Evolution in Electrical and Electronic Engineering Vol. 4 No. 2 (2023) 638-646

EEEE

Homepage: http://publisher.uthm.edu.my/periodicals/index.php/eeee
e-ISSN : 2756-8458

A Metal Bed Production Monitoring System using Internet of Things

Muhamad Ridzuan Idrus[1], Tasiransurini Ab Rahman[1,2]*

[1]Faculty of Electrical and Electronic Engineering,
Universiti Tun Hussein Onn Malaysia, Batu Pahat, Johor, 86400, MALAYSIA

[2]Computational, Signal, Imaging and Intelligence Focus Group,
Faculty of Electrical and Electronic Engineering,
Universiti Tun Hussein Onn Malaysia, Batu Pahat, Johor, 86400, MALAYSIA

*Corresponding Author Designation

DOI: https://doi.org/10.30880/eeee.2023.04.02.077
Received 28 June 2023; Accepted 20 August 2023; Available online 30 October 2023

Abstract: As the human population grows, the demand for essential goods, including metal beds is increasing day by day. This scenario benefits the bed manufacturing industry. However, the ratio of supply and demand is unbalanced due to inaccurate data on the quantity of production. Therefore, *A Metal Bed Production Monitoring System using Internet of Things (IoT)* was developed to overcome this problem. The implementation of this work uses an ESP32-type microcontroller module to develop a prototype of a metal bed production monitoring system for the manufacturing industry. The input received from the production line will be detected by the infrared sensor placed on the metal bed frame mold. This work provides a visual dashboard a production line information archived by using the Node-Red platform. The collected data is converted to *.excel* form which allows the management to monitor the quantity of production.

Keywords: Metal Beds, IoT, ESP32, Infrared Sensor

1. Introduction

Numerous types of technology have been developed for Malaysia's industry to support the economy. The increase in population causes the demand for production to increase. This scenario leads to a lack of production in which the government is forced to allocate additional funds to import products from abroad because local suppliers cannot meet the current demand. The Malaysian Investment Development Authority (MIDA) is aware of this situation and started promoting the Fourth Industrial Revolution (IR4.0) industry in July 2021 [1].

IR4.0 brings several significant technological advancements with stunning new digital technology capabilities ready to change manufacturing industries and optimize the use of energy resources [2]. The primary technologies that comprise IR4.0 include big data and analytics, autonomous robots, 3D

**Corresponding author: surini@uthm.edu.my*

simulation, cyber security, cloud computing, additive manufacturing, augmented reality, and industrial Internet of Things (IoT).

An IoT platform serves as an interface for device-to-user data transfer and reception. Device management, connection, analytics, data management, security, and application development are frequently offered by an IoT platform. Many industries across the country have advanced thanks to the IoT system. IoT technology has been used in manufacturing systems; including cloud servers, robotic systems, and monitoring systems.

Technology and innovation should facilitate people's daily tasks, however, in the manufacturing industry, it has a downside from various angles. The technology is significantly expensive to implement. The small and medium industries are the most affected by the lack of a productive monitoring system [3], such as in a metal bed factory.

The metal bed factory in Malaysia relies on manual systems for monitoring and recording the quantity of production. They currently do not have an IoT system for collecting data as part of their monitoring system. Thus, this work is developed to overcome the problem, where the system can monitor and record the metal bed production automatically. The IoT system used in this work aims to send information from the production line to the management. The management will receive information about the production line through the cloud system.

The implementation of this work uses an ESP32-type microcontroller module. The input received from the production line will be detected by the Infrared Sensor designed and placed on the metal bed frame mold. The IoT platform used in this system is Node-Red, which provides a visual dashboard that displays data received from the Arduino Cloud. With this implementation, the data collected from the prototype test can be translated into Excel form and allow the management to monitor the quantity of production.

2. Materials and Methods

2.1 Materials

This work is divided into two parts: software, and hardware. Specifications and properties of materials, equipment, and other resources used in the software used are as follows:

i. Software: Wokwi, Node-red, and Arduino IDE
ii. Hardware: ESP32, Infrared sensor (IR), LED indicator, jumper wire and breadboard.

The ESP32 is not only used as Wi-Fi but it is a line of SOC microcontrollers that are affordable, low-power, and equipped with a dual-core processor, Bluetooth, and Wi-Fi. Additionally, the ESP32 has many more new functionalities than the ESP8266.

There are two types of IR sensors; active and passive. The infrared source and infrared detector are the two components of an active infrared sensor. Photodiodes and phototransistors are two types of infrared detectors [4]. When an object reflects the infrared energy from the infrared source, it falls onto the infrared detector. Infrared detectors are essentially passive infrared sensors. Passive infrared sensors do not use infrared sources and detectors. Instead, they rely on infrared energy as the heat source in thermal infrared sensors. Higher detection performance is offered by infrared quantum-type sensors. It is faster than infrared detectors of the thermal kind. The wavelength affects how photosensitive the quantum-type detectors are.

Figure 1 shows a schematic diagram that visualizes the connection between the LED, the ESP32 module that is used to run the system, and five IR sensors that are used to detect the frame.

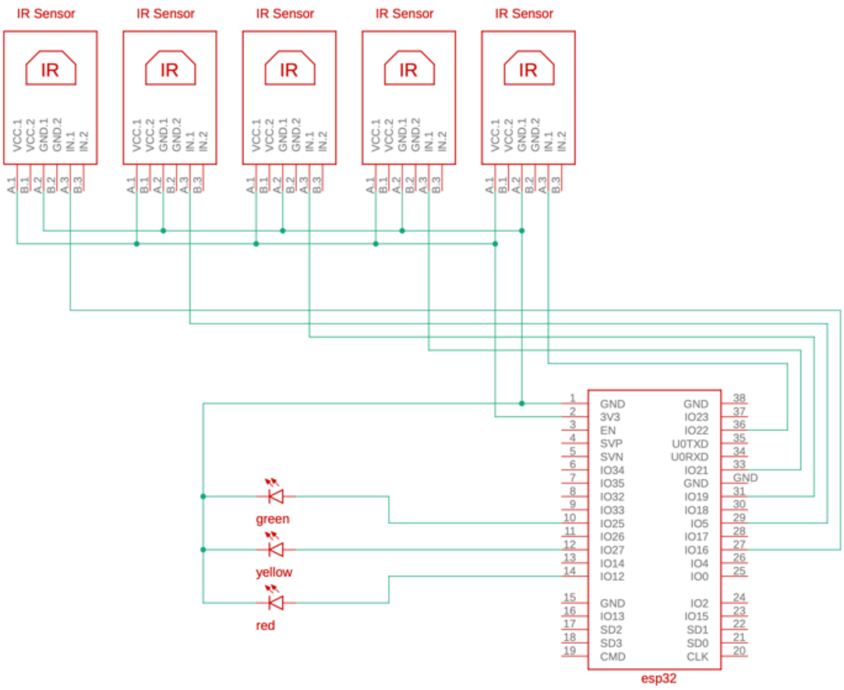


Figure 1: Schematic diagram for circuit components

2.2 Methods

Figure 2 shows a structure design for a metal bed in factory production. Metal bed production requires main parts such as a headboard, floorbase, and footboard. This work is focused on monitoring and recording the welding section for the floorbase part.

Figure 2: Structure design for metal bed

Figure 3 visualizes the sensor placement used to detect the frame bed. When all the sensors on the mold detect the metal, it will signal the system indicating that the product is ready to be processed. However, if the sensor is not detected, it will show the status on the LCD as 'On-going'. The sensor sends a signal to the IoT cloud and can be monitored through the IoT interface apps.

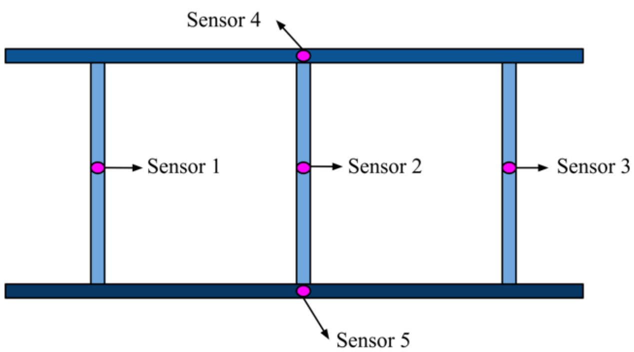


Figure 3: Mold design for the floorbase

Figure 4 shows a wire harness made from jumper wire wrap with an electrical sleeving tube. It is a jumper wire, thus easy to remove and install from the prototype and component. It involves little care to do the maintenance work; troubleshooting and replacing faulty components.

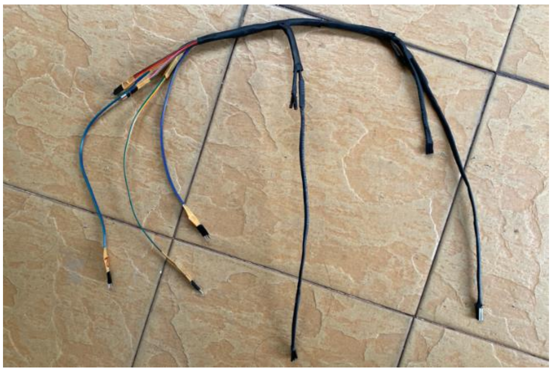
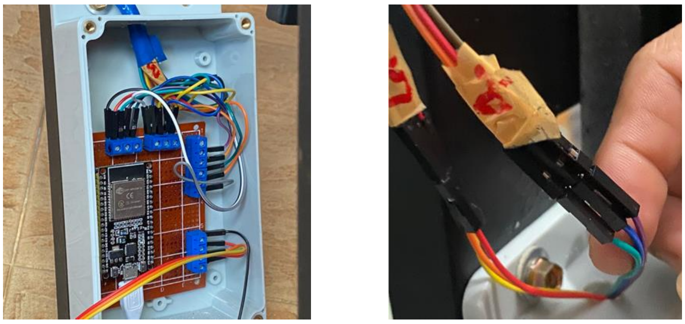


Figure 4: Wire harness for the circuit implementation

Figure 5(a) shows the installation of a wire harness to the mold prototype. The circuit board is stored in a PVC junction box. The components were carefully installed to prevent any physical contact. Additionally, the wire harness is tagged as shown in Figure 5(b) to prevent short circuits or incorrect connections.



(a) (b)

Figure 5: Installation of (a) circuit board and (b) cable tagging

An initial observation that can be seen by a worker in the production line is the LED indicator. As shown in Figure 6, the installation of the sensors was done to the surface of the mold. It is to facilitate any future improvement and maintenance work.

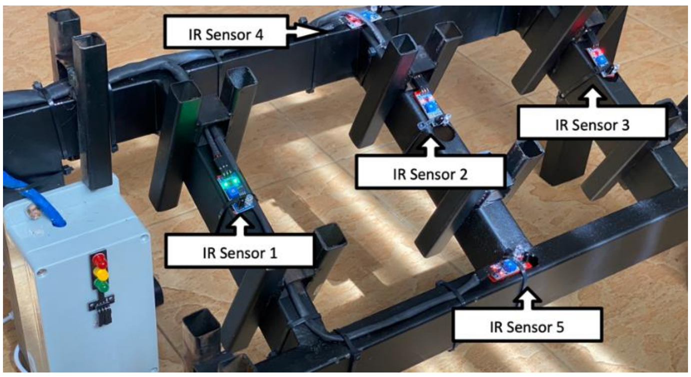


Figure 6: Mold prototype with implemented circuit

2.3 Visual dashboard

The user interface is the information barrier between the two subsystems, where data is transformed to suit the opposite subsystem. There are other interfaces besides the human-machine interface, such as human-environment; and machine-environment. A graphical user interface (GUI) is one type of user interface that usually contains graphical content, such as windows, icons, and buttons.

These should be representative and understandable to the user to control the input of data into the program. Graphical content can be arranged in different ways to communicate with a person interacting with an interface. For the viewer, a visual dashboard must represent important information, such as general information and control production details, as shown in Table 1.

Table 1: Visual dashboard graphical content

Information	Description
General information	- Product name - Date - Real-time
Control production	- Target - Actual - Different

3. Results and Discussion

The development of this work is done by applying an IoT platform and component. The explanations are focused on a final prototype, software simulation result, Arduino IDE monitor, an IoT platform dashboard, notification from telegram, Google sheet data and how the constructed system is evaluated. Results are divided into three; visual dashboard, data collected and notification.

3.1 Software simulation

Wokwi is one of the free source websites that uses the same language as Arduino. The monitor's serial output is the same as the Arduino, as shown in Figure 7. Because of that, the output result of the system testing is displayed on this simulation software. The first stage is *'Complete 50%'*. After that, the second stage will start. When completed, it will display the status '*Complete*'. The system will count the product and the data obtained will be recorded on a Google sheet. This process will be running until the product reaches the desired target.

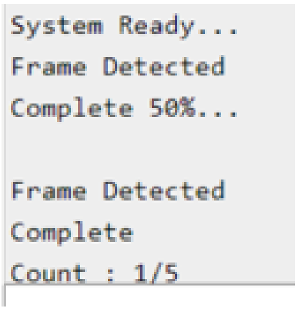


Figure 7: *Wokwi* simulation result

The coding is loaded to the ESP32, which is ready to start. The serial monitor on the Arduino IDE will display the output, as shown in Figure 8. At the same time, the computer needs to connect to the same Wi-Fi server as the one used in coding. This is for the Arduino to publish the output to the IoT platform, *Node-Red*.

Figure 8: Arduino IDE simulation result

3.2 Visual dashboard

In this work, a visual dashboard is created with production line information. *Node-Red* is used as an IoT platform that displays the visual dashboard of the system. There are two parts: general information and control production information, as shown in Figure 9. The data displayed on the dashboard is the result transmitted from the Arduino, thus the speed of data transmitted and received depends on the speed of the internet users. Data from the system will be sent to Google Sheets for storage records.

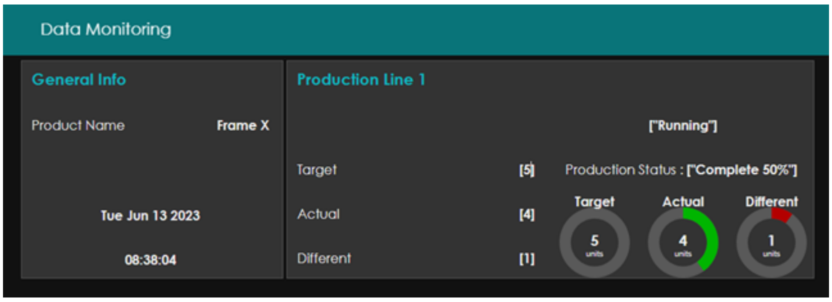
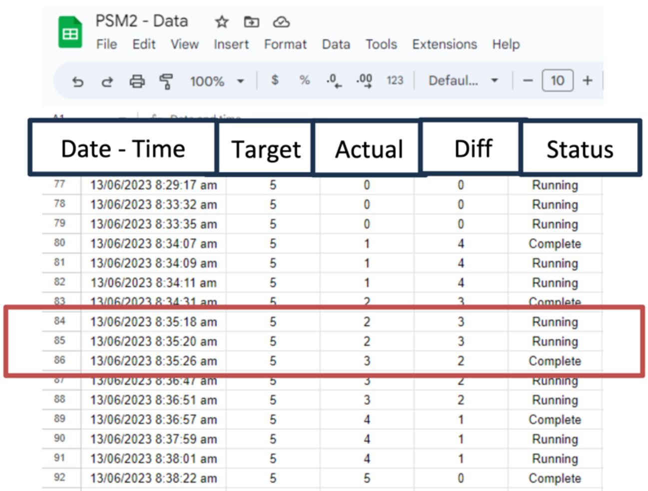


Figure 9: Visual dashboard of bed monitoring production line

3.3 Data collected

Google sheet data provides the data of total production per day and the time taken for one product to be completed. Figure 10 shows a product on the welding section running at 8:35:18am (line 84) and completed at 8:35:26 (line 86). This means that the time taken to complete a single product is 8 seconds during testing. The production time is important in real bed manufacturing especially for the management team to estimate how much time it takes to produce the product.



	Date - Time	Target	Actual	Diff	Status
77	13/06/2023 8:29:17 am	5	0	0	Running
78	13/06/2023 8:33:32 am	5	0	0	Running
79	13/06/2023 8:33:35 am	5	0	0	Running
80	13/06/2023 8:34:07 am	5	1	4	Complete
81	13/06/2023 8:34:09 am	5	1	4	Running
82	13/06/2023 8:34:11 am	5	1	4	Running
83	13/06/2023 8:34:31 am	5	2	3	Complete
84	13/06/2023 8:35:18 am	5	2	3	Running
85	13/06/2023 8:35:20 am	5	2	3	Running
86	13/06/2023 8:35:26 am	5	3	2	Complete
87	13/06/2023 8:36:47 am	5	3	2	Running
88	13/06/2023 8:36:51 am	5	3	2	Running
89	13/06/2023 8:36:57 am	5	4	1	Complete
90	13/06/2023 8:37:59 am	5	4	1	Running
91	13/06/2023 8:38:01 am	5	4	1	Running
92	13/06/2023 8:38:22 am	5	5	0	Complete

Figure 10: Data collected from the production line

Figure 11 shows the graph for the date and time versus the number of production. The graph provides the time allocated for producing one product and the daily range of average quantities obtained. The number of productions was set to a maximum of 10. The counter started to count when the first product was produced. The total time to complete the total production is 6.73 minutes. It refers to how long it takes for a worker to complete production according to the target set. The information on the graph can assist the management team in calculating the optimum production quantity in a month.

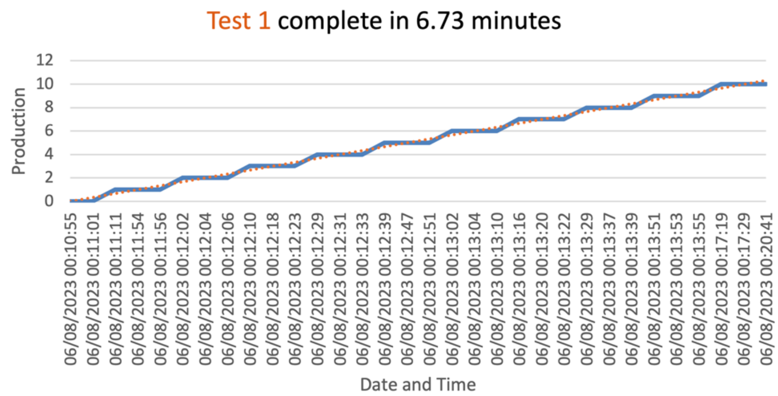


Figure 11: Testing of *A Metal Bed Production Monitoring System using the IoT*

3.4 Notification

The *Node-Red* platform will notify *Telegram* that the system is ready when the manufacturing line starts operating. The user will get an alert message where 'System Ready' will be the text of the message sent by the *Telegram* bot. The 'Target Complete!' message will be received once the product has arrived at the desired quantity.

Figure 12: Notification alert

As shown in Figure 12, the management team will get an alert message. The *Node-Red* platform will notify *Telegram* that the system is ready when the manufacturing line starts operating. 'System Ready' will be sent to the *Telegram* bot. The 'Target Complete!' message will be received once the product has reached the target.

3.5 Prototype

Figure 13 shows a complete structure of the floorbase bed metal frame with the mold prototype. The installation of the sensors was done on the surface of the mold. It is to facilitate any future improvement and maintenance work.

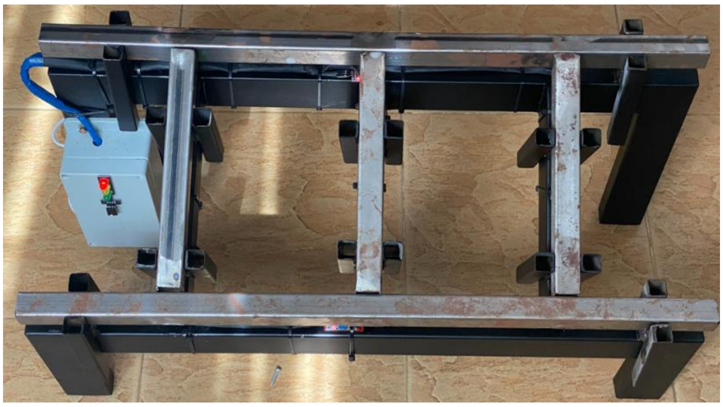


Figure 13: Mold prototype with the implemented circuit

3.6 Discussion

The following items can assist the management of the metal bed manufacturer after all testing is completed and the data collected is recorded. First, the collected data can be used to calculate the optimum quantity produced in a month. This is possible because the system provides the time allocated for producing one product and the daily range of average quantities obtained. The management can then determine how many workers are required to reach the intended quantity.

4. Conclusion

Currently, a monitoring method in metal bed manufacturing is not too systematic. This is due to insufficient precise data for the quantity of metal bed production. *A Metal Bed Production Monitoring System using the IoT* tried to overcome this issue by providing an automatic monitoring system.

The main objective of this study has been achieved by the development of a prototype for a metal bed production monitoring system. An ESP 32, IR sensor and LED have been used in the prototype with the metal construction of the mold. This work applied the *Node-Red* platform where it serve as a link between users and the hardware part.

After the development of *A Metal Bed Production Monitoring System using the IoT*, the tests were conducted to verify the system's functionality. The sensor can detect the metal frame and send a signal to the microcontroller before being displayed on the visual dashboard. The system is also able to provide early monitoring by LED indicators and telegram bot notification alerts.

Acknowledgement

The authors would like to thank the anonymous reviewers for their constructive comments, as well as the Faculty of Electrical and Electronic Engineering, Universiti Tun Hussein Onn Malaysia for their logistics support.

References

[1] Othman, Zakirah, Mohamad Faizal Ahmad Zaidi, and Wan Ahmad Jaafar Wan Yahaya. "Adoption Strategy for Electrical and Electronics (E&E) Small and Medium-Sized Enterprises (SMEs): Malaysia IR4. 0 Perspective," Journal of Advanced Research in Applied Sciences and Engineering Technology, vol. 28, no. 3, pp. 27-38, 2022.

[2] Balakrishnan, Bavaani, Zakirah Othman, and Mohamad Faizal Ahmad Zaidi. "Review of IR4.0 readiness and adoption in Malaysian manufacturing sector." International Journal of Business and Economy, vol. 3, no. 2, pp. 24- 35, 2021.

[3] Pech, Martin, and Drahoš Vaněček. "Barriers of new technology introduction and disadvantages of Industry 4.0 for industrial enterprises." Serbian Journal of Management, vol. 17, no. 1, pp. 197-206, 2022.

[4] L Tao, T. Volonakis, B. Tan, Y. Jing, K. Chetty, and M. Smith. " Home activity monitoring using low resolution infrared sensor." Cornell Univ., pp. 1-8, 2018, https://doi.org/10.48550/arXiv.1811.05416