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An Automatic Bus Route Monitoring System for the Federal University of Technology, Minna

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ABSTRACT
Transportation between both university campuses has become a tedious and tiring activity because of the existing disconnect between the university's transport system and the commuters due to the rapid increase in student population. The major factor responsible for this disconnect is the information gap between the passengers and the bus(es) en-route. This study therefore, proposes to bridge this gap by designing and implementing a system to monitor bus route and create awareness to the waiting passengers at the bus park via an audio system communicating remotely with the distant bus in transit via GPRS technology. Results obtained prove the efficiency of the project, in helping commuters make better decisions.

KEYWORDS: *Bus tracking, Bus route, GPRS, GPS, Latitude, Longitude*

1 INTRODUCTION

As cities continue to grow in size, challenges arise in the design of urban mobility infrastructure, and one of the key challenges of rapidly growing cities is to provide effective public transport services to satisfy the increasing demands for mobility (James & Nair, 2017). The Federal University of Technology Minna (FUTMinna) with its rapid growth rate, is attest to the problem stated in above (James & Nair, 2017). The university has two campuses located approximately 20km apart. As a result, providing an "effective" means of transportation to cater for the entire population of her students proves to be a herculean task.

There have been series of solutions proposed to increase the efficiency of public transportation around the world, ranging from systems using either or a combination of Global System for Mobile Communication (GSM), General Packet Radio Service (GPRS), Global Positioning System (GPS) technologies, and Radio Frequency Identification (RFID) (Shyam, Kumar, Shashi, & Kumar, 2015), (Raad, Deriche, & Sheltami, 2021), (Kumbhar, Survase, Mastud, Salunke, & Sirdeshpande, 2016), (Ahmed et al., 2019), (Dhende, Kaotekwar, Kokane, & Karambelkar, 2017).

1.1 REVIEW OF RELATED WORKS

Vehicle tracking systems have been in existence and employ various technologies to achieve their respective aims or goals. They have been deployed worldwide, and there is a high possibility of having improvement on existing methods and/or devising new methods to achieve the goal of near-perfect transportation and traffic management systems.

A. Developing a Smart Bus for Smart City using IOT Technology.

The proposed method in (Kadam, Patil, Kaith, & Patil, 2018) employed a combination of GPS, Bluetooth, GPS, and GPRS technologies to track a bus. The bus trackers on board were equipped with two pairs of IR sensors connected to an Arduino Uno microcontroller via Bluetooth. The Arduino Uno was equipped with a GSM/GPRS web module for purpose of web connectivity. The IR sensors on the bus were used to carryout headcount of passengers boarding and alighting from the bus and this information, alongside the exact (live) location of the bus as computed by the GPS was updated to a cloud server where processing was done and further transmitted to an application hosted on an android device. The estimated time of arrival (ETA) was calculated using the Euclidean Distance Formula and was also displayed on the android application alongside the number of passengers aboard as at the time of query.

B. Intelligent Bus Monitoring System

The proposed method achieved its aim by implementing a system consisting of a GPS/GSM modem, PIR sensors, DC motors, switches, and a smartphone, all of which were coordinated by an ARM cortex microprocessor. Tracking of the bus was done both offline via GSM and online via GPRS and GPS modules. Upon detection of an accident, the system updated the exact location of the vehicle via GPS/GSM technology and sent a message to relevant authorities informing them of the accident and the location of the vehicle. The system also proposed a smartphone application to remotely monitor and obtain the exact location of the bus, obtain an estimated arrival time, and also number of passengers and available seats aboard at any time to help users facilitate decision making (Shinde & Ansari, 2017).

C. UiTM Campus Bus Tracking System Using Arduino Based and Smartphone Application

The system discussed herein employed GPS, Wi-Fi, and web technologies, all coordinated by an Arduino microcontroller board. The installed GPS unit attached to the microcontroller received the coordinates (longitude and latitude) from GPS satellites and sent them to the Arduino microcontroller for processing. The Arduino Uno then updated the data in the local server. The mobile smartphone application, which was wirelessly linked with the microcontroller's local server, was allowed to read the data on the server after proper authentication and relay it to users via its user-friendly user interface. The system also provided an LCD display which displayed the real-time location of the bus as obtained from the Arduino microcontroller (Kamisan, Aziz, Ahmad, & Khairudin, 2017).

D. College Bus Tracking Android Application using GPS

The implemented system was divided into the Hardware Unit and the Monitoring Unit. The monitoring unit of the system made use of a SIM 900 GSM module as a modem for data transmission to the server using GPRS, and a GPS module which obtained location data from GPS satellites. Both modules coordinated by an Arduino microcontroller. The location data on reception by the GPS tracker was sent to the microprocessor and then to the GSM module whose task was to communicate and store the data on the database. On the monitoring system which was majorly software, a user-friendly Android application (written in Android Studio) was developed and interfaced with the hardware unit and the server via the internet. The major function of the application was to download the location data (longitude and latitude) from the server and display the real-time location of the bus. The obtained information was displayed on Google Map with the aid of Google Maps API (Kumar, Aishwarya, & Mounika, 2016).

2 METHODOLOGY

This paper proposes a cost-effective method of tracking vehicles (campus shuttle buses) that run between both campuses of the university. The system, sub-divided into two; the Bus Segment and the Bus Park Segment, replaces the conventional GPRS and GPS live-tracking approach to bus tracking by comparing the coordinates

(Longitude and Latitude) of pre-defined locations along the route with the real-time location of the bus while in motion. For the purpose of this paper, the route of concern will be the Bosso – Gidan-Kwano route, and the predefined locations and their coordinates are listed below:

i. Bosso Campus
ii. Kure Market
iii. Kpakungun
iv. NECO Office
v. GidanKwano

The onboard NEO-6 GPS sensor tracks the real-time coordinates of the vehicle and relays the information to the Atmega 328 microcontroller, which communicates with the Bus Park Segment via the A6 GSM module. The communication is made over GSM by sending SMS to the inserted SIM card on the GSM module of the Bus Park Segment. The received information is decoded and a signal is sent to the Mini mp3 player for playback to the audience at the bus park.

2.1 BUS SEGMENT

This unit consists of an Atmega 328 microcontroller, a bulk converter, an A6 GSM module, a NEO-6 GPS module, filtering and coupling capacitors, resistors, and LEDs. The A6 module captures the real time coordinates of the bus in motion or at rest and sends it to the GSM module for transmission via SMS to the Bus Park Segment. The block diagram of this segment is shown in Figure 1.0 alongside the flow diagram of operations of the segment in Figure 2.

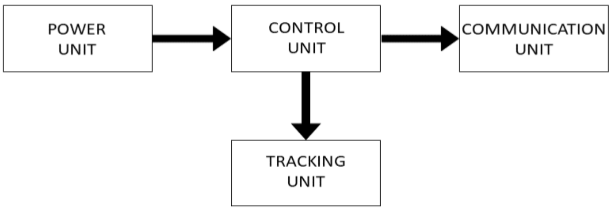


Figure 1: Block diagram of the bus segment

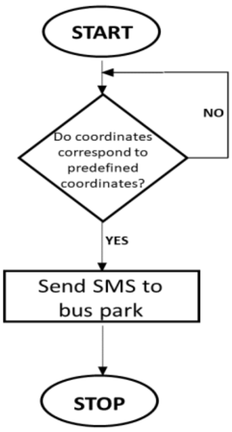


Figure 2: Flow diagram of the bus segment

2.2 BUS PARK SEGMENT

This segment of the system consists also of an Atmega328 microcontroller, an A6 GSM module, a bulk converter, a DF mini player, a 4-ohm speaker, filtering and coupling capacitors, indicator LEDs, and resistors, all powered by a two 3.75V battery units connected in series to give a 7.5V power supply. The A6 GSM module receives the information from the Bus Park segment and communicates it to the DF mini mp3 player board connected to the microcontroller.

The DF mini player is a serial MP3 module with an integrated MP3 and WMV decoder chip also equipped with a micro SD card driver, FAT16 and FAT32 file system support. It converts the received message into audio format and delivers particular messages audio messages via the speakers. The block diagram and the flow diagram of the segment are shown in Figure 3 and Figure 4 respectively.

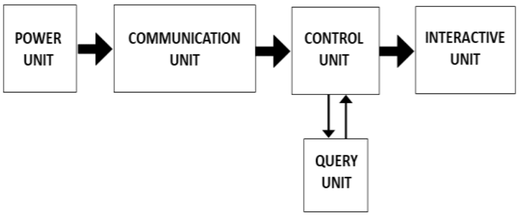
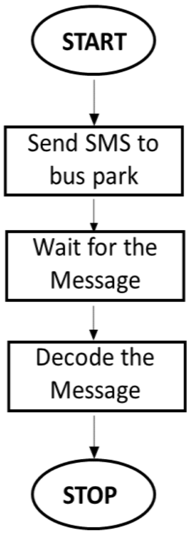


Figure 3: Block diagram of the bus park segment



Figure

2.3 ALGORITHM

***STEP 1**: INITIALIZE SYSTEM*

***STEP 2**: GPS RECEIVE VEHICLE COORDINATES*

***STEP 3**: COMPARE WITH PREREGISTERED COORDINATES*

***STEP 4**: CHECK FOR A MATCH IN THE COORDINATES*

***STEP 5**: IF THERE IS A MATCH, SEND SMS TO BUS PARK UNIT. IF NONE, NO SMS IS SENT*

***STEP 6**: BUS PARK UNIT PLAYS THE CORRESPONDING AUDIO MESSAGE TO THE COORDINATES THAT WERE RECEIVED*

3 RESULTS AND DISCUSSION

The following images show the results obtained when the bus arrived each of the predefined locations. However, this is a proposed work as at the time of writing this paper and modifications are currently ongoing.

3.1 RESULTS FROM BUS SEGMENT

Figure 5: Final construction indicating the bus segment is completely initialized

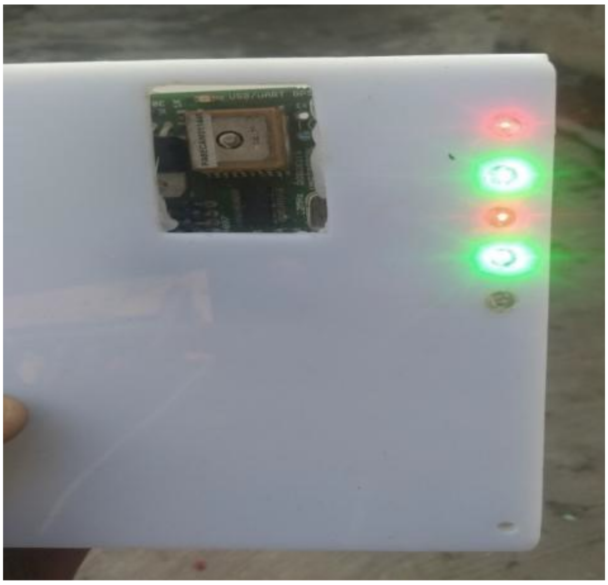


Figure 6: Final construction indicating the bus segment GSM signal strength

The Bus Segment is a device that tracks the bus location in real time. The LEDs in Figure 5 shows the signal level of the device.

3.2 RESULTS FROM BUS PARK SEGMENT

Figure 7: system indicating the bus is or has gone beyond Bosso campus

Figure 8: system indicating the bus has reached Kure Market

Figure 9: system indicating the bus has reached Kpankungu Roundabout

Figure 10: system indicating the bus has reached NECO Office

Figure 11: system indicating the bus has reached Gidan Kwano Gate

Figures 7, 8, 9, 10, and 11 are images from the Bus Park Segment, it houses a speaker that announce the real time location of the bus when the system is queried and also LEDs to show the matched location of the bus. Figure 12 shows the result displayed the when system was queried at particular interval

BUS SEGMENT

The steps taken to test the operation of the bus segment are as follows;

STEP 1: switch on the bus segment via the switch at the side of the casing. When the system is on, the five LEDS on the bus segment comes on in sequence to indicate the adequate power supply is circulating in the circuit. Four of the LEDS represent the GSM while the last led is for the GPS.

STEP 2: the LEDS remains on until the GSM module on-board initializes this usually takes up to 3 seconds. After its eventual initialization, the LEDS turn off in sequence to indicate a successful initialization.

STEP 3: the controller queries the GSM module to know how much of signal strength is available, based on the received value, the controller turn on four LEDS.

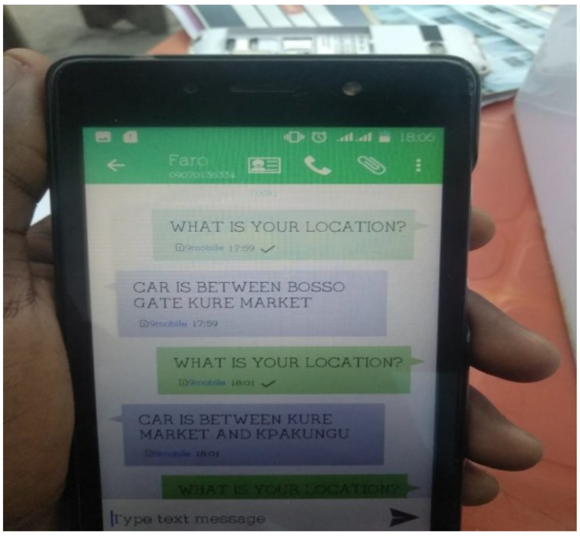


Figure 12: Showing Result when system was queried at particular interval

STEP 4: the system waits for the GPS to connect to the satellite, after successful connection, the GPS starts blinking at a constant interval. This is only visible through the transparent casing but when the GPS start receiving real coordinates from the satellite, the GPS LED starts to blink at constant interval.
STEP 5: the bus segment sends an SMS to the bus park segment to notify of its connection.
STEP 6: the bus segment starts comparing the received coordinate to that of the predefined coordinates. These are school gate Bosso campus, Kure market, Kpakungun roundabout, NECO office and school gate Gidan Kwano campus.
STEP 7: when there is match in the coordinates the bus segment sends a message to the bus park segment. The programmed messages are Bosso gate for school gate Bosso, Kure for Kure market, Kpakungun for Kpakungun roundabout, NECO for NECO office and gk gate for school gate Gidan Kwano.

BUS PARK SEGMENT

The steps taken to test the operation of the bus segment are as follows;
STEP 1: the switch of the bus park segment at the side of the casing was pushed. When the system came on, the five LEDS on the bus segment comes on in sequence to indicate the adequate power supply is circulating in the circuit. All the LEDS in this case are for the GSM.
STEP 2: the LEDS remains on until the GSM module on-board initializes this usually takes few seconds. After its eventual initialization, the LEDS turn off in sequence to indicate a successful initialization.
STEP 3: the system announced the welcome message- “Good Morning Fellow Students. I am Hamza the school bus monitoring system welcome to the school bus park. System trying to locate bus” Was made by the speaker. This message rounds up the initialization process of this segment.
STEP 4: the system waited for the messages from the bus segment to know the location of the bus. Throughout the course of journey, the following sounds were heard- “bus is at school gate Bosso campus”, “bus has reached Kure market”, “bus has Kpakungun roundabout,” “bus has reached NECO office”, “bus has reached school gate Gidan Kwano campus” and as the announcement is made the LEDS were coming up respectively.
STEP 5: the system awaits SMS query from students. During the course of the journey the bus park segment was queried severally and the following messages were received. - bus is at bus park Bosso campus, bus is between school gate Bosso campus and Kure market, bus is between Kure market and Kpakungun roundabout, bus is between Kpakungun roundabout and NECO, bus is between NECO and school gate and bus is at bus park Bosso campus.

4 CONCLUSION

This project is aimed at providing a solution to an inherent problem in the FUT Minna transportation system. It has been tested to be working and hopefully the University will consider it for implementation in other to serve it desired purpose. It is a low power solution that can save student a lot of energy and resource. The system when fully implemented will give the University bus system a modern look and the technology with which University is recognized for it will be clearly evident even in the bus transit system. Further work on the developed solution is still on going and more detail results will be showed cased in our next publication.

However, an improvement is ongoing presently, working on the limitations and shortcomings to give a better result.

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REFERENCES

Ahmed, A., Parvez, M. R., Hasan, M. H., Nur, F. N., Moon, N. N., Karim, A., . . . Jonkman, M. (2019). *An intelligent and secured tracking system for monitoring school bus.* Paper presented at the 2019 International Conference on Computer Communication and Informatics (ICCCI).

Dhende, S., Kaotekwar, V., Kokane, V., & Karambelkar, V. (2017). Intelligent bus system using rfid, zigbee and gprs. *International Research Journal of Engineering Technology, 4*(4), 3.

James, J. G., & Nair, S. (2017). *Efficient, real-time tracking of public transport, using lorawan and rf transceivers.* Paper presented at the TENCON 2017-2017 IEEE Region 10 Conference.

Kadam, A. J., Patil, V., Kaith, K., & Patil, D. (2018). *Developing a Smart Bus for Smart City using IOT Technology.* Paper presented at the 2018 Second International Conference on Electronics, Communication and Aerospace Technology (ICECA).

Kamisan, M., Aziz, A., Ahmad, W., & Khairudin, N. (2017). *UiTM campus bus tracking system using Arduino based and smartphone application.* Paper presented at the 2017 IEEE 15th Student Conference on Research and Development (SCOReD).

Kumar, G. K., Aishwarya, C., & Mounika, A. S. (2016). College Bus Tracking Android Application using GPS. *International Journal of New Innovations in Engineering and Technology, 4*(4), 40-44.

Kumbhar, M., Survase, M., Mastud, P., Salunke, A., & Sirdeshpande, S. (2016). Real time web based bus tracking system. *International Research Journal of Engineering and Technology, 3*(2), 632-635.

Raad, M. W., Deriche, M., & Sheltami, T. (2021). An IoT-Based School Bus and Vehicle Tracking System Using RFID Technology and Mobile Data Networks. *Arabian Journal for Science and Engineering, 46*(4), 3087-3097.

Shinde, N., & Ansari, S. (2017). Intelligent bus monitoring system. *International Journal of Computer Applications, 975*, 8887.

Shyam, N., Kumar, N., Shashi, M., & Kumar, D. (2015). SMS Based Kids Tracking and Safety System by using RFID and GSM. *IJISET-International Journal of Innovative Science, Engineering & Technology, ISSN*, 2348-7968.