reaching non-reachable area, easy to add new devices and increasing the global market competition[3]. To achieve these advantages, manufacturing systems needs smart devices, computer intelligence and wireless sensor networks[4]. Programmable devices in any flexible factory system (FMS) have electronic, mechanical and electromechanical parts with material handling units. These can be connected to computers for monitoring, decision making, and manufacturing administration tasks[5].

The use of wireless sensor network (WSN) together with intelligent algorithms allows FMS to deal with different parts of programmable machines to have different products according to the market request. However, to have the best results from any FMS, it is required to gain suitable organization and real-time algorithms for scheduling, planning and control. The structure of the distribution services for the real-time operation of FMS has been discussed by Yang et.al [6]. The proposed system has several features such as more reliable, flexible and efficient. Shin and his group [7] developed FMS using certain number of programmable devices to have multi-types of flexibilities. Each machine performs different operations to balance the machine workload and minimize the part movements.

Brownfield [8] developed WSN-based medium access control protocol for FMS. It turns off any sensor node that does not have work to save battery energy and give long life time and wide range for the WSN. A programmable mechanism was proposed by Ahmed [8] to protect the WSN from any internal attacks like. This technique is important in any WSN-based FMS when it is used for monitoring and real-time control.

Real-time control considered one of the big challenges of FMS to achieve the desired flexibility of the system. This problem is divided into three categories long-term, medium-term and short-term control level based on the time frame. Long-term and medium-term control levels deal with production planning strategies, while short-term control deals with the management of the plan and real time control [10]. In fact, FMSs are used to reduce the need for the human resources in the production of goods and services process and customize the products without human workers. These processes need real-time monitoring and control of FMS [11]. Nowadays, most of the engineers execute control development tasks on the base of their technical knowledge, skills and the manufacturing requirements, processes and devices [12].

Scheduling and routing algorithms are required in manufacturing systems to reduce the processing time in order to increase the benefit of production[5,13,14]. Scheduling depends on four resources: duration, previous task, availability of resources, and target completion date of the product. Soft-computing methods have been developed for scheduling and routing operations. Mejthab and Al-Aubidy[13] presented design and implementation of real-time scheduling algorithms for a FMS. Three fuzzy-based scheduling algorithms have been developed for operation sequencing, task sequencing and routing. The paper concluded that using fuzzy scheduling algorithms will give good performance when compared with other scheduling algorithms. Scheduling based on genetic algorithms was developed by Prakash and his group [15] to manage the operation of a certain FMS. It has three programmable machines, three load/unload stations, three AGVs. The obtained results indicate that the proposed scheduling for sequencing and routing is promising for such FMS. Rossi and Dini [14] developed a real-time scheduling algorithm capable to deal with dynamic changes based on its environment.

This paper presents design, implementation and evaluation of a real-time controller for a FMS using WSN to exchange information between elements and components. The implemented system, as illustrated in Fig. 1, has programmable machines with load/unload stations, a conveyor belt, manipulator, and MATLAB Simulink for processing online videos from IP Camera.