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ESP8266 Based Production Monitoring System for Sewing Machine in Garment Industry to Evaluate OEE

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ABSTRACT*:* Garment Industry is an important part of the Indian economy, providing second largest occupation in India and contributing 4% to GDP. We have sufficient availability of raw material and skilled labour; still we are lagging in export as compared to countries like Bangladesh and Vietnam. There is an essential need to increase the efficiency of garment industry to maintain its position in the world market. Manpower utilization and machine utilization are the two key factors which if used significantly results in high productivity. So there is an essential need to develop a monitoring system which is able to get the exact value of these two factors directly from machine, so that we can control avoidable losses by analysing efficiency of machine and its operator. The proposed monitoring system simply consists of reflective sensor which helps in identifying performance of machine by actually monitoring the status of the needle of a sewing machine. It also consists of real-time clock which avails us with an accurate run time of machine. These data from the machine are sent to a database server with the help of Wi-Fi module which is used to evaluate real- time overall equipment efficiency and do needful amendment at right time.

KEYWORDS: production monitoring system, Internet of things, reflective sensor, garment industry, Wi-Fi

I. INTRODUCTION

In the case of the garment industry, India is rich in two factors- availability of raw material and cheap as well as skilled labours but it is unable to produce that sufficient productivity. If management can get the real time report from machine they can analyse properly where industry is actually lagging and where amendments need to be made.

If labour and machine are continuously under the eye of executives, this will create a pressure on labour to avoid extensive breaks. In another way, it will benefit to labour, suppose if they are dealing with some wearied down machine then by analysing the weak efficiency of a machine, the supervisor will make required maintenance of the machine. For fulfilling our target we are making use of current technology-Internet of things- which has brought the fourth revolution in Industries and came up as Industrial Internet of things for industry based application. Internet of thing is a way of connecting living or non-living things with each other provided with unique identification. It is an approach to control or monitor any distant object which may be a man or machine by either a man or machine. Complete IoT-based system revolves around four processes - identity, perception, processing and information transfer. For connecting the things they need to provide an identity which can be in the form of RFID, barcode or unique IP address. Then comes perception, the purpose of which is to get connected with either man or machine. So for fulfilling that a sensor or actuator based system need to develop which is going to produce the required data. After that, data is processed and made transferable and finally using any IoT protocols (Bluetooth, Zigbee, Wi-Fi, GSM etc.) data is transferred to its system centre.This work is IoT-based and the ultimate target is achieved by performing above four processes. In this project for unique identification we have provided different IP address to each machine, and then the perception here is

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to get real time data-actual counts and runtime from a sewing machine. Processing of data is done in the controller and to transmit data we have made use of low power and low-cost Wi-Fi module ESP-12.

II. RELATED WORK

A study was performed on a garment industry namely Unitex Ltd Bangalore in which researchers Achuth N and Shashi Kiran G concluded that Indian garment industry is still sticking to the traditional way of collecting and analysing the data from the machine. It discusses the various process and production flow in a garment industry where computerized analysis is possible [1]. It also presents that in order to sustainably hold a firm footing in the production of Ready Made Garment (RMG) computerization at each stage is needed. This is a very relevant need which came in light earlier also and the researchers of Ahmedabad Textile Research Association had developed a production monitoring system [2] for the garment industry. Their system consists of sensing means, which are mounted on the main shaft and in front of wheel plate and master computer to display the information. This system involves a lot of hardware for each sewing machine like LCD display, real time clock, keyboard, a master computer, cable etc. Researcher of this industry estimated the avoidable losses and concluded that instead of post-mortem approach if we work on these losses at right time then efficiency can be highly increased.For a realizable and simple use of technology already implemented system in different industries across the world are studied. It is concluded that Overall Equipment Efficiency (OEE) index is considered as the basis of evaluating production in industries and to get real time figures use of production monitoring system is found in trend in many industries[4][5]. For monitoring production in industries PLC-SCADA based subsystem using LAN or RS-485 like communication means were used to be in trends [3]. In an industry of China, an embedded web server-based monitoring system [6] is proposed to connect heterogeneous systems. It is completely realizable and a network is formed using LAN cables. After the advent of IoT all these cables and wires, lots of circuitry everything gets replaces by wireless options. Internet of things brings up the fourth revolution in industries which eases monitoring and controlling in industries. This paper [7] has reviewed closely Industrial IoT technology, all its advantage and challenges have been elaborated which needs to be considered essentially before developing an industrial IoT-based application. There are many issues in IoT like security, large scalability, reliability and availability which need to be considered before developing IoT-based system few remedies like managing latency and scalability through localization of computation is also mentioned in their study. Scalability issues have also been discussing in paper “Database-as-a-Service for IoT” in which database is proposed as a service for the IoT-based application. They introduced few important feature that needs to be followed while creating a system for IoT storage like- supporting the various protocol, REST (Representational State service) based web service, able to uniquely identify each resource. The REST [8] architecture allows for a uniform way to access and modify a resource. There are various proposed IoT protocol, in this [9] paper use of Wi-Fi has been done to monitor the cold heading machine and grinding machine in a workshop. They utilized displacement sensor to collect a real-time object from machine and USR-WiFi232-T to transmit data to a server. Encourage with the quick advancement of IoT-based application a low power and ease Wi-Fi module ESP8266 is in the pattern. Understudy from GTU PG School proposed an "ESP8266 based Implementation of Wireless Sensor Network with Linux Based Web-Server". In their venture they associate distinctive sensor hub through ESP8266 and send its information on web server executed on Raspberry-pi, information from this server is further gotten and upgraded in MySQL database.

III. PROPOSED SYSTEM

During the close observation of various sewing machines, it is found that here are various places where some sensor can be placed so as to analyse stitches carried out during garment manufacturing. We found one of the best possible locations to be near stitching needle. On the behalf of principle of operation of the needle, we select IR sensor which is mounted in such a way that it will work on reflection principle. Block diagram of proposed monitoring system has been shown in fig 1, explanation of its blocks are as following.

Sensor nodes-A pair of reflecting sensor is placed in front of stitching needle holder of sewing machine such that needle when goes down for stitching, acts as an obstacle for this sensors.IR sensor works on the principle that when Infra-Red(IR) rays emitted by IR transmitter get reflected due to the obstacle, received by IR receiver will produce a high output.

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Analog-to-digital converter-Analog output of the sensor is converted into digital output using LM358 in the form of “0” and “1” So whenever needle will go down will produce output “1” and when up it will produce “0”. This needle status in form of “0” and “1” will go into controller ATmega328.

Controller –ATmega328 controller has been used which is an 8-bit microcontroller based on AVR. It has built-in communication protocol like I2C and UART and many other essential features.

Real Time Clock-RTC module of DS1307 is connected to ATmega328 through two wire interface for reading the on and off time of the machine.

Level shifter: MOSFET based level shifter is needed to drop down voltage in between, as ATmega328 operate on 5V and ESP-12 on 3.3V.

Fig 1: TCRT-5000 sensing the movement of needle in sewing machine

Wi-Fi-In order to connect the machine to server Wi-Fi module ESP-12 is connected to the controller through a level shifter and have used SPI protocol.ESP-12 is based on IEEE 802.11 b/g/n Wi-Fi protocol and it supports various network protocol. Here considering the need for consistency of data we have utilized TCP/IP network protocol for communicating with the server.

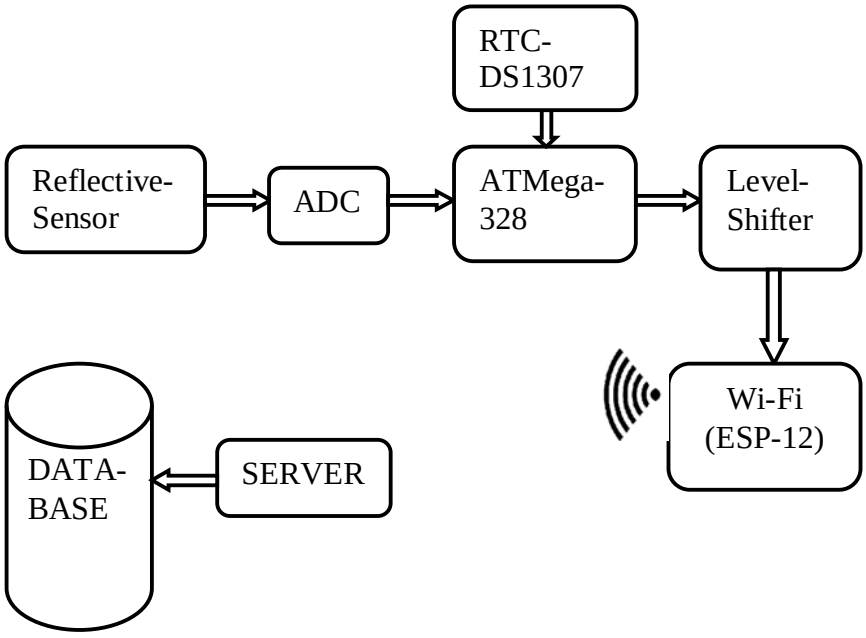

Fig 2: Block diagram of garment production monitoring system

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Database Server- For developing a database server we opted WAMP a complete environment of Web server for windows. It consists of four key elements of any web server-Operating-system (Windows), Apache, and MySQL to handle databaseand PHP for creating a dynamic page.

For understanding the complete working, it's better to know the function of controller first. Here our controller is the heart of complete system involve in four task –one is receiving digital data from LM358, second analysing it if stitches are taking place or machine is in rest mode , third reading time from RTC when needed, fourth- through UART sending data to ESP-12 so that it can be transmitted wirelessly to server.

IV. WORK FLOW

The basic steps in which working of our complete system can be summarized are-

1. Wi-Fi module ESP-12 is connected to server and start sending machine status to server.
2. Here in machine side controller regularly check the output from sensor.
3. If for a while series of "101010" is observed that is considered as start of machine.
4. That particular time is considered as start time and is read from RTC DS1307 and stored in controller ATmega-328, since controller is connected to Wi-Fi a regular transmission of data from controller to ESP-12 then to server takes place regularly.
5. Counter in controller is started, system always counts number of "01" that is every time state of sensor changes it is considered as stitches and is counted.
6. These data start time and stitches are sent to server continuously.
7. If for a while static condition is observed that means if for 10 seconds regularly series of "11111" or "00000" is read it is assumed as machine halt.
8. Then counter stops counting.
9. Time at which machine stops stitching, is read from RTC and stored as stop-time.
10. These data of start time and stop time and also count values that is number of stitches has been sent to Wi-Fi module continuously which in- turn unceasingly sent to server to update database.

In this way we collect data from this IoT based monitoring system so that supervisors able to monitor the working of each sewing machine in garment industry.
With the help of PHP and SQL on server side we collect this data and update in database.
These data of runtime and actual stitches is used by industry production engineers and managements to evaluate overall equipment efficiency, machine capacity, line efficiency etc. kind of analysis. Also directly from these database, charts are prepared of comparative efficiency of various machines which gives a clear vision of industry as to which link is weak in industry and which needs a necessary amendments.
We further uses fusion-chart like tool in PHP to directly prepare chart from database, so that a clear graphical vision of production going on in industry can be analysed in one go.

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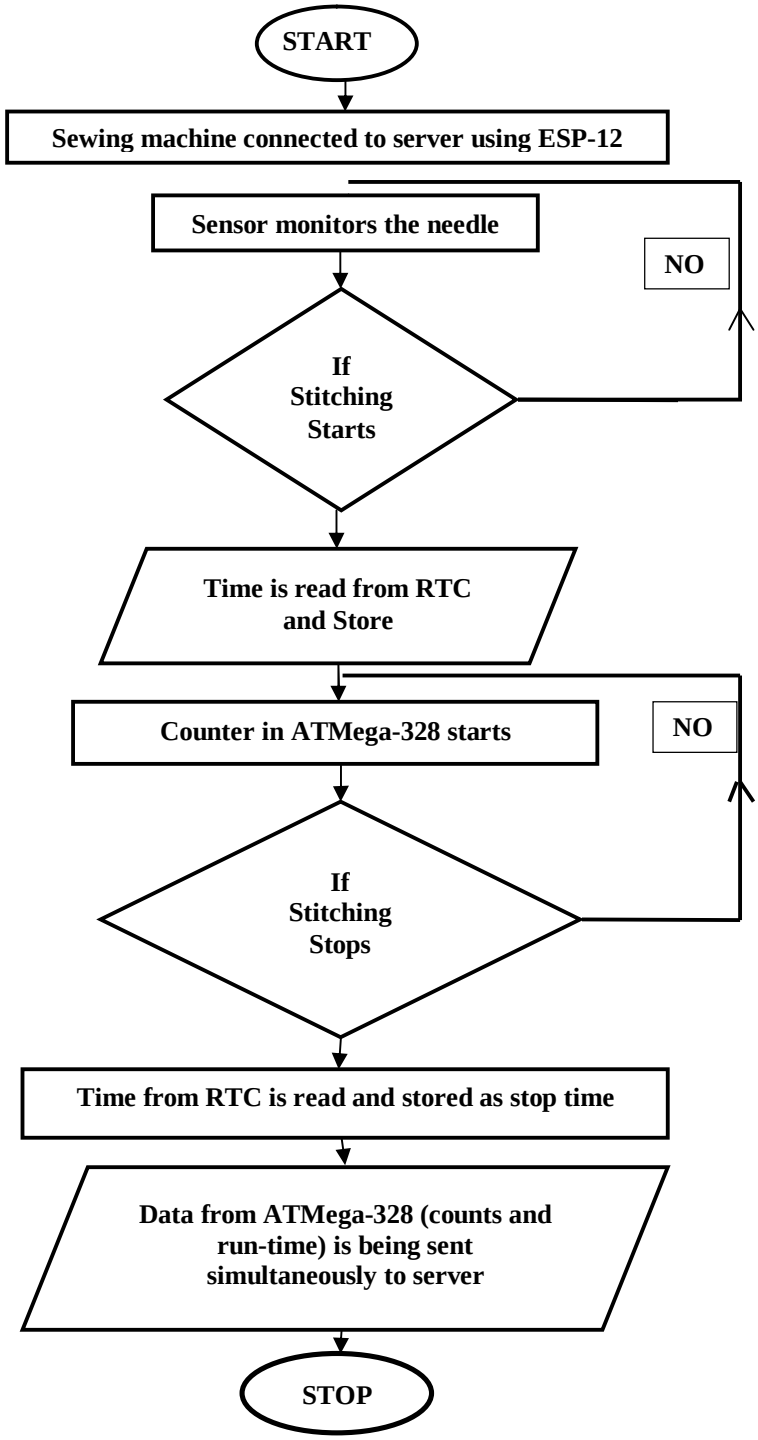

Fig 3: Flow chart of working

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V.RESULT

A) EVALUATION OF OEE:

Table 1is the primary database which is been directly updated from machine. Here data like stitches, start time and stop time, is directly received from module and then runtime and speed is calculated using functions in PHP.

Table 1: Database of single machine

Serial_No	Machine_id	start_time	stitches	stop_time	run_time	speed
1	1_db	10:05:46	6492	10:10:15	269	1448
2	1_db	10:11:23	2613	10:12:58	95	1650
3	1_db	10:13:04	3507	10:17:02	238	884
4	1_db	10:25:06	3802	10:28:19	193	1182
5	1_db	10:45:23	4012	10:48:34	191	1260
6	1_db	10:49:14	7743	10:56:14	420	1106
7	1_db	10:56:44	11619	11:05:19	515	1354
8	1_db	11:15:06	7813	11:21:13	367	1277
9	1_db	11:24:15	7904	11:30:43	388	1222
10	1_db	11:36:43	15348	11:48:13	690	1335
11	1_db	11:56:21	6612	12:01:52	331	1199
12	1_db	12:04:14	4213	12:07:47	213	1187

Table 2 : Comparative data from database of different machin

S_no	Machine_id	Avg_speed	Total_runtime
1	1_db	1290	5410
2	2_db	1102	4345
3	3_db	1196	5908
4	4_db	1389	5784
5	5_db	989	2320
6	6_db	1289	5396
7	7_db	1494	5921

Using data from table 1 equipment efficiency can be measure in following way-

Overall Equipment Efficiency[11] is

$$\boldsymbol{OEE = Availability * Performance * Quality} \qquad eq \text{ (Error! Bookmark not defined.)}$$

where-

$$\boldsymbol{Availability(Speed) = Total\ Runtime/Total\ time} \text{ eq (1. 1)}$$

where –

Run time=Stop time-Start time

Total Run time = Summation of each run time

Total time=Total working hour

$$\boldsymbol{Performance = Total\ stitches/Target\ stitches} \text{ eq (1. 2)}$$

where -

Total count =Total number of stitches /run time

Target counter =Rated stitches per minute

$$\boldsymbol{Quality = Good\ Quality/Total\ Count} \quad \text{eq (1. 3)}$$

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B) COMPARATIVE CHART:

Table 2 shows the merged database which collect data from primary database of different machine and shows the average speed and total runtime of different database.

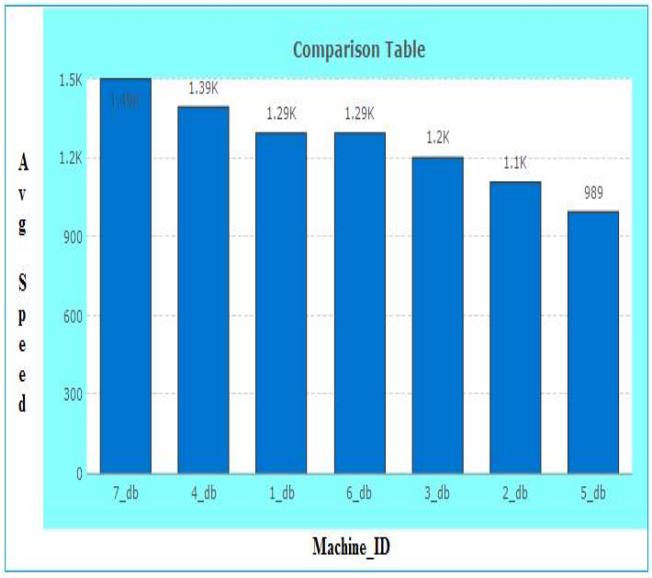

Fig 4: Comparison of Average speed of different machines

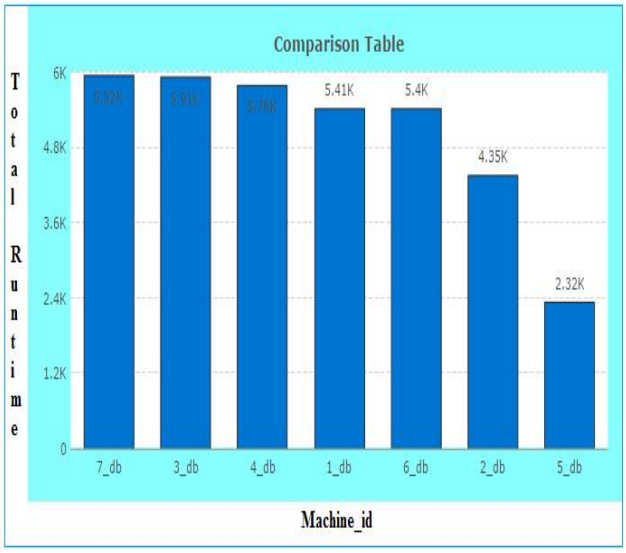

Fig 5: Comparison of total runtime of different machines

Above two figures represent the chart prepared from table 2. In Fig 4 comparison between averagespeed of different machines are shown, different machines are identified by their different machine_id,here all machines are arranged in decreasing order of their speed. Similarly, comparison chart of their total run-time is also prepared.

These are few analysis methods and reports are depicted.
All this work traditionally is done by supervisor manually through pen and paper at end of the day. Then on the basis of those results, planning for next day is accomplished and many times this necessary but hectic job is just dropped. So this results in low efficiency of production, but in proposed method if concurrently we are getting data directly from machine then all analysis and supervision job will become effortless and stress-free.

V. CONCLUSION

In this project we have made sure in designing and placing our monitoring system so that it must not disturb the operator operating the sewing machine. Different sensor has been tested on machine and then TCRT-5000 is chosen which is able to meet our requirement of fast response time, cost and stable structure which does not get interrupted by vibration of machine. Also for getting accurate time we have used an additional real time clock rather than using built in RTC of Atmega-328. Further with traffic and distance concern, a cost effective and commonly used Wi-Fi module ESP-12 is used which is employ just for connecting to server and continuously sending real time data from machine, although there is a bit lag between data sent to ESP-12 and data updated in database but still at last the data received in database is accurate, which can be used by executives for checking efficiency of machine and labour.

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