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Real-Time Supervision of Manufacturing Plant using IIoT

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Abstract: Downtime is a major threat to any manufacturing business. One of the most dreaded scenarios is that if one segment in manufacturing line backs up, it can have a snowball effect on the other segments waiting for the completion of prior tasks in order to produce a finished product. This research aims to reduce the amount of time for which the machine or the workers are in idle state. This is achieved by upgrading the manufacturing plant with an optimal method which tracks the manufacturing plant downtime in real time and the status of the plant is updated using Internet of Things technology. This research work is validated for Anti-lock Braking System (ABS) plant and the downtime reduction of the ABS plant is verified in real time through the cloud platform.

***Index Terms*: Anti-lock Braking System (ABS), Industrial IoT (IIoT), Internet of Things (IoT), Manufacturing Plant.**

I. INTRODUCTION

In a manufacturing company, a product can be manufactured in various ways namely Production line, Continuous flow, Custom manufacturing and fixed point manufacturing. This work concentrates on Anti-lock Braking System manufacturing which follows a combination of production line and custom manufacturing method. It includes assembly various parts of the product and based on the vehicle like car, truck, etc., the process can be customized. This work effectively supervises various parameters required to ensure correctness of the manufacturing plant.. The main objective of this project is to develop a monitoring system that can effectively monitor the parameters that may lead to breakdown of the line and also check for the conditions which must be maintained in real-time to ensure the safety of the line and it also provide an alert system if some of the listed conditions fails. When the Manager in charge of the line is updated in real-time with the status of the line, idle time of the machines can be reduced drastically. As the listed reasons for the breakdown of the line is common to any manufacturing line, this work can be implemented for any manufacturing unit irrespective of Slip Control System.

II. . LITERATURE SURVEY

For effective supervision of the manufacturing plant, work done by the researchers in understanding the structure of the manufacturing plant and the concept of IIoT must be studied. The main blocks of the manufacturing industry are studied [1]. On the top of the hierarchy lies the enterprise which maps to the entire organisation and the next level will consist of many sites where each site will focus on one product as requested by the customers .Then each site will have many areas where each area will take care of one section of the final product. Each area will be divided into process cell where processing of the data will be performed like testing, developing design, etc. The next level will be unit where manufacturing and assembling of the parts takes place. Each unit receives components from the equipment and control module which forms the base of the hierarchy.

Being studied the basic blocks of the manufacturing industry, it is stated that the present wired communication can be converted into wireless communication[2] by introducing User Equipment in between Base Station to reduce the energy consumption. By using wireless network, two models for Human Machine Interaction (HMI) are introduced[3] namely pick by Tablet and pick by HMI by considering productivity and quality constraints. Hence by reviewing the above work, it is concluded that wireless communication can be incorporated in a manufacturing industry.

Focusing on IIoT, the need for introducing IIoT is to enhance the transparency of the manufacturing process[4] . IoT with fourth industrial revolution is called as IIoT which helps the industry to achieve better product efficiency, etc. IIoT can be defined as an application of IoT in a manufacturing industry[5] . The main technologies that make up the IIoT are Internet of Things (IoT) and Cyber-Physical Systems (CPS)[6] where CPS will ensure secure transfer of data as it will be uploaded to the cloud platform. Moving on to the integration method, IIoT can be integrated in either horizontal or vertical way [7]. Horizontal integration will result in better quality assurance and vertical integration will lead to better flexibility. The main challenges in implementing IIoT are security, the way in which data s collected and the processing security [8].

III. PROPOSED SYSTEM

In Assembly Line room, the reasons for the failure of the production line are identified and it can be listed as Line Breakdown, Line Changeover, Material Unavailable, No Plan, Line Adjustment and Startup. The block diagram of the proposed system is represented in the fig.1.

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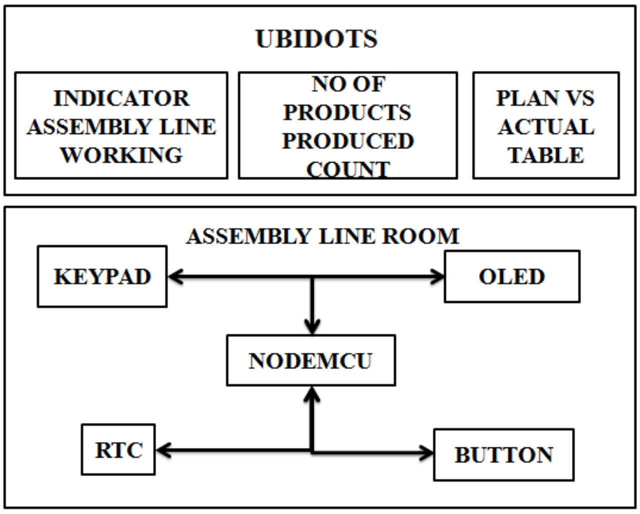

Fig.1Block Diagram of the Proposed System

By using NodeMCU as a main controller and keypad as an input device, user can provide the condition of the line to main controller via keypad. As NodeMCU has in-built Wi-Fi access, the data received can be uploaded to cloud platform (Ubidots) [9]. In addition, if a user presses the key which corresponds to Line Breakdown condition, rather than displaying the integer data in the display device, the breakdown time can be displayed which can be used to reduce the downtime of the line by analyzing the time period. It is developed by using Real Time Controller (RTC) and the production count is also updated in the cloud and it is designed in such a way that the count will reset its value for every hour so that *Plan Vs Actual* production can be analyzed where Plan will be a default value (100 pieces).

IV. IMPLEMENTATION

To reduce the time for which the modules are idle in the Assembly Line room, the modules must be examined in real-time and if the reason for failure of the line is identified, the information must reach the respected 'personnel' in minimum time. It is accomplished by using IIoT where the data received by the main controller will be automatically uploaded in the cloud platform and hence the respected personnel can be updated with the status of the line in real time. NodeMCU being a Wi-Fi enabled microcontroller is being used as a CPU for this project and based on the line condition, the operator can provide the input using keypad. The Line condition table is shown in Table 1.

KEYPAD INPUT	DATA
0	LINE IS WORKING GOOD
1	LINE BREAKDOWN
2	LINE CHANGEOVER
3	MATERIAL UNAVAILABLE
4	NO PLAN
5	LINE ADJUSTMENT
6	STARTUP

Table 1 Line Condition Table

By referring to the table 1, the operator can enter appropriate number through the keypad based on the condition he/she identifies. For the Line Breakdown condition alone, the display unit displays the idling time using RTC through which Top Management will know the status of the line in real time.. With the help of this data, better analyses of breakdown time can be performed. For all other cases, the data received will be uploaded to website, where visual representation of the Line condition can be viewed by the respective personnel in real time at any location. As an enhancement, the total number of products produced will also be uploaded to website by using a Single Pole Single Throw (SPST) button. As an extension, hourly update of production count is developed using a combination of RTC and button.

A. Schematic Diagram

In this section, the eight digital pins of NodeMCU (D1-D8) are connected to the 8 pins of the 4*4 keypad, the digital pin D0 is connected to the button switch. The digital pins D1 and D2 of the NodeMCU are responsible for I2C interface. RTC and OLED display modules communicate through I2C interface and hence those two pins are utilized. The 9v battery is connected to Voltage in (Vin) and ground pin of the NodeMCU as an external power source. The circuit diagram of the Assembly Line room consisting of NodeMCU, RTC, Keypad, Button and OLED display can be represented as in fig.2.

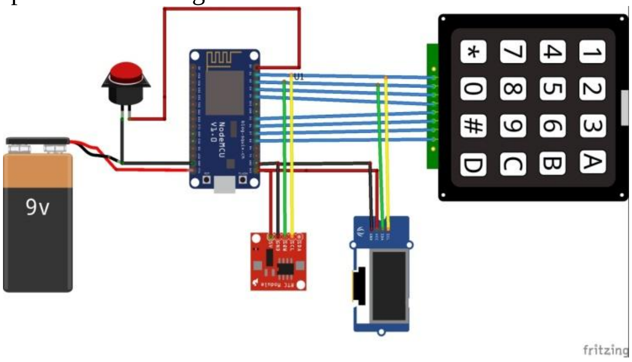

Fig.2 Assembly Line Circuit Connection

B. Flowchart of the system

The real time monitoring of the system is done by getting the input from the user either through keypad or button switch as shown in fig.2. If the button switch is pressed, the count value will be incremented until reaches threshold value. When any number is pressed in the keypad, the corresponding logic is executed as in the flowchart which is shown in fig.3.

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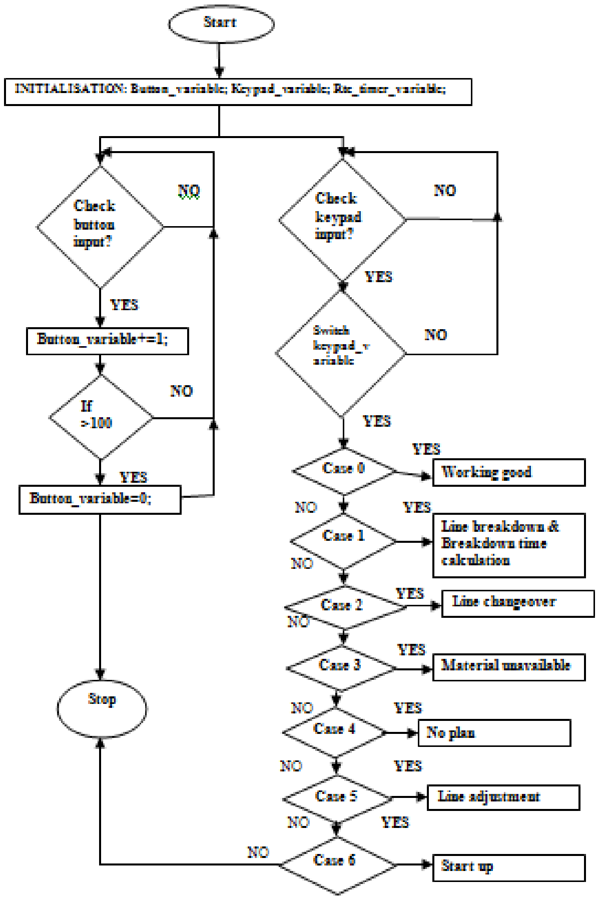

Fig.3 Assembly line Flowchart

C. *Hardware Connection Diagram*

The hardware implementation of the circuit diagram in fig.2 is implemented to verify the functionality indented and it is shown in fig.4. After verification of the proof of concept , the final product is created and it is shown in fig.5.

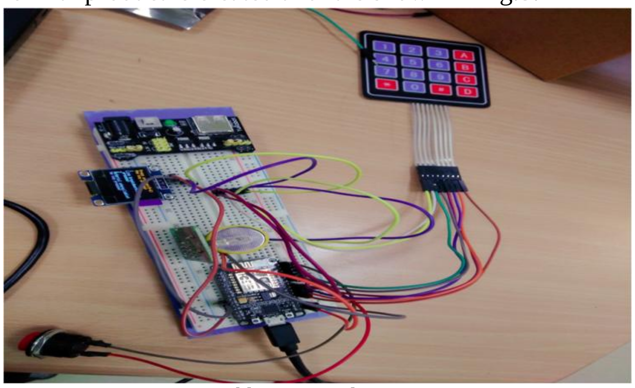

Fig.4 Assembly Line Hardware Connection

Fig.5 Assembly Line Final Product

V. RESULTS

The overall Assembly Line room dashboard is developed where a widget for keypad input, button count, Assembly line condition (depends on keypad input) and Plan Vs actual table (depends on button count) are created and it is shown in fig.6.

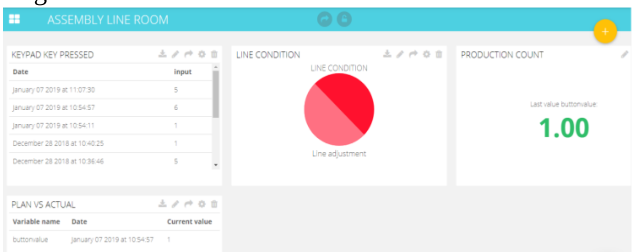

Fig.6 Assembly Line room Dashboard

Once a number is pressed in the keypad, the particular number will be uploaded in the Keypad widget and the corresponding line condition will be displayed in text and color format in the Assembly line condition widget. Once a button is pressed after each product production, the count will be updated in the production count widget. In *Plan Vs actual* table widget, button count will be updated simultaneously and once the count reaches the threshold (100 pieces), it will reset its value to zero.

VI. CONCLUSION

In this paper, the real-time supervision of manufacturing plant specifically ABS plant is designed and implemented. Also the status of the ABS plant is shared through the cloud platform to give information to the technical personnel so as to take remedial activity. This is achieved with Industrial Internet of Things (IIoT). Thus the production efficiency of the ABS plant is increased. In future, the same technology could be explored for other manufacturing plants.

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