Faculty of Natural and Applied Sciences Journal of Scientific Innovations
Print ISSN: 2814-0877 e-ISSN: 2814-0923
www.fnasjournals.com
Volume 5; Issue 4; March 2024; Page No. 1-7.

Design and Construction of an Improved Production Line Counter

[*]Adekanmbi, M., Ogotute, A.A., & Amaechi, C. J.
Department of Physics, Ignatius Ajuru University of Education, Port Harcourt, Rivers State, Nigeria.

***Corresponding author email:** sherpmart@yahoo.com

Abstract
A production line is a type of production system where products or products go through several workstations in a fixed or predetermined sequential order. In this work, a production line counter was designed, and also applies CAD approach to ensure minimal errors during construction. This device consists of an ESP32 development board which serves as the microcontroller in this design, an SD-Card module for offline data storage, a Real Time Clock (RTC) for accurate recording of time and date and a 5V power supply. The counting of objects or products in this work is restricted to unidirectional counting. This is to be achieved using an IR sensor consisting of an IR emitter and an IR receiver. As objects pass by this sensor, IR waves from the IR emitter which emits infrared waves are reflected and received by the IR receiver which results in a HIGH output signal from the IR sensor. This HIGH signal is received by the microcontroller and increments the counter value by 1. The counter value is updated on the SD Card and on the IP address of the ESP32 which serves as the webserver. This counter value can thus be accessed via a web browser by the Wi-Fi of the ESP32 thus, enabling offline and online access to data and also providing an automated means of storing and retrieving data of the production process.

Keywords: Design, Construction, Production, Line Counter, Improved.

Introduction

The huge advancement in the field of electronics is directly responsible for the surge in technical development in today's society, and the future seems to hold no bounds for it. Electronics have advanced in line with this technological development, making human activity in many spheres of life more meaningful and less stressful. Automation is one of the many areas that is being influenced and progressed by technical advancements in electronics (Adjardjah et al., 2016). The huge advancement in the field of electronics is directly responsible for the surge in technical development in today's society, and the future seems to hold no bounds for it. Electronics have advanced in line with this technological development, making human activity in many spheres of life more meaningful and less stressful. Automation is one of the many areas that is being influenced and progressed by technical advancements in electronics (Benoit, 2000).

According to Mohana et al. (2019), a production line is essentially a system for producing goods that pass through a set number of workstations in a planned or fixed order. These workstations are made up of one or more machines that carry out particular tasks, like assembly, inspection, counting, and processing, on the product. Numerous industries have adopted the idea of production line automation as a result of the development of more advanced technologies related to production lines. Several industries, including those in the food, automotive, paper, home products, and semiconductor manufacturing sectors, are among those utilizing production line automation technologies at the quickest rate of growth (Gershwin, 2012). The production line typically consists of several workstations, such as counter workstations, which decide how many products will be produced. This workstation is crucial to the efficient operation of a production line since it is frequently used to calculate the rate, speed, and length of production. As a result, it is crucial to the entire performance and functionality of a production line. Counters use a variety of technological methods to count the amount of items. The type of product processing carried out on the production line typically determines the technology to be used (Liang & Xiao, 2013).

Counters are tools used in computing that record (and occasionally display) the frequency of a given event or process, frequently about time. The sequential digital logic circuit, which contains numerous output lines and a clock input line, is the one that is most frequently employed. The binary or BCD number system is represented by the values on the output lines as a number. The value in the counter is increased or decreased with each pulse applied to the clock input. A cascade of flip-flops is typically used to create counter circuits. Counters are a frequently used component in digital circuits. They can be created as standalone integrated circuits or occasionally as a component of larger integrated circuits (Bierbooms, 2012). Depending on the type of counter, the output may be encoded or a direct representation of the counts (a binary number). Examples of the formal include ring counters and counters that output Gray codes.

Different techniques are used by electronic counters to convey data. These could involve the usage of a liquid crystal display panel or a seven-segment display screen. The majority of the time, this data is transferred to an external device, such as an SD card, or over an electronic communication protocol, like GSM, RF, Bluetooth, internet, or Wi-Fi. While combining Wi-Fi and an SD-Card, respectively, this study aims to combine data transit and storage. Based on the IEEE 802.11 family of standards, the Wireless Fidelity (Wi-Fi) family of wireless network protocols allows data exchange between nearby digital devices using radio waves. Wi-Fi is mostly used for local area networking of devices and Internet access. Line-of-sight usage is recommended for Wi-wavebands Fi's due to their comparatively high absorption levels. Common obstacles like walls, pillars, household items, etc. tend to reduce the communication range. However, in busy areas, this also aids in ensuring minimal interference across several networks. An access point (or hotspot) typically has an interior range of 20 meters (66 feet), but some contemporary access points advertise an outdoor range of up to 150 meters (490 feet). Hotspot coverage might be as limited as one that does not allow roaming between them, or as big as many square kilometres (miles), employing multiple overlapping access points. Wi-Fi has improved in spectrum efficiency and speed throughout time (Erden et al., 2015). As of 2019, some Wi-Fi models running on compatible hardware can reach close-range rates of 9.6 Gbit/s (gigabit per second) (Mohana et al., 2019)—in walled-in rooms. To show and document data, this work suggests the design, development, and deployment of an enhanced production line counter that makes use of the Internet of Things (IoT) and an ESP32 Wi-Fi module. This counter device will have an Infrared sensor (IR sensor), an SD-card module with a 1GB SD-Card attached to it, a Real-time clock (RTC) to provide exact date and time details of each count, a 5V DC power source, and connection wires. This project uses an SD-Card module and a real-time clock to provide offline data storage and accessing (RTC) (Chituru, 2017).

Materials and Methods

A digital counter is a piece of electronic equipment used to count things, persons, or events. Using an ESP 32 as the microcontroller, a 1GB SD-Card for data storage, an SD-Card module, an RTC for precise time and date determination and documentation, a 5V power supply, and an IR sensor, a unidirectional production line counter is presented in this work. The idea behind this effort is to deploy IR sensors on conveyors that move along production lines to identify objects that pass by them. The infrared rays from these things that pass by the IR sensor are reflected to the sensor, which results in a LOW trigger. An internal logic NOT gate circuit on the IR is used to process this low trigger single. This object count is uploaded to the SD Card with the corresponding time and date. The count is also uploaded by the ESP32 via web server protocol, allowing for the object count to be viewed in real-time via Wi-Fi. The production line counter is designed using Proteus Professional Design Suite. A sensor that sends a HIGH signal to the sensor's output pin. The ESP32's GPIO (general purpose input/output pin) receives this output signal. The microcontroller interprets each HIGH signal as +1, increasing the item count by 1 as a result.

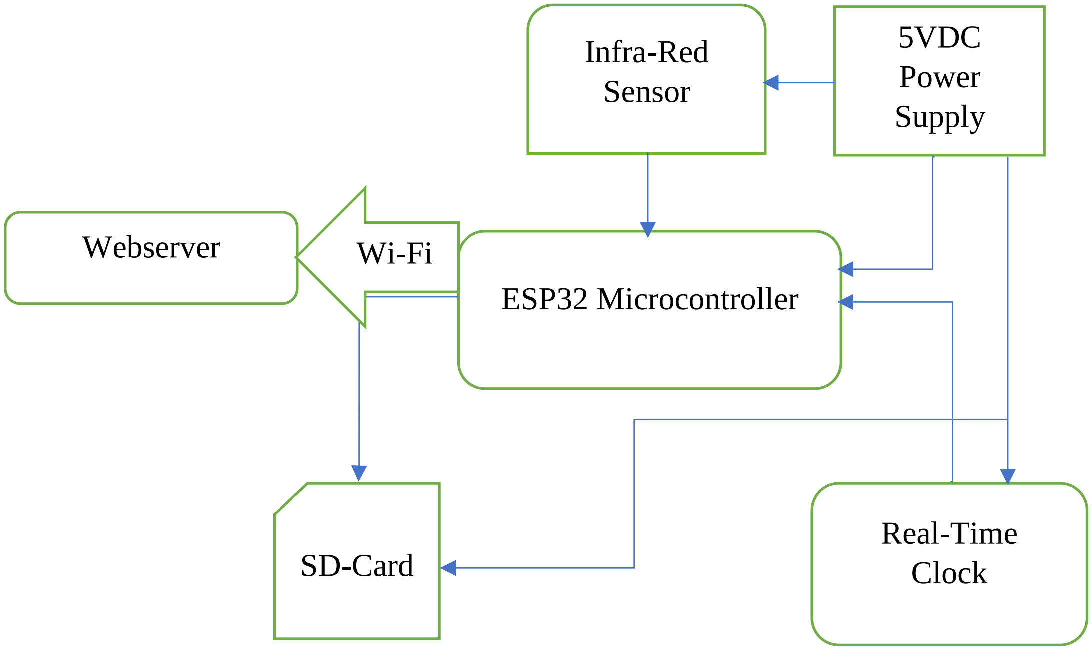

Figure 1: Block Diagram showing Component Interaction of Production Line Counter

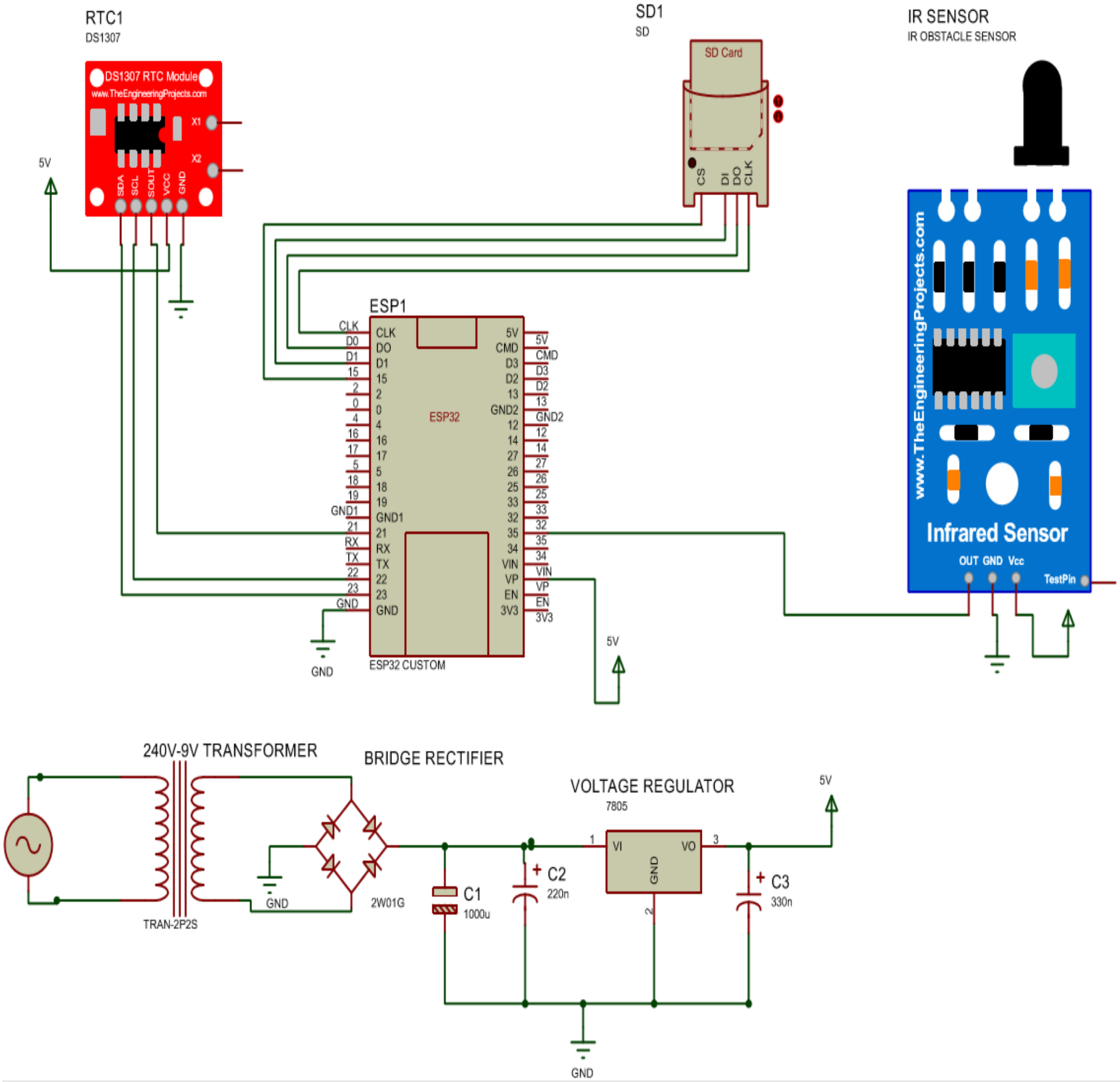

Figure 2: Circuit Diagram of Production Line Counter

Table 1: List of Hardware Components

S/N	Components	Value /Model Number	Rating
1	ESP32	ESP32	16bit
2	SD CARD	TF Micro SD Module	2GB
3	INFRARED SENSOR	Flying fish	5V
4	REAL-TIME CLOCK (RTC)	DS1307	5V
5	VOLTAGE REGULATOR	LM 7805	5V
6	TRANSFORMER	220/9V	220/9V AC
7	CAPACITOR	1000µf,220nf,330nf	Micro and nano farad
8	RESISTOR	10K Variable	10k
9	BRIDGE RECTIFIER	2W10G	1000V

Having sourced the materials for the production line counter circuit as illustrated in Figure 2, these components are connected by soldering them on a vero board interface. The ESP 32 is attached to the vero board by soldering female headers onto the vero board on which the pins of the ESP32 are inserted. This approach allows for the ESP 32 to be replaced or removed from the circuit without the need to unsolder. This same approach is adopted for the LCD, RTC and the SD-Card module. Female-to-female jumper wires are used in connecting the IR sensor to male headers soldered beside the row of female headers on which the ESP 32 sits. All GND pins are connected and all VCC pins are connected to the 5V rail on the Vero Board. The GND rail and 5V rail are connected to the GND and the 5V pins of the ESP32 respectively. In soldering, a soldering iron, soldering flux and soldering lead of 1.5mm is used.

Results

SD-CARD Datalogger: Results obtained from the SD-Card are presented in a '.txt' format, displaying the date, time and number of products counted. These results are presented in Appendix A. Results obtained from the SD-Card are presented thus:

Table 2: SD-Card Datalogger Results

DATE	TIME	ITEM NUMBER
28/07/2022	08:58:15	0
28/07/2022	08:58:15	1
28/07/2022	08:58:36	3
28/07/2022	08:59:03	4
28/07/2022	08:59:28	5
28/07/2022	09:00:57	6
28/07/2022	09:01:52	7

From the results obtained from the SD-Card, it can be seen that counting occurred every half second. This can be attributed to the delay time set at 500 milliseconds in the C++ code using the syntax "delay (500);". From the result obtained from the SD-Card, a total of 7 counts were recorded.

WIFI: Using a web browser connected to the IP Address of the ESP32 module (192.168.4.1), the number of items. Figure 3 shows a screenshot of the production line counter data obtained from the Chrome browser. The time and date as well as the number of items counted can be seen on the webpage.

Cite this article as:
Adekanmbi, M., Ogotute, A.A., & Amaechi, C. J. (2024). Design and construction of an improved production line counter. *FNAS Journal of Scientific Innovations, 5*(4), 1-7.

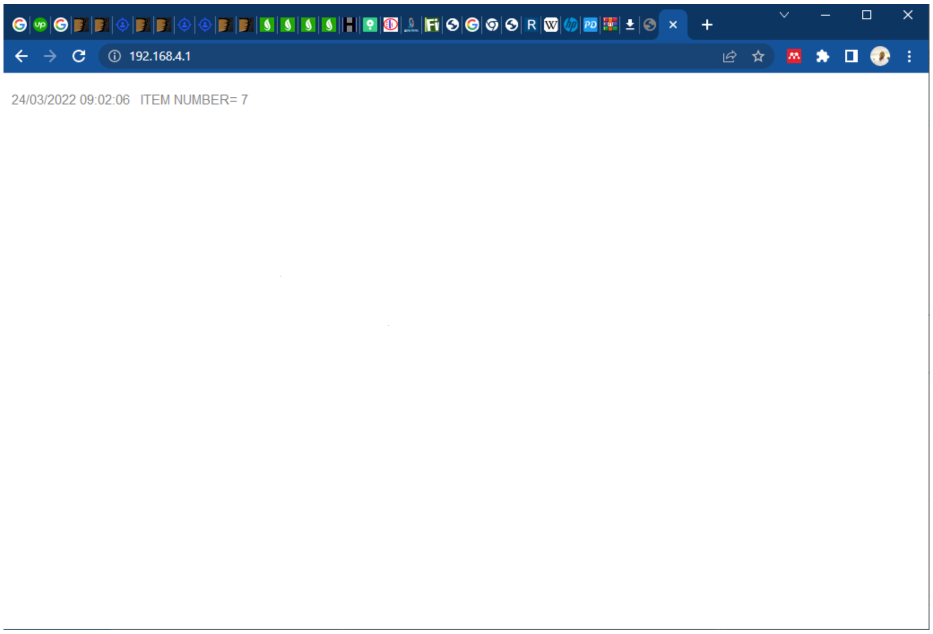

Figure 3: Screenshot of Product Count on the Web browser using WIFI.

Discussion

The components used in the design of the production line counter circuit were all selected from the component library on Proteus. The electrical power required to operate the production line counter is provided by a 5V DC power supply. This power supply was found to supply 5V DC voltage at 1A sufficiently. components such as the ESP32, SD-Card module, IR Sensor and RTC were all connected to the 5V and GND terminal of the constructed 5V power supply. The power supply was also found to be stable as no form of malfunctioning was recorded during the testing of the production line counter device.

From the results obtained during testing of the production line counter, it was observed that the IR sensor was able to effectively detect and count each object that passed within 5cm of its view (receiver and transmitter). From the test results obtained, a total of 7 objects were counted. Counting or detection was observed to occur at an interval of 500milli-second. The time and date of each count were also observed to be logged on the SD Card as well as the count number. This data was also accessible when a web browser connected to the ESP32 WIFI network was used in assessing the IP Address of the ESP32 as can be seen in Figure 4. Through the use of RTC and SD-Card modules, the production line counter developed in this work demonstrated that adequate documentation and storage of production data could be automated using C++.

Conclusion

This work presents a Wi-Fi-based production line counter using the ESP32 development board. The counting of objects or products in this work is restricted to unidirectional counting. These objects or products are counted using an IR sensor consisting of an IR emitter and an IR receiver. The emitter emits an Infra-Red wave which upon hitting an object nearby is reflected. This reflection is picked up by the IR receiver resulting in a digital HIGH signal from the IR sensor output. This signal is interpreted by the ESP32 as an +1 increment in the number of objects. An SD-Card and RTC are used in storing and providing date and time stamps for each object count. These object counts or product counts are updated to a webserver which is the IP address of the ESP32. This data could be accessed by connecting to the Wi-Fi of the ESP32 and connecting to the IP of the ESP32 using a web browser thus, enabling offline and online access to data thus providing a more efficient production line counting system. This application of the CAD approach in the design and development of the production line counter device ensured minimal errors during construction.

References

Adjardjah, W., Essien, G., & Ackar-Arthur, H. (2016). Design and construction of a bidirectional digital visitor counter. *computer engineering and intelligent systems*, *7*(2). 51-67.

Benoit, B. (2000). Introduction to feedback control systems. *coronado system*. 1-60.

Bierbooms, R. (2012). Performance analysis of production lines: discrete and continuous flow models. *Technische Universiteit Eindhoven*, 1-180.

Chituru, *C*.G. (2017). Design, construction and testing of a digital attendance register (DAR). University of Port Harcourt, 1-35.

Erden, F., Alkar, A. Z., & Cetin, A. E. (2015). A robust system for counting people using an infrared sensor and a camera. *Infrared Physics and Technology, 72*(1). 122-134.

Gershwin, S. B. (2012). Qualitative observations on production line behavior-intuitive and counter. *4th International Conference on Information Systems, Logistics and Supply Chain Quebec*. 1-54.

Liang, N., & Xiao, J. (2013). Design of automatic production line training system based on plc. *Sensors & Transducers, 155*(8)*.* 271-277.

Mohana, P.K., Dhar, P., & Naseem, K. (2019). Industrial automation with bidirectional visitor counter. *IOP Conference Series: Materials Science and Engineering, 590*(1). 1-7.

Cite this article as:
Adekanmbi, M., Ogotute, A.A., & Amaechi, C. J. (2024). Design and construction of an improved production line counter. *FNAS Journal of Scientific Innovations, 5*(4), 1-7.