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AUTOMATIC TUBE COUNTER MONITORING SYSTEM USING INFRARED SENSOR BASED ON NODEMCU ESP8266

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ABSTRACT

Technology is needed in every industry because it can simplify the production process, improve production quality, and enhance the company's reputation in the sight of consumers. Tube counting activities at PT Batuah Energi Indonesia remain based on manual methods involving time and estimations of LPG cylinder load standards, which facing inaccuracy issues. Even though PT Batuah Energi Indonesia has facilities that handle many LPG cylinders from various users and LPG cylinder providers. While the accurate quantity of cylinders becomes beneficial for industries, companies require technology that can count the number of LPG cylinders, that have already been filled, automatically. As a result, this study was carried out to demonstrate to students how to develop automatic tube counters using an infrared E18-D80NK as a tube detector, NodeMCU microcontrollers ESP8266 as controllers, Arduino IDE for developing programs, and IoT for remote monitoring. The approach of the tool developed, specifically the infrared proximity sensor E18-D80NK based on NodeMCU ESP8266, which can be coded using its compiler, the Arduino IDE. For detecting the number of tubes using the infrared sensor E18-EN80K and wireless data transmission utilizing the Blynk application. The results of the automatic tube counter monitoring tool were successfully tested with a 100% accuracy rate, utilizing the E18-D80NK infrared sensor and NodeMCU microcontroller ESP8266, and can be monitored remotely using Blynk.

***Keywords**: LPG Tube Calculation, NodeMCU ESP8266, E18-D80NK Infrared Sensor, Internet of Things.*

I. INTRODUCTION

PT Batuah Energi Indonesia LPG Bulk Filling Station (SPBE), located on Trans Kalimantan, East Kapuas, is a private company that assists PT Pertamina (Persero) in managing LPG gas by filling and distributing LPG gas tube to the public. LPG stands for Liquefied Petroleum Gas. LPG is a hydrocarbon gas produced by oil and gas refineries along with the main components of propane and butane gas. LPG gas is a fuel taken from natural gas contained in the earth and processed into gas that can be used by the community as an innovation in the use of natural resources in Indonesia so that people do not only focus on one fuel.

The presence of technology in the industrial world is something that is needed by every company to facilitate the production process. One of the related production processes carried out is the calculation of the amount of filling tube production that will be distributed to the community from the SPBE workshop area of PT Batuah Energi Indonesia. The production process carried out in the workshop area is the process of unloading or lowering the tube to the conveyor, the filling process, the batting process or closing the tube, the wrapping process or tube sealing, and finally the process of loading or entering the tube into the fleet that can be distributed. From this process, calculating the number of filled tubes can be done with a manual counting tool or hand tally counter applied to the wrapping path to the loading area at PT Batuah Energi Indonesia SPBE workshop [1].

In general, in some companies, especially in SPBE, PT Batuah Energi Indonesia still uses manual methods in the calculation process. PT Batuah Energi Indonesia has a workshop or filling hall that accommodates many consumer tubes from various local areas. This is very inefficient because by calculating the amount of production manually, there is a possibility of calculation errors with human error indicators such as employee inaccuracy in calculating the number of tubes to be loaded. Manual calculations also have several shortcomings including the time it takes a long time, fatigue of people who count, and inaccurate calculation results. To solve that problem, companies need automatic counting system tools [2][3].

There are several solutions offered by research related to automatic number-counting systems. The First Automatic Goods Counting Tool Using an Infrared Sensor Based on Arduino Uno, by Husain, et al in 2020 [4]. The second is the NodeMCU Esp8266 Based Visitor Counter Tool and Telegram Application Bot, by Ahmad Fauzan, in 2022 [5]. The third is the Prototype of Conveyor Material Calculation Based on Arduino Uno Microcontroller, by Susanto, in 2020 [6]. The research refers to evaluating infrared sensors and ultrasonic sensors HC-SR04 and comparing these sensors to manual measurement devices [7][8]. The results of infrared sensor readings are not significantly different from those of manual calculation measuring devices, demonstrating that infrared sensors are feasible to be used as number reading sensors [9]. Some of these studies were successfully constructed to be used as a reference for tools to be implemented and enhanced at PT Batuah Energi Indonesia.

This article, "Automatic Tube Counter Monitoring System Using Infrared-Based Sensor NodeMCU ESP826 At SPBE PT Batuah Energi Indonesia" is an innovation for implementing an automatic number counters system explained in [10]. It is expected that these tools will assist and facilitate workers in an industry and a company agency in calculating the tubes they have produced in large quantities, improving production quality, minimizing errors in a manual calculation, and making company activities effective and efficient as an answer of the problem described in [11].

Based on the description above, the problem discussed in this project assignment is how to design a system monitoring automatic tube counter using infrared sensor based on NodeMCU ESP8266. How to apply infrared sensor E18-D80NK as a tube detector that moves through it [12]. How to apply the NodeMCU ESP8266 microcontroller as a controller, receiver and data processor in the electronic system for an automatic LPG cylinder counter [13][14]. And how to apply IoT (Internet Of Things) as monitoring automatic tube counter using blynk [15].

The goal with the title “System Monitoring Automatic Tube Counter Using Infrared Sensors Based on the NodeMCU ESP8266 at SPBE PT Batuah Energi Indonesia" it can design systems monitoring automatic tube counter using infrared sensors based on NodeMCU ESP8266. Can apply infrared sensors E18-D80NK as a tube detector that moves through it [16]. Can apply the NodeMCU ESP8266 microcontroller as a controller, receiver, and data processor in the electronic system of an automatic LPG cylinder counter. Can apply IoT (Internet of Things) as monitoring automatic tube counter using blynk.

II. RESEARCH METHODS

The development research methodology used in this study involves the process of creating new products or systems based on existing scientific knowledge. In this specific case, the research aims to develop an automatic tube counter using an infrared sensor, specifically the NodeMCU-based ESP8266, for monitoring systems at SPBE PT Batuah Energi Indonesia. This system will incorporate three push buttons and LED indicators for control and feedback. The core functionality of this automatic tube counter relies on the operation of infrared (IR) sensors. These sensors are programmed to automatically count the number of tubes passing through them by detecting their presence. They accomplish this by obstructing the IR sensors' light beam, which triggers the counting mechanism. The three push buttons provided will enable specific functions such as stopping, continuing, or resetting the count, while the LED indicators will visually communicate different statuses or actions within the system.

To achieve its goals, the study used a specific set of materials and tools. A 14.5 cm x 9.5 cm x 5 cm acrylic box, a 16 mm push button, a 5 mm LED holder, jumper cables, aviation plugs (3 Pin 12 mm GX 12-3 metal), a USB data cable (type b), a female DC power jack socket (2.1 mm), a 5x37 cm PCB Board, and tin were among the components used. The tools incorporated a laptop or PC, an Infrared Proximity

Sensor E18-D80NK, NodeMCU ESP8266, a Blue LCD I2C 20 x 4, Stepdown DC LM 2596, 5 mm red, yellow, and green LEDs, a 12VDC power supply, a switch, a 6-30V DC motor, and soldering tools. These materials and tools were instrumental in conducting the study, allowing for the execution of experiments and the development of the intended project.

This study focuses on the creation of an automatic tube-counting device utilizing the NodeMCU-based infrared proximity sensor E18-D80NK and the ESP8266 microcontroller. The objective is to engineer a device capable of accurately counting the number of tubes automatically. The development of this tool encompasses two fundamental procedures: the design of the automatic tube counting device and the design of the associated program for tube counting. These two key processes work in tandem to achieve the desired functionality, where the device's hardware and software components are meticulously designed to ensure precise and efficient tube counting.

A. Automatic Tube Counter Design

The automatic tube counter, employing the infrared proximity sensor E18-D80NK, was conceptualized using microcontroller software that incorporated the form menu within the insert option. However, the progression of this research encountered delays due to the company's circumstances in fabricating conveyor lines, hindering the direct implementation of the tool. Despite this setback, the design process resulted in the creation of two distinctive designs: the prototype design (depicted in Figure 1) and the intended design for implementation at PT Batuah Energi Indonesia (illustrated in Figure 2). Both designs serve as reference points for deploying automatic tube count counters. The primary aim of this tool is to test an automatic tube counting system utilizing the infrared proximity sensor E18-D80NK. The forthcoming design of the tool is delineated as follows, building upon the groundwork laid out in these initial prototype and proposed implementation designs.

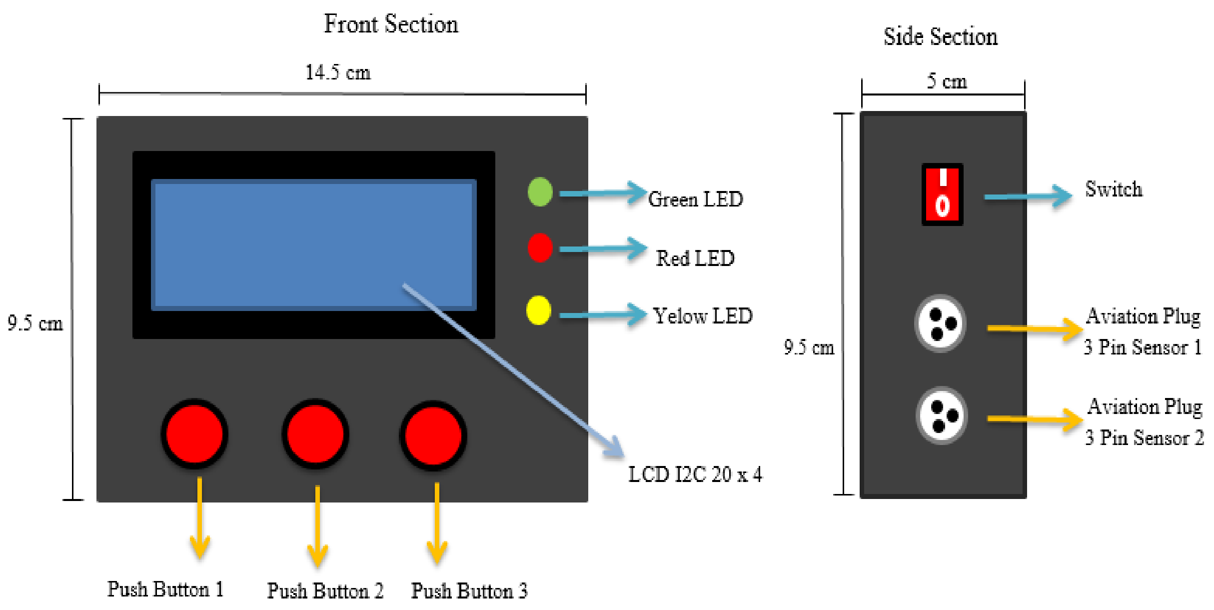

Figure 1. Design cover front section of automatic tube counting device and design cover side section of automatic tube counting device

The implementation of the automatic tube counter monitoring system using the NodeMCU-based infrared sensor ESP8266 at SPBE (Fuel Filling Station) PT Batuah Energi Indonesia involves strategic planning for its placement. This system will be positioned at key locations within the facility to effectively monitor and count the tubes or objects passing through these points. The planning process includes determining the optimal spots for installing the infrared sensors, considering factors such as traffic flow, visibility, and accuracy in tube counting. The goal is to ensure the sensors are situated in locations where they can efficiently detect and count the tubes, contributing to a reliable and accurate monitoring system at PT Batuah Energi Indonesia's SPBE.

Figure 2. System tool layout planning Monitoring automatic tube counter at SPBE PT Batuah Energi Indonesia

B. Automatic Tube Counting Program Design

The wiring design planning for the automatic tube counter monitoring system using the NodeMCU ESP8266-based infrared sensor was created utilizing Fritzing software. This software enables the easy assembly and visualization of the components required for the counter monitoring system. In Figure 3, the design showcases the schematic layout of the series of tools that are planned to be created for this system. It illustrates the arrangement and connections of the NodeMCU ESP8266, the infrared sensor, and other components necessary for the automatic tube counter. This visual representation aids in understanding the wiring and connections, facilitating the construction and implementation of the automatic tube counter monitoring system.

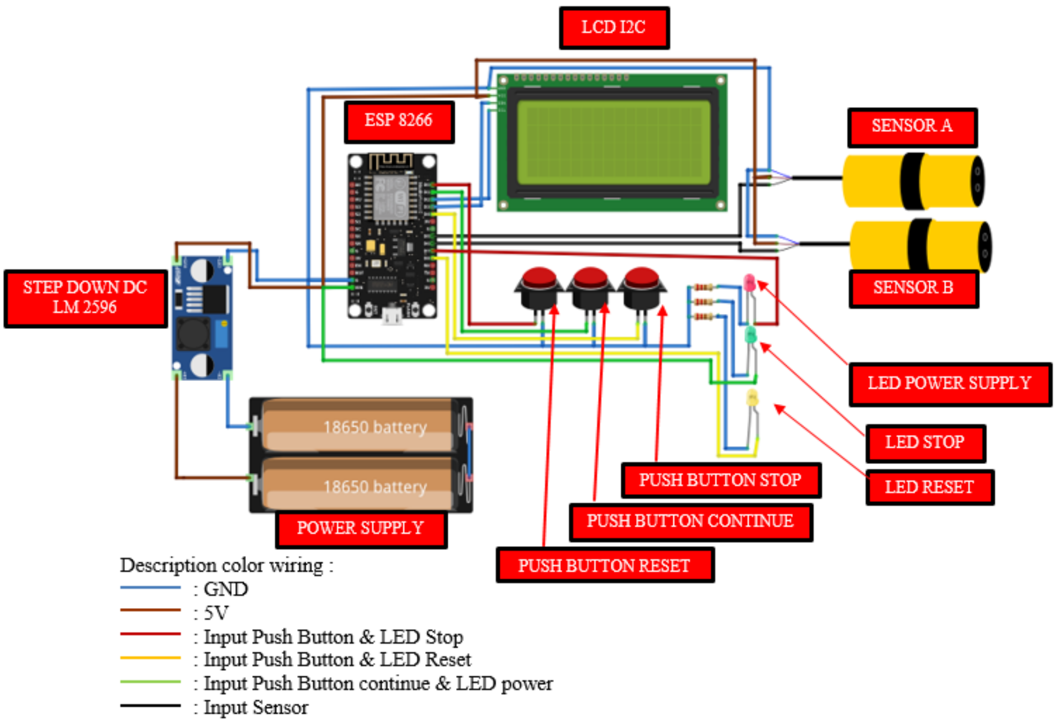

Figure 3. System suite of tools Monitoring Counter Uses Fritzing Software

Components that function as output are LEDs. The LED will indicate a color display as a notification for each tube detected by the sensor infrared. Component push button function as input. To make this tube counter tool requires 3 push buttons with different functions, namely reset, stop, and continue button. When reset button clicked, then will reset the count becomes 0, if clicked button stop it will stop the counting process so that the tube passes in front of the sensor infrared the sensor will not read, and if it clicks button further, the sensor will read the passing tube again and the counting process can continue. These components are connected to the NodeMCU pins as shown in Table 1, namely the NodeMCU ESP8266 pin configuration with infrared sensors. Table 2 describes the NodeMCU ESP8266 pin configuration with 12C LCD, and Table 3 describes the NodeMCU ESP8266 pin configuration with button & LED.

Table 1 NodeMCU ESP8266 pin configuration with infrared sensors

Sensor Infrared	Connect to NodeMCU
Brown cable	Connect to the Vcc
Blue cable	Connected to the Ground
Black cable (infrared A)	Connect to D6
Black cable (infrared B)	Connect to D7

Table 2 NodeMCU ESP8266 pin configuration with I2C LCD

LCDI2C	Connect to NodeMCU
Brown cable	Connect to the Vcc
Blue cable	Connected to the Ground
Purple cable (SCL)	Connect to D1
Red cable (SDA)	Connect to D2

Table 3 NodeMCU ESP8266 pin configuration with button & LED

Button & LED	Connect to NodeMCU
Blue wired LED	Connected to the Ground
Green LED black cable	Connect to the Vcc
Red LED red wire	Connect to D0
Purple wired yellow LED	Connect to D8
Button blue cable	Connected to the Ground
Button reset yellow cable	Connect to D4
Button stop red cable	Connect to D5
Button continue the green cable	Connect to D3

The program designed for the automatic tube counting device utilizes the infrared proximity sensor E18-D80NK and is created using the C++ programming language within the Arduino IDE software. This program is specifically tailored to operate the system responsible for counting tubes automatically. It involves writing code in C++ using the Arduino Integrated Development Environment (IDE) to control and process data received from the E18-D80NK infrared sensor, enabling accurate tube counting functionalities. The program's design encompasses algorithms and instructions written in C++ to interact with the sensor, process its input, and accurately count the tubes passing through the system. This program forms the core intelligence behind the automatic tube counting device, ensuring its efficient and precise operation..

Figure 4. Automatic tube counting program design.

In order to create a program for an automatic tube counter using the E18-D80NK infrared proximity sensors with the Arduino IDE software, the C++ programming language is utilized. The Arduino IDE, an open-source platform, facilitates the development of the program to enable the microcontroller to effectively respond to the data received from the infrared sensors. This program is intended to manage the detection and counting of objects passing through the sensors. By leveraging the Arduino IDE and its compatibility with the E18-D80NK sensors, the aim is to create a functional and accessible solution for automatic tube counting, allowing for ease of use by individuals leveraging the open-source nature of the software.

A flowchart provides a visual representation of the sequence of actions, decisions, and processes within a system, aiding in understanding the system's functionality and operation. The specific details of Figure 5's flowchart would likely illustrate the step-by-step processes involved in the automatic tube counting system, possibly detailing the sensor readings, counting mechanisms, decision points, and output actions.

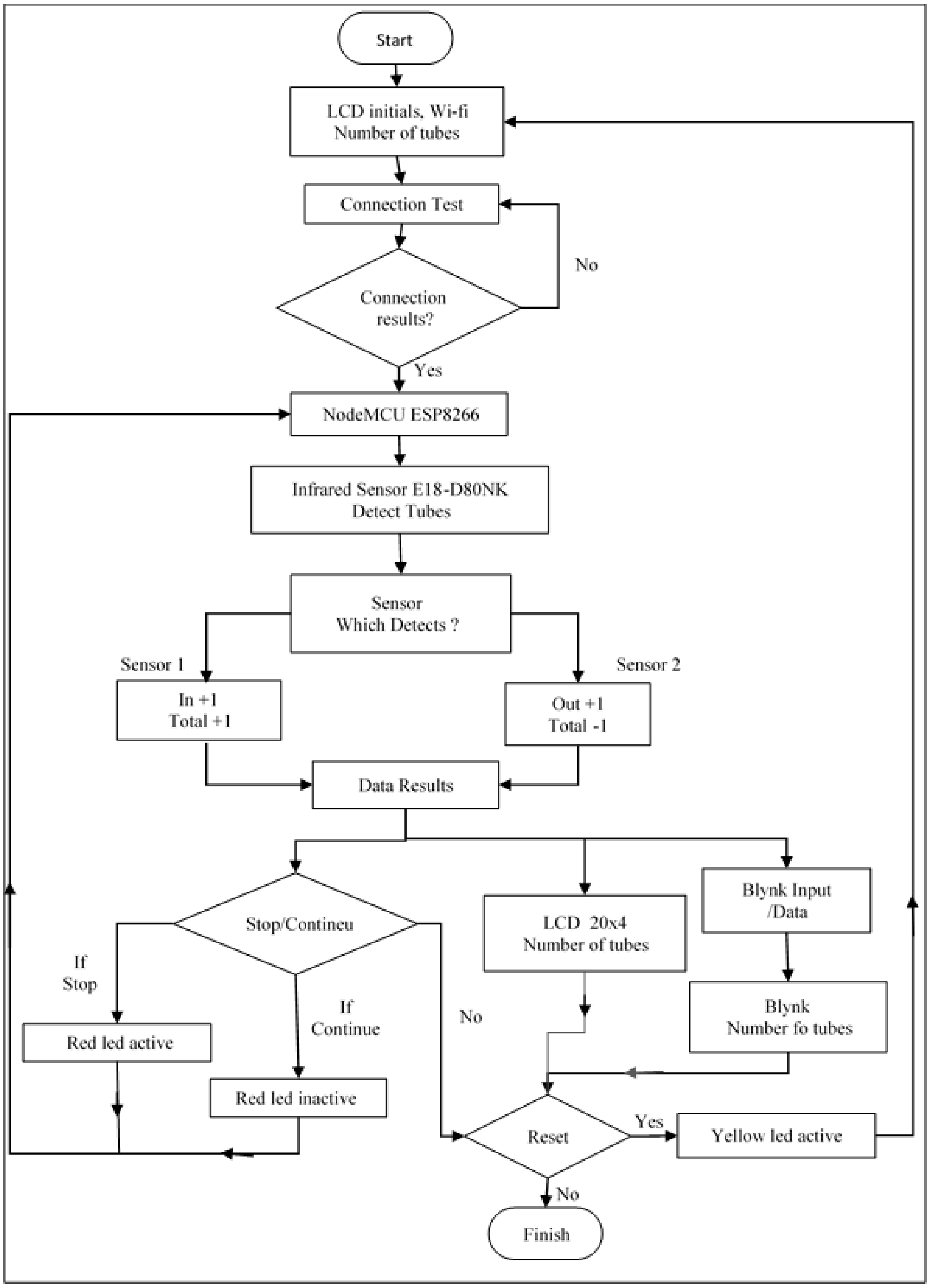

Figure 5. Flowchart system monitoring automatic tube counter.

The flowchart for the main procedure of the automatic tube counter tool initiates an initialization process for the LCD and Wi-Fi signal search, establishing a connection to the NodeMCU. Once linked, the tube counting process begins. The NodeMCU executes the programmed instructions, primarily involving the infrared sensor inputs. These sensors, labeled as sensor 1 and sensor 2, function to detect the passing objects. When sensor 1 to sensor 2 identifies an object, the count increases by 1; when sensor 2 to sensor 1 reads an object, the count decreases by 1. The results of input and output data management display on the LCD and Blynk in real-time, employing the push button function. Pressing the stop button activates the red LED and halts the sensor readings. Pressing it again deactivates the red LED, allowing the sensor to resume object detection. The reset button triggers the yellow LED briefly and resets the tube count to zero on both the LCD and Blynk displays. This comprehensive process details the systematic operations and functionalities involved in the automatic tube counting tool.

The Standard Operating Procedures (SOP) for the automatic tube counting tool utilizing the E18-D80NK infrared proximity sensors with NodeMCU ESP8266 are outlined as follows:

1. Calculation Timing: The counting occurs post the tube wrapping or final sealing process, marking tubes ready for dispatch.
2. Sensor Placement and Data Input: Two infrared sensors (E18-D80NK) are situated along the one-way conveyor area for tube loading, detecting tubes as objects. When an object is detected, the sensors relay data input to the NodeMCU ESP8266.
3. Increment Counting (Incoming Sensor): If infrared sensor A detects the first object and then infrared sensor B detects the second object, termed the incoming sensor, the count value increases by one.
4. Decrement Counting (Reverse Sensor): If infrared sensor B detects the first object and then infrared sensor A detects the second object, known as the reverse sensor, the count value decreases by one.
5. Display Readings: Readings taken by the E18-D80NK sensors are displayed on the 20 x 4 LCD and depicted on Blynk when successful.
6. Pausing Reading Process (Stop Button): Upon pressing the stop button, the sensors cease calculating passing objects. A bright red LED indicates the pause, while the 20 x 4 LCD and Blynk display the last recorded data.
7. Resuming Reading Process (Continue Button): Pressing the continue button reactivates the sensors to resume calculating passing objects. The red LED turns off, and the 20 x 4 LCD and Blynk display the latest data.
8. Reset Functionality: Initiating the reset button sets the count to zero. A yellow LED lights up briefly, signifying a reset, and the 20 x 4 LCD display and Blynk exhibit data from the initial count.

These SOPs provide a comprehensive guideline for the functioning and operation of the automatic tube counting system, defining the processes triggered by sensor readings and button inputs, as well as how the data is displayed and managed through various control mechanisms.

III. RESULTS AND DISCUSSION

The findings of this study are prototypes of conveyors and automatic counting equipment. Figure 6 shows an illustration of the prototype and the tool.

Figure 6. Prototype of automatic conveyors and counting devices.

Following the results of the prototype conveyor and automatic counting device, the following tests were performed. The first test was to measure the voltage readings of the NodeMCU ESP8266. Table 4 contains the test results.

Table 4 NodeMCU output voltage testing

No Pin	Voltage Out (Volt)
A0	0.0
G	0.0
VU	5.02
S3	0.0
S2	0.0
S1	0.0
SC	0.0
S0	0.0
SK	3.97
G	0.0
3V	3.02
EN	0.77
RST	0.85
G	0.0
VIN/	0.0
3V	3.01
G	0.0
TX	3.95
RX	3.95
D8	3.95
D7	3.94
D6	3.94
D5	3.96
G	0.0
3V	3.24
D4	3.94
D3	3.95
D2	3.95
D1	3.95
D0	3.95

The second test is LCD testing of NodeMCU ESP 8266 process data monitor findings. The test results are shown in Table 5.

Table 5 LCD testing of data monitor results

No Pin	Voltage Out (Volt)
1	0.0
2	4.95
3	1.39
4	3.95
5	3.95
6	0.0
7	4.95
8	4.94
9	4.93
10	4.93
11	0.0
12	3.95
13	3.95
14	0.0
15	4.95

16	0.0

The infrared proximity E18-D80NK sensor is tested in the third test. Table 6 displays the test results.

Table 6 Voltage testing infrared proximity E18-D80NK sensor

No	Infrared Sensor	No Pin	Voltage Out (Volt)
1	Sensor A	D1	5.04
2	Sensor B	D2	5.07

The fourth test involves comparing the readings of the E18-D80NK infrared proximity sensor to push buttons, a 20 x 4 LCD, Blynk data, and LED indications. The test results are shown in Table 7.

Table 7 Testing the response of components to infrared proximity sensor readings

No	Push Button	Component	Response
1	Stop	LCD 20 x 4	Active
		Data Blynk	Active, no data changes
		Indicator LED	Red LED is active
		Infrared sensor A to B	Active, does not read objects
		Infrared sensor B to A	Active, does not read objects
2	Continue	LCD 20 x 4	Active
		Data Blynk	Active, data changes in real time
		Indicator LED	Red LED is not active
		Infrared sensor A to B	Active, reading objects
		Infrared sensor B to A	Active, reading objects
3	Reset	LCD 20 x 4	Active
		Data Blynk	Active, changes data to zero
		Indicator LED	Yellow LED is active
		Infrared sensor A to B	Active, reads the object from the beginning
		Infrared sensor B to A	Active, reads the object from the beginning

The fifth test results are shown in Table 8. The test was carried out by comparing the detection state of infrared proximity sensors A and B. The output of this sensor reading is data with the following conditions.

1. When infrared proximity sensor A detects an object, and subsequently infrared proximity sensor B detects an object, the computed value + 1 is used to identify this sensor as an entry sensor.
2. When infrared proximity sensor B detects an object, infrared proximity sensor A detects an object, and the computed value is -1, this sensor is referred to as a reverse sensor.

Table 8 Calculated response testing to infrared proximity sensor readings

Infrared sensor	Test	Manual	Automatic	Accuracy Percentage
Infrared sensor A to B	1	10	10	100%
	2	20	20	100%
	3	30	30	100%
	4	40	40	100%
	5	50	50	100%
	6	60	60	100%
	7	70	70	100%
	8	80	80	100%
	9	90	90	100%
	10	100	100	100%
Infrared sensor B to A	1	10	10	100%
	2	20	20	100%
	3	30	30	100%
	4	40	40	100%
	5	50	50	100%
	6	60	60	100%
	7	70	70	100%
	8	80	80	100%

Infrared sensor	Test	Manual	Automatic	Accuracy Percentage
	9	90	90	100%
	10	100	100	100%

Furthermore, Figure 7 shows how the components are integrated and set up within a casing box and utilized in a real-world setting, demonstrating the practical application of the automatic tube counting system. Part A is the part which includes the essential components housed within a casing box. It comprises the NodeMCU ESP8266, jumper cables, LM 2596 step-down module, I2C LCD, push buttons, LEDs, and a PCB board. The arrangement and integration of these components likely form the core of the counting system. Part B represents the practical implementation of the tool. It features a conveyor system equipped with two infrared sensors used to detect and calculate the quantity of passing tubes. Additionally, there's a display for indicating the tube count and LEDs used to show the status of various push buttons (stop, reset, and continue functions).

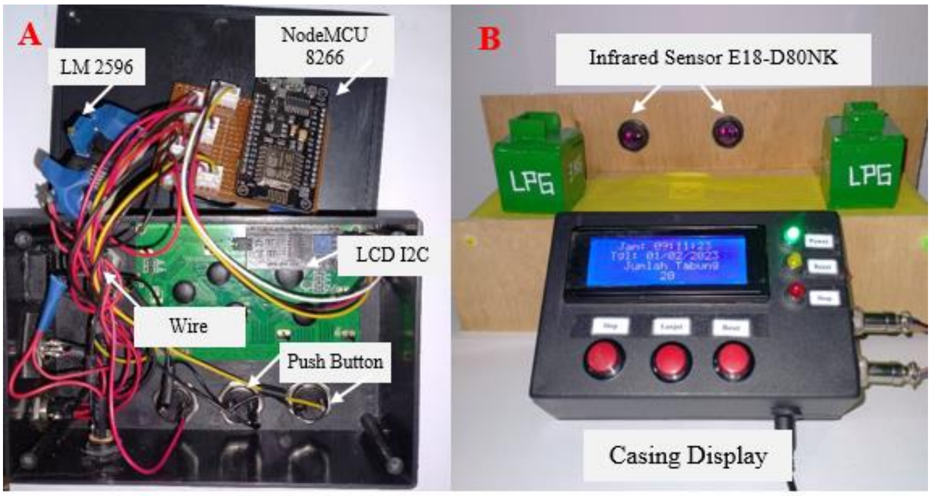

Figure 7. Views of the automatic tube counting tool from the inside and outside

Figure 8 illustrates the Blynk Display Scenarios. These scenarios would present the graphical interface's responses when different push buttons (stop, continue, reset) are activated. They provide visual feedback or information on the Blynk application, giving users insights into the operational states and actions of the automatic tube counting system. Figure 8A represents the Blynk application displaying the status or notification when the stop button is activated. It includes information or indications about the pausing of tube counting, showing a specific message or status denoting the system is in a paused state. Figure 8B reflects the Blynk application response when the continue button is activated. It exhibits information or indications of resumed tube counting, displaying a distinct message or status showing the system is back in an active counting state. The Blynk display reaction after pushing the reset button is shown in Figure 8C. It displays information or notifications about the reset action, such as a message or a status indicating that the counting has been reset to zero.

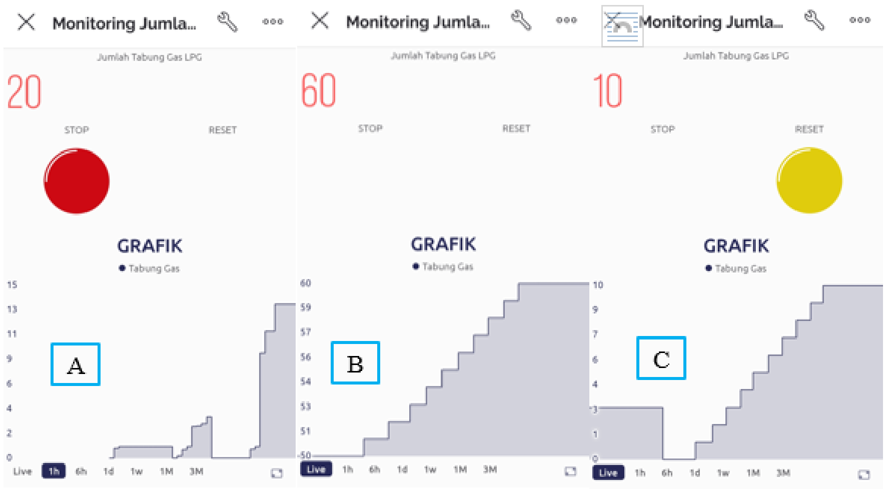

Figure 8. Display the number of counting tubes in the Blynk application.

The research conducted, referenced in [4], implemented an automatic counting system employing a single infrared sensor and a reset button. In contrast, the current research implemented an enhanced system utilizing two infrared sensors and three buttons. By utilizing dual sensors and an expanded control interface with multiple buttons, the enhanced system design in the current research offers advantages in accuracy, reliability, and functionality over the previous system detailed in reference [4]. Additionally, the utilization of three distinct buttons (reset, stop, and start) provides enhanced control over the sensor readings and calculation results. The combination of the E18-D80NK sensor's superior infrared light range with the precise control afforded by the three distinct buttons contributes to an efficient and flexible automatic counting system. This setup allows for greater accuracy in object detection while providing users with better control and management of the counting process. The research in reference [12] used a 16x2 LCD panel and IoT display via a website. Conversely, this current research used a 20x4 LCD, which provided a larger display area. In summary, the current research's use of a 20x4 LCD with a larger display surface enables more complete and detailed information, such as count, time, and date. Furthermore, using Blynk for IoT monitoring provides accessible and user-friendly remote monitoring capabilities via various devices, improving the system's accessibility and functionality.

IV. CONCLUSION

The conclusion that can be obtained from the data above is that the automatic tube counter monitoring system tool was created with a 100% accuracy rate utilizing a NodeMCU-based infrared sensor Esp8266. The E18-D80NK infrared sensor can be used as a tube detector that moves across the sensor. The NodeMCU Esp8266 microcontroller can be used in automatic tube counting systems as a controller, receiver, and data processor. Blynk can be used to implement IoT as a tube counter monitoring system. Suggestions for future research development include using printed PCB boards for this series of calculating devices to ensure more organized component placement by eliminating the need of cables and developing efficient electrical paths. This is intended to prevent a variety of undesired outcomes while also easing the process of repairing or replacing components.

ATTACHMENT

Obviously, there are still some shortcomings in carrying out research and producing the results of this thesis report, so the author offers suggestions for the development of future research, specifically, for this series of calculating devices, the researcher should use a printed PCB board so that the laying of components is more organized, by reducing the use of cables and creating efficient electrical lines. This seeks to prevent a variety of undesirable events while also making the process of repairing or replacing components easier.

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