IoT based railroad portal security system prototype design

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Submission date: 26-Jan-2024 03:46PM (UTC+0700)
Submission ID: 2278851320
File name: Aticle_52_Faisal_Irsan_Pasaribu.pdf (282.69K)
Word count: 4400
Character count: 21893

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Abstract. Transportation has an important role in human life that is useful for facilitating daily activities. A good transportation system is able to guarantee safety, security, smoothness, speed, punctuality and convenience for the community. The train is one of the modern means of transportation with the power of movement through various crossings guarded by officers. Even though it has been guarded, the guard can be negligent and can cause accidents, namely the result of not closing the railroad crossing gates and the negligence of road users who break through the gate. The purpose of this research is to design a prototype of a railway portal security that can be operated with an IoT-based control system. This system is expected to reduce the risk of accidents due to not w[39]ng railroad crossing gates, thereby reducing fatalities. In this research method, the goal is to design a control system based on the Blynk Internet of Things application. Blynk functions to program nodemcu to give commands when the train movement has been read by the PIR sensor. The connected PIR works at an angle of 300 with a distance of 3 cm, 5 cm and 7 cm in top, bottom, left and right conditions. The program will work to raise the latch as the train passes. The system design is in accordance with the structure and function properly. The PIR sensor reads the motion of the train then the ESP8266 nodemcu successfully sends a command to the servo motor which works at a voltage of 3.3 volts at a distance of 10 cm in 3 seconds, 12 cm in 4 seconds and 14 cm in 3 seconds. to open the latch. This research was conducted at the Muhammadiyah University of North Sumatra with the help of a toy train as a simulation tool. In the application of securing railroad crossings on IoT-based highway traffic lanes, PT KAI can apply it, because this tool is very simple and can be applied by PT. KAI.

Keywords : Automatic Railroad Cross, Internet Of Things, Remote Control, Nodemcu ESP8266, Pir Sensor.

INTRODUCTION

Background

Transportation has an important role in human life that is useful for making it easier for humans to carry out daily Activities [1].The train is a modern means of transportation with the power of motion either running alone or in combination with other trains that move on the rails associated with the train travel schedule [2],[3]. With the

development of technology, there is a tendency to apply automatic control systems in modern industrial processes [4]. The tools in everyday life that work based on the appropriate position or angle are mostly still done manually.

With technological advances, especially in the field of very modern telecommunications networks, the internet has become a primary need for all circles of society. With this progress, an innovation has emerged where technological devices can be controlled remotely via the internet to be more efficient and save time called the Internet of Things or IoT [5]. The design of this prototype also uses a toy train as a vehicle and a rail doorstop using a plastic-based toy. In this study the author also uses motion sensors as the main focus to move the doorstop.

According to data from PT KAI, in Indonesia from 2016 to 2020 an average of 2 to 7 times there were accidents due to the absence of doorstops or negligence of the brigade. With the idea of researchers in designing this prototype, which is expected to be immediately applied to railroad crossings that do not yet have doorstops and guard posts by utilizing IoT technology

REVIEW OF THE LITERATURE

Internet Of Things (IoT)

Internet of Things or also known by the abbreviation IoT, is a concept that aims to expand the benefits of continuously connected internet connectivity that allows us to connect machines, equipment, and other physical objects with network sensors and actuators to obtain data and manage their own performance, so it's possible machines to collaborate and even act on newly acquired information independently [2].

The Internet of Things was first introduced by Kevin Ashton in 1999 in one of his presentations. Now many large compan are starting to explore the Internet of Things, such as Intel, Microsoft, Oracle, and many others [3]. Many predict that the influence of the Internet of Things is "the next big thing" in the world of information technology, this is because IoT offers a lot of potential that can be explored. A simple example of the benefits and implementation of the Internet of Things, for example, is a refrigerator that can notify the owner via SMS or email about what food and drinks have run out and must be stocked agan [4] [5].

Blynk Apps

Blynk App is an application designed for Internet of Things. This application is able to control hardware remotely. There are 3 blynk platforms provided, namely [6]

a. Blynk App, serves to create application projects using various variations of the widgets that have been provided. However, the widget usage limit in one account is only 2000 energy. Energy can be added by buying it through the playstore.

b. Blynkserver, serves to handle projects on the blynk app and communicates between smartphones and the hardware made. Blynk server (Blynk Cloud) can be used on a local network and is open source.

c. Blynk libraries, serves to facilitate communication between the hardware and the server and the entire process of input and output commands [6]. Below are the features provided by blynk: Same API and UI to support hardware and devices:

- Connection with the cloud using: wifi, bluetooth, ethernet, USB
- (serial), and GSM Easy use of widgets
- Programmless pin manipulation
- Easy integration using virtual pin
- tory of monitoring data
- Device-to-device communication using Bridge Widget
- Can send emails, tweets, and push notifications.

Node Mc ESP8266

Node Mcu is an Open-source fir are and development kit that helps to prototype IoT (Internet of Things) products in a few lines of scripts. Lua NodeMcu is an open source IoT (Internet Of Things) platform. NodeMcu uses Lua as a scripting language. It is based on the Elua project, and built on top of the ESP8266SDK1.4. Using many open source projects, such as lua-cjson. It includes firmware that ru n Wi-FiSoCESP8266, and hardware based on the ESP-12 module. The specifications provided by Node Mcu are Open source, Interactive, Pre-programmed, Low cost, Simple, Smart, FI [7], [8]

Node MCU is an open source IoT platform and development kit th ses the Lua programming language to assist in prototyping IoT products or can be sketched with the adruino IDE. This development kit is based on the ESP8266

module, which integrates GPIO, PWM (Pulse Width Modulation), IIC, 1-Wire and ADC (Analog to Digital Converter) all in one board. GPIO Node MCU ESP8266. The MCU node measures 4.83cm long, 2.54cm wide, and weighs 7grams. This board is equipped with WiFi and Firmware features that are open source [8].



Fig. 1. NodeMCU ESP8266

Servo motor

A servo motor is a motor with a closed feedback system where the location of the motor is immediately informed back to the control circuit in the servo motor. Servo motor is one type of DC motor [9]. Among them are stepper motors, servo motors work in close loop. The motor shaft is associated with the control circuit, then if the shaft rotation has not reached the desired place, the control circuit will continue to look for a place until it reaches the desired Servo motors are widely used in R/C (remote control) devices such as cars, planes, helicopters, and ships, as well as actuators for robots and cameras place [10]..



Fig 2. Servo Motor

Arduino IDE

Arduino UNO a microcontroller board based on the ATmega328. Arduino UNO has 14 digital input/output pins (6 of which can be used as PWM outputs), 6 analog inputs, a 16MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button [11]. Arduino UNO contains everything needed to support the microcontroller, easily connect it to a computer with a USB cable or supply it with an AC to DC adapter or use a battery to get started [12].



Fig.2 IDE Arduino IDE

(Integrated Development Environment) which is intended to create commands or source code, perform error checking, compile, upload programs, and test the results of Adruino's work through a serial monitor[1], [5]. Pin Input and Output Arduino Uno In Figure 2, Adruino IDE has IDE toolbars that provide instant access to important functions, namely: Verify button, to compile the currently working program.

- Upload button, to compile program and upload arduino board or in MCU Node.
- News button, creates a new worksheet.
- Open button, to open a program with a system file file.
- Save button, to save the program being worked on.
- Stop button, to stop the serial monitor that is currently running

Motion Sensor (PIR Sensor)

Sensor comes from the word Sense (to feel or sense), is to define a sensor as a device that receives a stimulus and responds with an electrical signal. Furthermore, Fraden defines a stimulus, or stimulus, as a certain quantity, property or condition that can be felt and converted into a sigma [13] The purpose of a sensor is to respond to some kind of input and convert that input into an electrical signal. The output of the sensor can be a current or a potential difference. Each sensor in principle is to convert energy (energy converter). The sensor is a type of transducer that is used to convert mechanical, magnetic, heat, light and chemical quantities into voltage and electric current [13]. Sensors are often used for detection when measuring and controlling.

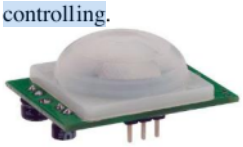


Fig.3 Motion Sensor

The characteristics of the sensor are carried out to determine the performance of the sensor that has been designed. In this case the sensor is considered a black box whose characteristics are determined by the relationship between the output signal and the input sigma [13].

Smartphone

A smartphone is an 'smart' mobile phone that has capabilities with uses and functions that are not much different from computers in general. Regarding the exact standard of the definition of 'smartphone', it is still not very clear from the manufacturer that produces the gadget. [8], the certainty of the actual definition of a smartphone is still not officially confirmed. Many industry parties think that the smartphone has a definition that will continue to change over time. According to David Wood, Executive Vice President of PT Symbian OS, "Smartphones can be distinguished from ordinary mobile phones in two fundamental mental ways, namely how they are made and what they can do [7].

Smartphone is a term used to describe a mobile device that combines the functions of a cellphone, PDA, audio player, digital camera, camcorder, Global Positioning System (GPS) receiver, and Personal Computer. Currently, the smartphone does not only function as a means of telecommunications, but has turned into a gadget that is capable of doing many things. This generation began with the PDA (Personal Digital Assistant) which has capabilities such as reading and sending email and running various applications. Over time, smartphones can be used as smart home controller applications. Currently, many smart home control applications have been developed using smartphones [1]

SYSTEM PLANNING AND METHOD

Scheme of Merger Entire Installation System Forming Tool

The process capability of the tool will determine the success or failure of the tool that has been done. The tools that have been worked on have errors or need to be repaired, in each trial, measurements are taken which will later be used to analyze hardware and software as well as other supporting components.

The application of an IoT-based rail portal security system produces a miniature automatic train doorstop[14]. The hardware used in the miniature consists of a sensor pir, nodemcu ESP8266, servo motor, buzzer:

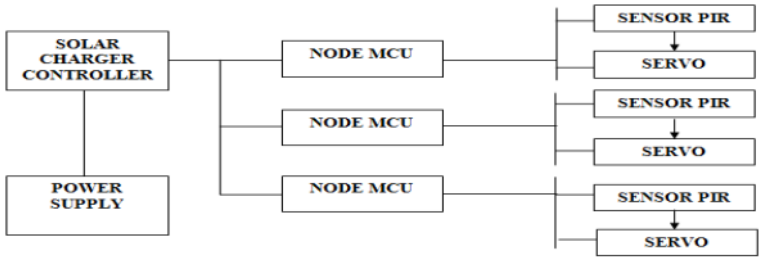


Fig. 4. Circuit Chart

Research Methodology

The design for controlling the carriage doorstop automatically or manually. With the application of Blynk on this miniature doorstop, the tool can be operated remotely automatically. The Nodemcu ESP8266 module in this study is the control of all systems in regulating traffic security from congestion when the train passes. The Nodemcu used in this study is Nodemcu ESP8266 [10]. Steps to perform a series of NODEMCU

1. Open Arduino app
2. After opening the next step is to install the ESP8266 board on the Arduino IDE.
3. Next, connect the NodeMCU to your computer or laptop.
4. Before uploading the program, make sure that the board settings are on Generic ESP8266.
5. Next, upload the program to the NodeMCU, wait until a display like this appears in the Ardiono IDE log.
6. When entering the process, press and hold the flash button on the Nodemcu module for a few seconds so that the module enters flash mode, wait for the dotted display to appear on the log.
7. After appearing 100% means the program has been successfully uploaded

However, there are two types of servos that are commonly marketed, some are limited in rotation, some rotate up to 360 degrees but also servo motors can rotate up to 180 degrees. The servo motor consists of three wires, the VCC (red), GND (brown), and PWM (orange) wires. The function of the VCC and GND cables is clear as a power supply line. While the PWM cables are to regulate The direction of servo rotation. In general, PIR sensors are made with a pyroelectric sensor that can detect the level of infrared radiation. Everything emits a small amount of radiation, but the hotter the object / creature, the higher the level of radiation emitted. The PIR sensor is the main sensor used in miniature automatic train doorstops. This sensor acts as a detector for miniatures. Testing of the sensor is carried out to determine the level of accuracy and accuracy of the sensor.

The high category is an active sensor and high sensitivity, while low is an inactive sensor and weak sensitivity. The sensor was tested 3 times with different results, namely:

1. With a sensor distance of 7 cm and an angle of 30 ° in each corner. At the top of the sensor is not active, bottom is active, right is active, left is active.
2. With a sensor distance of 5 cm and an angle of 30 ° in each corner. At the top of the sensor is not active, bottom is active, right is active, left is not.
3. With a sensor distance of 3 cm and an angle of 30 ° in each corner. At the top the sensor is active, bottom is active, right is active, left is active.

The PIR sensor above is that the farther away the sensor is, the weaker the sensitivity of the sensor will be, and vice versa.

The sensor is expected to see if the sensor can work optimally or not. With sensor reading distance, sensor reading time, delay time, servo open condition as follows:

1. With a sensor reading distance of 7 cm, a sensor reading time of 3 seconds, a sensor delay time of 5 seconds, and the servo condition being closed from the initial open position.
2. With a sensor reading distance of 5 cm, a sensor reading time of 4 seconds, a sensor delay time of 3 seconds, and the condition of the servo being closed from the initial open position.
3. With a sensor reading distance of 3 cm, a sensor reading time of 3 seconds, a sensor delay time of 3 seconds, and the condition of the servo being closed from the initial open position.

The results of the sensor with 3 times are carr15out to get the results that all sensors are active. The sensitivity of each sensor to motion readings is quite good. Blynk is an iOS and Android operating system platform as a control module for Arduino, Raspberry Pi, ESP8266 and other similar devices via the internet[6]. With the Blynk, it is intended to facilitate the performance of the miniature train doorstop and can be operated remotely. This test was conducted to determine the performance of Blynk in manual view and automatic bea [5]. Blynk on Nodemcu aims to see Nodemcu work on Blynk's orders and can command the servo motor to open and close the carriage latch. To connect nodemcu to blynk, you must use the internet Networks [15], so in this test we use a hotspot. Tests were carried out on 3 Nodemcu, the following are the tests:

1. The first nodemcu internet connection is active, the blynk connection is active, the led indicator on the nodemcu is active, the condition of the device is active.
2. The first nodemcu internet connection is active, the blynk connection is active, the led indicator on the nodemcu is active, the condition of the device is active.
3. The first nodemcu internet connection is active, the blynk connection is active, the led indicator on the nodemcu is not active, the condition of the device is active.

The results of the 3 nodemcu programmed by Blynk function to command the servo motor so that it can automatically close the latch when the PIR sensor has read the motion of the train, all successfully turn on ,[16] [17]. And it is concluded that the achievement of research objectives of research objectives.

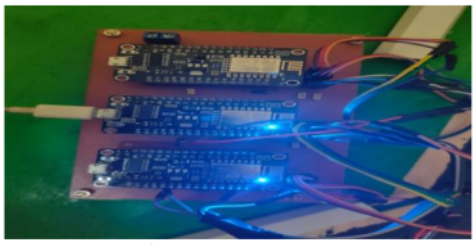


Fig. 5 Hardware Device

RESULTS AND DISCUSSION

Tool Design Results

The process of testing the tools that have been done will determine the success or failure of the tools that have been done. whether the tool that has been done has an error or needs to be repaired, in each test measurements are taken which will later be used to analyze hardware and software as well as other supporting component Miniature Railroad Doorstop

The application of an IoT-based rail portal security system produces a miniature automatic train doorstop. The hardware / hardware used in the miniature consists of a sensorpir, nodemcu ESP8266, servo motor, buzzer.:

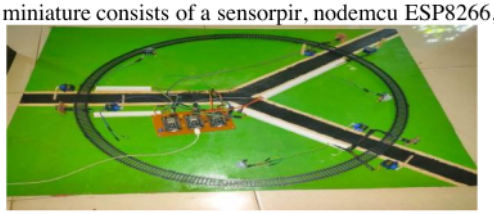


Fig 6. Miniature Doorstop

Overall Test Results

On the way the train passes through crossings guarded by railroad gate guards [14], [17]Because even though it has been guarded, every guard can be negligent and can result in an accident. Train accidents are caused by various things, namely schedule errors, negligence of the railroad crossing gate guards who do not close the railroad crossing doors, and the negligence of other road users for breaking through the gates. Therefore, the purpose of this research is to make a prototype design procedure for securing a railway portal that can be operated by an IoT-based control system in order to reduce the risk of accidents on the railroad due to the absence of railroad crossings so that it can cause fatalities. This research method targets the design of an Internet of Things-based control system, then connects the Internet of Things control system to other devices, namely motion sensors (PIR Sensors) and servo motors to move the doorstop and then replace the train schedule on this prototype. This research was conducted at the Muhammadiyah University of North Sumatra with the help of a toy train as a simulation tool.

Table 1. Nodemcu Pin Connection Table and DC Servo

Nodemcu ESP8266	**Servo DC**
Pin D4	PWM
3.3V	VCC
GND	GND

Table 2. PIR Sensor Test

NO.	**Sensor distance (cm)**	**Sensor angle Pir**				
		0°	30°(up)	30°(down)	30°(right)	30°(left)
1.	7 cm	High	Low	High	High	High
2.	5 cm	High	Low	High	High	Low
3.	3 cm	High	High	High	High	High

In testing the PIR sensor in table 2, the high result is an active sensor and high sensitivity, while low is an inactive sensor and weak sensitivity. The sensor was tested 3 times with different experiments and results. With the result that the farther the sensor distance, the weaker the sensitivity of the sensor will be, and vice versa.

Table 3. Sensor Test

No Test	Sensor Reading Distance (cm)	Sensor Read Time (s)	Delay Time(s)	Open Servo Condition	Train Distance Ni Doorstop
1	7 cm	3 second	5 second	Closed	14 cm
2	5 cm	4 second	3 second	Closed	12 cm
3	3 cm	3 second	3 second	Closed	10 cm

In table 3, the results of sensor testing are carried out aiming to see whether the sensor can work optimally or not with respect to time. With several experiments such as sensor reading distance, sensor reading time, delay time, servo condition is open. With the results that have been carried out, the results show that all sensors are active. The sensitivity of each sensor to motion readings is quite good.

Table 4. Blynk Testing on Nodemcu

System IoT	Internet Condition	Blynk Connection	Indicator Led	Condition Tool
Nodemcu1	Active	Active	Active	Active
Nodemcu2	Active	Active	Active	Active
Nodemcu3	Active	Active	Not Active	Active

In table 4, the Blynk test has been carried out on the Nodemcu with the aim of seeing the Nodemcu successfully work on Blynk's orders and can command the servo motor to open and close the train door latch. To connect nodemcu to blynk must use the internet network. With the programmed results, Blynk functions to command the servo motor so that it can automatically close the latch when the PIR sensor has read the motion of the train, all of which are successful.

CONCLUSIONS

Conclusion

1. In testing the tool when the PIR sensor works, the program will work to raise the bar, this miniature is made to reduce the number of accidents when the train passes.
2. The design of the system is in accordance with the structure and functions properly, the PIR sensor reads the motion of the train and then the nodemcu esp8266 successfully sends a command to the servo motor to close the doorstop before the train crosses the highway.
3. Implementing the Internet Of Things (IoT) system using Blynk on the rail gate guard, Blynk receives a signal from the PIR sensor which has read the train's motion and then programmed the ESP8266 nodemcu to give orders to the servo motor to immediately move to close the doorstop automatically or even manually.
4. In the application of rail crossing security against IoT-based highway traffic lanes, PT. KAI can apply it, because this tool is very simple and can be applied by PT. KAI.
5. This research can be developed by adding a limit switch sensor, infrared as an electric motor driving a crossing portal, when a 2 km train is about to pass through the portal, this can be done if the IoT system error or is disturbed.

ACKNOWLEDGMENT

This work was supported by Universitas Muhammadiyah Sumatera Utara.

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