Integrating the automated car manufacturing system based on RFID and analysis using modules

R.Rahul and A.Kumaraswamy
Department of Mechanical Engineering, Sri Venkateswara college of Engineering, Pennalur, Sriperumbudur, Tamilnadu, pincode-602117, India.
E-mail: rahulgullu1997@gmail.com

Abstract. In this module the analysis of the automated car manufacturing system is done. RFID tag is used to read each section of automobile manufacturing. There is an IR sensor in each segment of work envelops to detect the job completion. The first segment is for engine front and rear suspension module of the car, the second one is to integrate the Chassis Marriage Module, the third for integrating the Trim line of a car, and the fourth for implementing the Final line and testing the Quality of the Car. Here the RFID tag reads and stores the information detected by IR sensor. The Arduino controller connected to the IR sensor sends the data wirelessly to the MATLAB software through ZigBee module. This makes the production work simpler and effective. Also the throughput can be checked and analysed. Thus the performance and efficiency of manufacturing process can be analysed. Also the failure performance at distinct levels can be calculated. This will certainly help in analysing the working condition of each work envelope at regular intervals.

1. Introduction
This is one type of system used to automate an industry, process or machine by acquiring data from the current process and analysing it for failures, delay in production and errors. This analysis of data is used for improvising the performance of the system, to monitor the system in real time and to minimize the errors in the process. The whole system is controlled by an Arduino controller. This system consists of three IR sensors at three different stations or work envelops that detects the movement and ultimately senses the completion of job. This sensed data is stored in the Arduino controller. There is an RFID system which consist of a transmitter and receiver used to display the details of the product moving in the line. The data from RFID and IR sensor is transmitted wirelessly to the MATLAB software for analysing. Corresponding graphs are being plotted. This helps in monitoring the system regularly with sufficient data and also improving the throughput of the process. The main aim is to bridge a gap between industrial workers, third party supplier, industrial machineries and goods. This makes the work easier and reduces the human effort replacing with highly accurate real time data.

[1] Investigated about the cloud services given to the customer end and third party suppliers which is done by the management. This is a profit based marketing system which allows operators with web services and cloud support which has a specific range of storage for web pages as per their requirements. Generally an application program interface (API) will be acting as an interface between a server and a user. In this case automatic service composition (ASC) is been employed for services provided by the company. This is an automatic data storing and retrieving method which works on a
cloud environment. This ASC comprises of four techniques for getting an optimized output, they are work flow planning, retrieving the services from the cloud, selection of best online services and execution of steps for the services. This method can be used to find the relation between customer and a supplier, to know the needs of the customer and fulfill them with desired profit. By providing this as a service, both can use the virtual data for the improvement of the production.[2] This study elaborates about the collection of data from the machines wirelessly and storing in a virtual platform, which can be retrieved for evaluation and comparison of data with an existing value for future references. Industries can be automated using internet of things (IOT). This is a kind of technology which acquires data from the machines and segregates it in a virtual platform called cloud and this cloud has separate layers of storage for each type of data. And the data is retrieved for real time simulation of process variables. Another method for acquiring data from the machines is through Ethernet IP, LAN, RS 232. These are the transmission cables used for fetching the data directly from the machines and interpreting it on a system. This is an easy process but quite risky wherein the data is open access to all, so it can be misused. Thus IOT is provided with security and shielded web services, interfacing software and cloud storage. This method of monitoring is implemented in computer numerical control (CNC) and output data is fetched and stored for analyzing purpose. Simultaneously this method is opted for robot controllers and all other automated machines, CNC’S etc.

[3] The work has focused on establishing the performance calculation in manufacturing industries and evaluating the throughput. Also how it can be used to improve the productivity in manufacturing efficiently. Key performance indicators (KPI) plays a major role in this system. It tells about the usage of a specific process at a right time and right place with less expenses. Which ultimately improves the productivity. This work concentrates on improving the productivity and involving the new technology in manufacturing process from the emerging trends.[4] An investigation was made in an industrial environment to integrate an external sensor to a robot which is controlled by a control system. For the reference and application of industrial robots, a robot with grinding and deburring machine was introduced.[5] Studied the architecture of decision support system (DSS) based on simulation of a process within a system and to optimize the production rate also to control it. It is used on a stochastic flexible job shop (SFJS). This was built based on supervisory control and data acquisition (SCADA). This deals with the acquisition of data from the manufacturing process and further moving it for analysis. The real time readings are recorded and monitored. Thus a real time simulation is obtained with the help of controller and the desired output is retrieved with the same quality and quantity.

[6] Studied the conditioning of input, analysis of feedback error, feedforward error and recovering of error in the process. By using a set of controllers and timers this can be possible. Various type of timers can be used in this process such as retentive timers and watch dog timers. The most preferred is watch dog timer. It detects the errors with the help of watch dog timer and alerts when there is an abnormal variation in output. This method is a type of augmentation and perception. So it can be used in the place where minimum number of error is expected. This can be done with help of Petri net controllers.[7] This paper clearly defines about the process flow and its methodology. This includes flow time, breakdown time and process time in real time application. The sensors are connected to a controller in the assembly process. This will result in increased production rate, increased flexibility and less error. So the idle time, running time, break down time of a machine is analyzed and better production can be obtained with less effort. The rejections in manufacturing are reduced gradually as the output from the process is monitored. The feedback is sent to the controller thus the errors are eliminated and also analyzed for optimized result with high precision. Results show that this type of monitoring method produced optimized results when compared to the data from the factories without the real time monitoring method. This kind of transformation will be a greater impact in the automation field and factories introducing industry 4.0.
2. Methodology

At the first stage of integration the front and rear suspension systems are being assembled with the body kit of the car. While crossing the RFID reader the sub assembly parts containing an individual identification tags will be detected. Those details of the parts are scanned and displayed in the monitor. At the second stage of integration the chassis is coupled with the body of the car, so this module is called as chassis marriage module. The chassis is said to be the skeleton of the car. Third stage is the process where all the extra materials are separated from the manufacturing line and sent to the bin. Hence this stage is called as trim line stage. Fourth stage is for testing the quality and inspection of the car. MATLAB software acts as an interface between machine and the computer. Data from the machine is transferred wirelessly to the MATLAB software. Signal conditioning elements like voltage regulator, analog to digital converter (ADC), transformer and bridge rectifier are used to amplify the signals entering the controller. Communication in this setup is based upon the serial peripheral interface (SPI) communication protocol. SPI is the common communication protocol used in industries to connect the field devices like machineries, robots etc. It operates based on master slave communication concept. When the master commands the slave responds. There can be one master controller and any number of slaves connected to it. This analysis is done based on the script generated with the help of python compiler. This code is imported in the MATLAB software thus the analysis is done as the script runs in the background.

**Figure 1.** Experimental setup
2.1. Pin description

| Arduino Name | Nano ICSP Pin | Type                  | Function                                |
|---------------|--------------|-----------------------|-----------------------------------------|
| MISO          | Input or Output | Master In Slave Out  |
| VCC           | Output       | Supply Voltage        |
| SCK           | Output       | Clock from Master to Slave |
| MOSI          | Output or Input | Master Out Slave In  |
| RST           | Input        | Reset (Active Low)    |
| GND           | Power        | Supply Ground         |

Arduino Nano microcontroller uses a loader program for initiating the communication and to transfer the data from microcontroller to pc. This startup loading program is called bootloader program. Generally the data is read by the startup program. The retrieved data is stored in a separate memory location allotted for storing the program. The program will be called from flash memory whenever the communication is going to be done. There is a reset button present in Arduino controller which is kept idle for a particular period of duration. Thus by keeping the Arduino program idle, the communication is done only by (MISO) master in slave out and (MOSI) master out slave in. This idle time of reset button is possible only by applying clock signals which holds it idle for a particular time period. The communication is done based on master salve concept. This is how the communication protocol works in an Arduino microcontroller.

3. Results and discussions

In the proposed system, car manufacturing based on RFID does the completion of works by checking and also analyzing the product details automatically without any human intervention. It is fully automated. The checking and detections is done by using RFID tags and IR sensors as well. This data’s are sent to the MATLAB software through ZigBee module using IR sensors for graphical analysis of product details and other details. Different kinds of outputs are obtained like indication of information in a dialogue box, current status of the work, upcoming process, product details, graph etc. Each RFID contains different kind of information encrypted in it which are in electronic form and can only be read by electromagnetic waves produced by an RFID reader. The graphs for the different stages of manufacturing are plotted with the appropriate results from the acquired inputs. This plots are used for analyzing the process. The corresponding graphs plotted are shown below.
3.1. Throughput analysis
The first stage is for engine i.e., front and rear suspension module of the car, second one is for the Chassis Marriage Module, the third for Trim line of a car, and fourth for implementing the Final line and testing the Quality of the Car. From the above results we can conclude that the condition of a process can be monitored and analyzed. We can calculate the percentage of job completion and failure rate. By knowing the amount of failure in manufacturing process, the errors can be minimized and an improved production rate can be achieved. This type of analysis helps us to get the information about the assembly parts, its current status and the percentage of job completed in production line. Monitoring the system with precise data and controlling the process is possible. This type of analysis makes the work simpler and improve the quality of production. This will ultimately help in reaching the milestone in automation.
4. Conclusion
From the current work it has been concluded that the performance evaluation of a manufacturing process can be done only by introducing a control system with appropriate sensors and signal conditioning elements. In the final analysis it has been summarised that the throughput of a manufacturing process can be increased predominantly by using the data monitoring methods. On the whole, implementing this type of integration and analysis method will improve the efficiency of the plant, makes the work more simpler, saves energy and also reduces the errors gradually. Though it is expensive for implementation than other industrial setups, it will be much useful for analysis of a system and plays a major role in automation.

5. References
[1] Bruno G and Biglia P 1985 Performance evaluation and validation of tool handling in flexible manufacturing systems using Petri nets InInternational Workshop on Timed Petri Nets 1985
[2] Chen C C, Lin Y C, Hung M H, Lin C Y, Tsai Y J and Cheng F T 2016 A novel cloud manufacturing framework with auto-scaling capability for machine tool industry Int. J. Comput. Integr. Manuf. 29 7 786-804
[3] Paik I, Chen W, Huhns M N 2014 A scalable architecture for automatic service composition”, IEEE Trans. Serv. Comput. 7 82- 95
[4] ISO 22400-2:2014(E) Automation systems and integration – Key performance indicators (KPIs) for manufacturing operations management
[5] Rifkin and Jeremy 1995 The End of Work: The Decline of the Global Labor Force and the Dawn of the Post-Market Era Putnam Publishing Group
[6] Theorin A, Bengtsson K, Provost J, Lieder M., Johnsson C and Lundholm T 2015 An event-driven manufacturing information system architecture IFAC-Papers On Line 48 547 – 554
[7] Kasturia E, DiCesare F and Desrochers A 1988 Real-time control of multilevel of manufacturing systems using colored Petri nets Proc. 1988 IEEE Int. Conf. Robotics and Automat. 1114-1119
[8] X Xu 2012 From cloud computing to cloud manufacturing Robot. Comput. Integr. Manuf. 28 75-86