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Bus Monitoring System Based on Internet of Things

Mohd Hakimi Zohari[1]*, Adam Mustaqim Azman[1], Mohd Hezri Mokhtar[1], Mohd Shamian Zainal[1], Lukman Iqbal Hussain[2]

[1] *Department of Electrical Engineering Technology, Faculty of Engineering Technology, Universiti Tun Hussein Onn Malaysia, 84600 Pagoh, Johor, MALAYSIA*
[2] *Alstom, Level 25, Axiata Tower No. 9, Jalan Stesen Sentral 5, Kuala Lumpur Sentral, 50470 Kuala Lumpur, MALAYSIA*

*Corresponding Author: programbnf@gmail.com
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Abstract

Bus Monitoring System based on Internet of Things is a system that monitors bus movement and the distance along its route to reach allocated stop area. Tracking system includes installing a digital device in the bus, and Blynk application on a smartphone to allow the user to monitor the bus real-time location. The project is a GPS tracking implementation based on Internet of Things. The real-time data will be sent to server and it will update the bus location periodically. The Blynk application will indicate where the vehicles are on their smartphone by using the Blynk application which is to provide the updated data to user at anywhere as long as both user and the bus have an internet connection. The Blynk server will track the position and store its information in the database. It is a real-time system as this technique transfers the data on the tracking system to the smartphone automatically. Users can use the application to get flexible in scheduling travel and decide when to board the bus. NodeMCU with built in ESP8266 microcontroller and Arduino IDE is used for both hardware and software module programming. Both of it is linked to the Blynk server and follows through the Blynk application that need to be installed in the smartphone. The user's waiting period can be minimized. This application can be used for main monitoring program to maintain tracking of all Pagoh campus buses. The effective route management can be performed effectively through the Bus Monitoring System.

1. Introduction

Global Positioning System (GPS) is a very important technology nowadays and it is unthinkable for us to live without GPS technology. Malaysia's National Key Result Area (NKRA) 2014 under Government Transformation Programme (GTP) was introduced to improve the socio economy growth of Malaysian. The improvement of urban public transport is one of the seven major sectors of NKRA. Although government had invested on public transportation over the years but people still choose to use their own transport instead of public transport. Then, the problem of heavy traffic still arises. There are many causes related this issue, one of those is the public transport schedule that is inefficient and inaccurate. For example, bus service, bus is not popular in Malaysia due to the unavailability of centralized bus tracking or monitoring. There are plenty of researches that have been conducted related to monitoring or tracking. The most common technology for tracking is Global Positioning System (GPS). GPS can be used to navigate, locate and, track. GPS can be found in airplanes, smartphones, and others. In case of public transport, for example bus usually has fixed time schedule for every bus stop. However,

weather, traffic conditions, and, bus driver's factor may cause delay in the service. By using GPS to track of public transport and view it from Google Maps or other IoT based application is a good alternative as proposed in this project. The IoT based application will receive the GPS data from the server in order to be visualized the tracking of bus location in the dedicated route. People can manage their time more efficiently benefitting from this system.

2. Problem Statement

Nowadays, the world has become highly technology dependent and it will be difficult for human to go through their day without technology. The GPS tracking technology has become more needed by humans. The perk of GPS tracker is a person can call to set up a service in an emergency situation or on specific time. The users can look at the tracking and know exactly the whereabouts of the oncoming service. For many users, transportation have been always being the problem for those do not have any vehicles. Usually, bus transportation will be used as a way to go to another places. However, users usually do not know the bus routes and the current bus location. Users can only know the timetable of the bus routes. It was kind of time wasting for users as they need to wait for the bus to arrive on their destination without any information. By making the Bus Monitoring System, users can monitor the whereabouts of the bus and their journey planning are more efficient as they can save time from waiting for the bus. The purpose of this project is to design and build an IOT based GPS tracker. The second objective is to build a prototype that is capable to function as a real GPS tracker. Then, the last one is to develop a program code that can function on the prototype to monitor the bus real-time location.

3. Materials and Methods

This section is to provide the explanation of the methodology used in order to develop bus monitoring system. This methodology will guide on how to achieve the project objective. Figure 1 shows the flowchart of the overview at positioning and sending the data to the Blynk application. It will be fed to the ESP8266 NodeMCU as the GPS module locating the current position. ESP8266 NodeMCU will read and collect the latitude and longitude values that correspond to a bus location. The result will then be shown on the screens of the smartphone where the user will receive the location in real time through the application called Blynk.

The emerging of "Internet of Things" is really helpful and it is not just only Internet-connected consumer devices. In fact, IoT is the technology that builds systems capable of autonomously sensing and responding to stimuli from the real world without human intervention [2]. Therefore, people need to develop a process flow for a definite framework over which an IoT solution is built. IoT encourages companies to rethink the ways they approach their businesses, markets and industries which gives them the tools for their business strategies improvement [3]. These days, IoT device will most likely use a microcontroller as its brain. A microcontroller is considered as a small computer with a microprocessor core, memory, and input/output (I/O) ports. The microprocessor is a central processing unit core of your microcontroller and handles all the local data manipulation and also the capabilities on decision-making. Random Access Memory (RAM) and Read Only Memory (ROM) are the memory for the system.

Microcontroller's software program was stored on the ROM while RAM stores and receives data while also supporting number crunching. The I/O ports were the final microcontroller component; it may be either analog or digital. Data from sensors were collected through the input ports. While any necessary actuation or local control were supported by the outputs in the IoT device. IoT applications are nearly limitless while enabling seamless integration of the cyber-world with the physical world [4]. IoT device could be remote and standalone or be co-located within a larger system. It also could perform local data analysis, combine data from many sensors and then take action.

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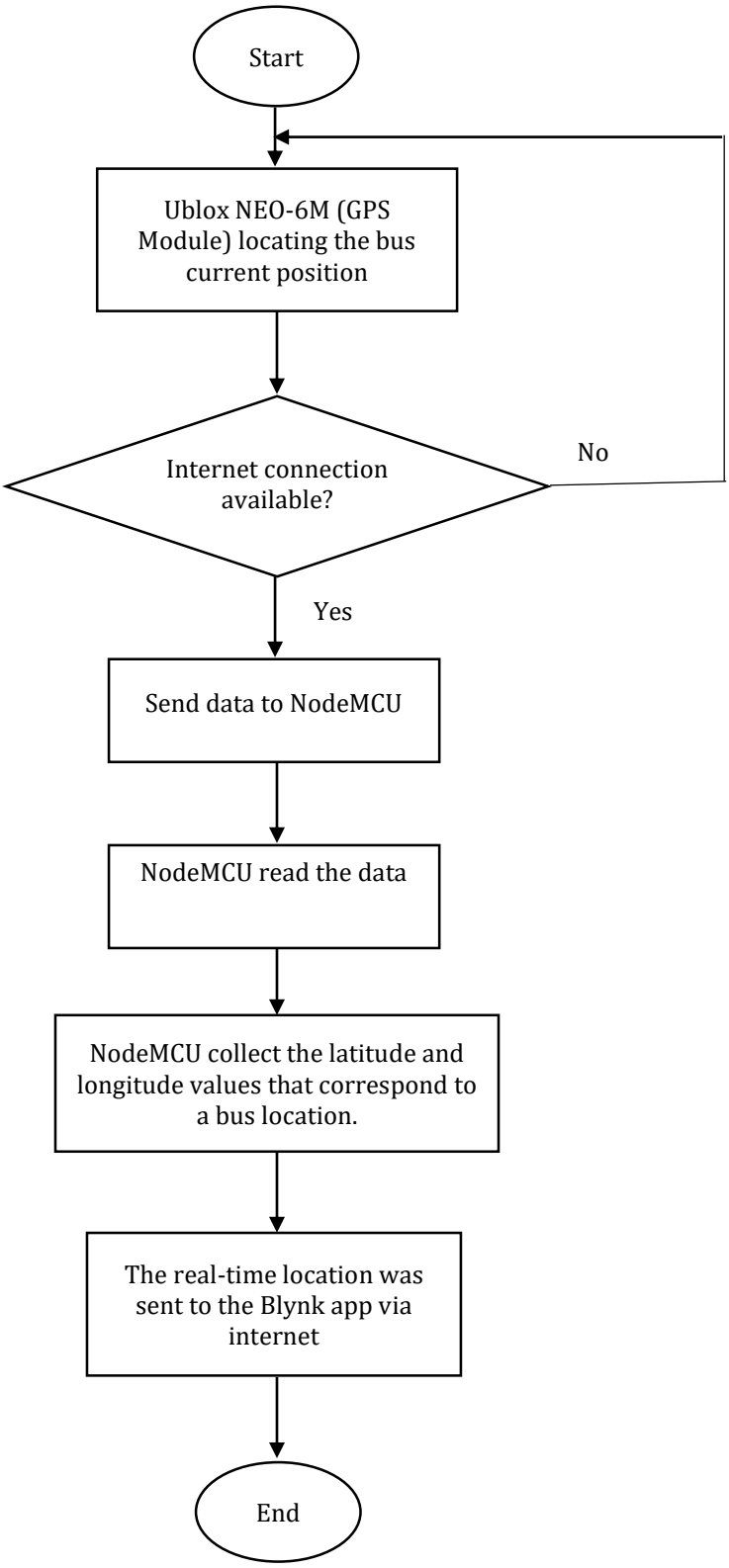

Fig. 1 *Flowchart of overview process*

3.1 Blynk Application

Blynk is a new platform that lets people to quickly build interfaces for monitoring and controlling hardware projects from neither Android or iOS device. It is a digital dashboard where graphic interface for our project by simply dragging and releasing the widgets. With this application people now can create a project dashboard and

arrange buttons, graphs, sliders, and other widgets onto the screen. User can turn pins on and off or display data from sensors by using the widgets. Figure 2 shows the Blnyk widget box that can be used for any application.

Making the hardware part normally was not that hard. Constructing the software interface is what usually difficult. By using Blynk, the software side can be much easier than the hardware. Blynk is the perfect solution for interfacing with simple projects. Currently, Blynk supports most Raspberry Pi models, Arduino boards, Particle Core, ESP8266, and other common microcontrollers or single-board computer. Ethernet shields and Arduino Wi-Fi are also supported. A control device plugged into a computer's USB port can be connected as well with Blynk.

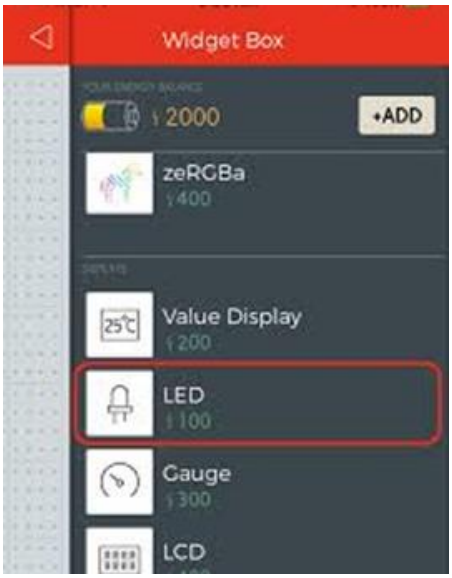

Fig. 2 *Blynk widget box*

One of the best aspects of Blynk is that the user can create a local Blynk server and keep every single thing within home network. This is very useful if user needs to establish a network in a remote location, or if user is concerned about traffic going through other machines in the cloud. There also other platforms that is used for controlling hardware over the internet like Temboo, Particle, IFTTT, ThingSpeak. Blynk is one of the most user-friendly and free to use. It is also an open-source under MIT license. The Blynk platform build with a few important components. There is Blynk application builder which allows for project application to be built by using various widgets. It is available for iOS and Android platforms. Then, there is Blynk server that are responsible for all the communications between smartphone that is running the hardware and the Blynk app. Blynk Cloud can be used or user can run their private Blynk server locally. To enable communication with the server and processes all the incoming and outcoming commands from Blynk app and the hardware can be done with Blynk libraries. All the components that have been mentioned communicate with each other to construct a fully functional IoT application that can be controlled from anywhere through a preconfigured type of connectivity [5]. User can control their hardware from the Blynk app running on any smartphone through the Blynk's personal server or Blynk Cloud. It works the same in the alternately by sending rows of processed data from hardware to Blynk application.

3.2 Project Overview

The GPS module locates the current location and sends it to the microcontroller [6]. To monitor the smartphone's real-time location, the GPS module is connected via internet connection to the microcontroller. The main functions of the GPS module are to read the geographic coordinates of the current location of the bus continuously [7]. By using GPS module, the updated data can be recorded via Blynk cloud server. The updated location of the bus can be tracked directly on Blynk apps software and users can also check the current bus location very easily. The project block diagram is shown in Figure 3.

3.3 Hardware Development

For the project, the NodeMCU need to be connected with the Ublox NEO-6M. To establish the connection, the D1 pin on the NodeMCU need to be connected with the Tx pin on the Ublox NEO-6M [8]. Then, the D2 pin on NodeMCU need to be connected to the Rx Pin on the receiver. Then the Vcc pin of the Ublox NEO-6M are connected to the 3.3V pin of NodeMCU. Next, connect the ground pin for both NodeMCU and the receiver. For the power source, the

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positive terminal is connected to the 5V pin on the NodeMCU while the negative terminal is connected on ground pin of NodeMCU. The circuit setup is shown in Figure 4.

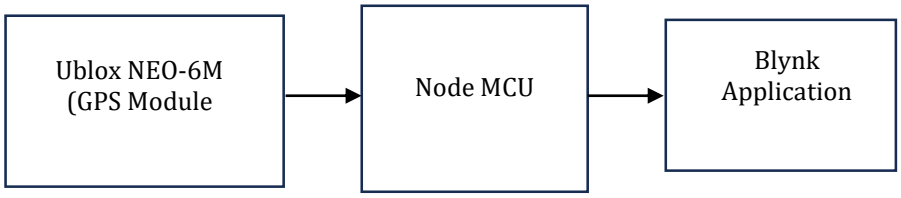

Fig. 3 *Project block diagram*

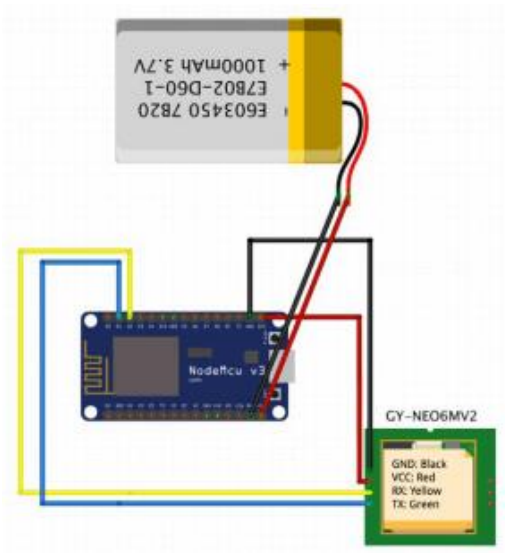

Fig. 4 *The circuit setup*

4. Result and Discussion

In this Paper will discuss about the data that had been carried out by doing the project thoroughly. The project will be conducted to monitor the real-time position of the bus through the Blynk application. By using a proper software to do the programming codes, it will ensure that the product and system can be tested [9]. All the safety precautions before beginning the project until the prototype completed had been taken to prevent unwanted accident from happen. Bus Monitoring System were tested on a university's bus route. The outcome is depending on the internet connection of the location. The Figure 5 shows the general view of the project. Firstly, the program code needs to be compiled and uploaded to the NodeMcu by using Arduino IDE software. After that the power supply need to be turned on to start the GPS tracker. If the power is turned on, the NodeMcu will blink the blue light as a sign it had been switch on. After that, the WiFi connection need to be turned on in order to send the data collected to the Blynk application. Then user need to wait a moment for the GPS module to routing the coordinate [10]. After obtaining the coordinate, Ublox Neo-6M will blink every time the current coordinate was obtained and was ready to send the data to the Blynk Server. After that the data will be displayed through Blynk application. The data of the coordinate also can be checked on the serial monitor on Arduino IDE software.

Fig. 5 *The complete project*

Therefore, the NodeMcu need to be connected to the PC as the power supply. This is done to check if the system is functioning well and connected to the Blynk server. After that, it will send the latitude and the longitude of the current location to the server. This program enables the end user to track the bus movement in real time which the data is set to be updated on Blynk server every one second. This will enable the user to see the movement of the bus through Blynk application. The latitude and the longitude are displayed on the Blynk application. The blue marker shows the position of the user while the black marker shows the position of the vehicle where the GPS tracker was put in. From the Figure 6, the movement of the vehicle can be seen in real time entering the university campus through the Blynk application.

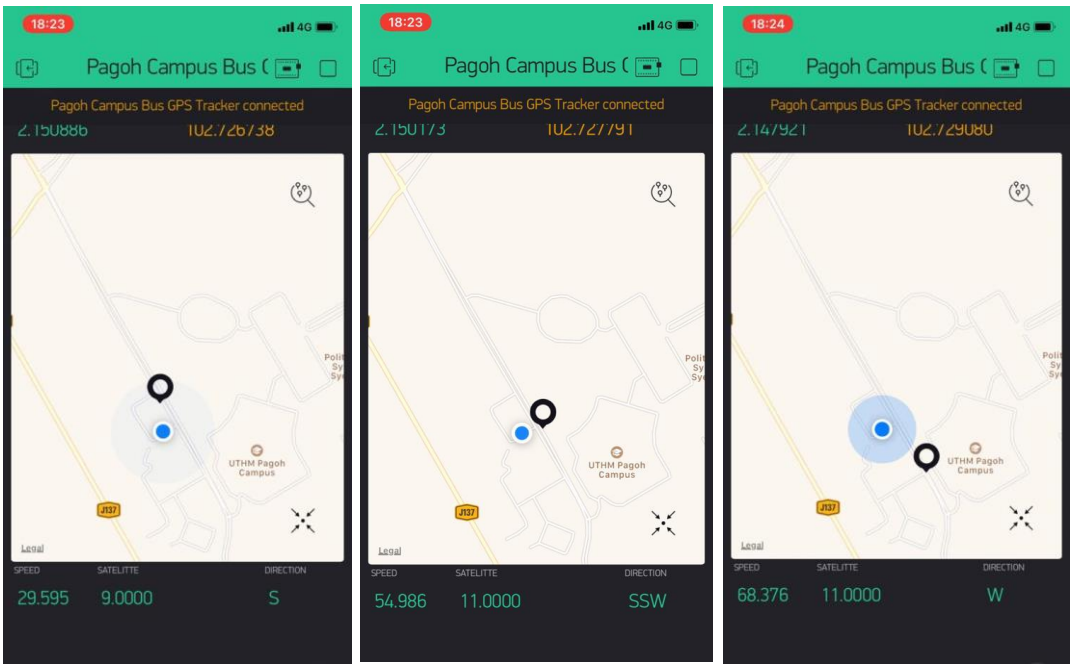

Fig. 6 *The bus movement shown realtime in Blynk application*

4.1 Discussion

The number of satellites that being used is ten for Block A and eleven for both Block B and C which all of these were the waiting area for the bus to pick up. Next, for the journey along the route of the bus which is the residential college bus parking area, the number of satellites available that can be detected by the GPS tracker is twelve satellites. When the bus arrives at the residential college front gate, the satellite detected were also twelve. Then when it arrives at university campus front gate, the satellites detected by the GPS tracker is eleven satellites. From the project outcome it concludes that the bus routes have a stable connection for the satellites as the GPS tracker can detect more than ten satellites at the critical area along the routes.

The number of satellites influenced the accuracy of the real-time position of the bus as more satellite being used at a time, the more accurate of the data as it was perpendicular with each other. Thus, having more satellites

connected to the GPS tracker is making the system more accurate so the data received at the end user are much reliable and accurate. These findings were done in order to know whether the Bus Monitoring System can been run efficiently for users or not. The system is functioning well as the satellites that been used along the journey were above ten satellites at each moment. Therefore, the data that been sent were reliable and pretty accurate.

The position of the GPS tracker was put on the vehicle influenced the number of satellites being used at that certain time. The accuracy of the real-time position of the bus is directly proportional with the number of satellites being used at a time. The placement of the GPS tracker on the vehicle are critical as it will affect the accuracy of the real-time position due to the number of satellites used at certain placement position. When the GPS tracker was placed inside the compartment whether in front or in the back compartment, the number of the satellites detected are low which three satellites detected at the front compartment and four satellites detected at the back compartment. This is because the compartment is closed area where there is no light that can come in thus the connection for the satellites became quite hard to be established. When the GPS tracker is placed on the passenger seat, the connection of satellites became more stable as each of front and back passenger seat record nine connected satellites for both of it. This due to the GPS tracker now can receive the satellites connection much easier compared to when placed on the compartment box. The satellites connection is increased to ten satellites connected when the GPS tracker is placed beside the driver seat. This is because the GPS tracker become much nearer to the front mirror of the bus and the receiver of the GPS tracker get more exposure of the sky. When the GPS tracker is placed near the mirror which is placed on the bus front mirror, it recorded the highest satellites connection which is twelve satellites connection. This is due to the GPS tracker receiver now can detect more satellites as it were exposed to the clear sky. Thus, the connection is easier to establish. All of these data were tested on the bus parking at the residential college

5. Conclusion

The purpose of this study is to develop a system that can track the location and the real time movement of the bus in the campus area for the users. Otherwise, this project also perhaps to help the user to know the exact location of the bus in real time. The idea is when the user wants to use the bus, they can open the Blynk application on their smartphone to check the location of the bus thus will help them to plan their time efficiently. The way of the system works is that when the GPS tracker is turned on and placed in the bus. The GPS module will track the location and the data will be sent and updated for every one second to the Blynk server. Users can see the movement of the bus in real time on their smartphone whenever they open the application on their smartphone as the data is updated for every one seconds to the Blynk server and can be seen on the Blynk application. Once the system was start, it will constantly update the current location every one minute. Bus Monitoring System project have achieved the initial project objective thus it is considered as a success. First, the phase of designing the IOT based GPS tracker by using the microcontroller have been done by identifying the component that need to be used as the hardware for this project. Next, the program code that can function to monitor the bus real-time had been developed successfully. Lastly, a prototype that is capable to function as a real GPS tracker for this project had successfully been built.

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Conflict of Interest

Authors declare that there is no conflict of interests regarding the publication of the paper.

Author Contribution

The authors confirm contribution to the paper as follows: ***study conception and design****: M.H.Z;* ***data collection****: A.M.A;* ***analysis and interpretation of results****: M.H.M, M.S.Z;* ***draft manuscript preparation****: A.M.A, M.H.Z, L.I.H. All authors reviewed the results and approved the final version of the manuscript.*

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