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Development Of Microcontroller-Based Tricycle Tracking Using Gps And Gsm Modules

Maduka Nosike Chinwike[1]
Department of Physics
University of Uyo

Ozuomba, Simeon[2]
Department of Electrical/Electronic and Computer Engineering , University of Uyo
simeonozuomba@uniuyo.edu.ng
simeonoz@yahoo.com

Archibong, Ekaette Ifiok[3]
Department of Physics
University of Uyo

Etinamabasiyaka Edet Ekott[4]
Department of Physics
University of Uyo

***Abstract*—This paper is about the development of a microcontroller-based tricycle tracker using GPS and GSM modems. The tracker system monitors tricycle within a geofenced environment to ascertain whether it can be charged for the daily levy for commercial tricycle operators. The system also has android app that runs on a smart mobile phone. In all, the system includes hardware part which comprises of atmega8 microcontroller , GPS and GSM modules. The microcontroller is coded with embedded C- language. The system demonstrates a perfect performance in terms of tricycle monitoring and identification of levy evaders, based on design aim. Apart from the tracker circuit, the system also has android app which runs on mobile phone and enable the collection of information on the location geo-coordinates of the tricycle in real-time. The entire tracker mechanism is packaged in a box which is installed inside the tricycle's engine to record the speed, movement and location of the tricycle.**

Keywords— Microcontroller, Internet of Things, Geofence, GPS, GSM, Tracker system

1. INTRODUCTION

Nowadays, Nigeria is battling high level of unemployment and the government is focused on various ways to tackle the problem. Also, with the lingering decline in revenue generation from fossil fuel, Sate governments across Nigeria are seeking for ways to diversify their revenue generation. Fortunately, in recent times the commercial tricycle popularly known as keke has become one of the readily available solutions to job creation and enhanced revenue generation. As such, various State governments across Nigeria are developing strategies to strengthen the tricycle as the dominant intra city transport vehicle and also to improve on the revenue collection mechanism from the tricycle operators [1]. Evident improvement in the revenue collection efficiency will enhance economic development and service delivery.

Unfortunately, the present manual approach to monitoring the tricycle operators for levy collection has failed to yield acceptable result. As such, in this paper, a microcontroller-based tricycle tracking system is presented for automated tracking of the tricycles in real-time. It is believed that once the automated tracking system is incorporated into the tricycle revenue collection system, the problem of high number of tricycle levy evaders presently experienced will be minimized.

Basically, the tracker system is mainly used for monitoring tricycle on the move and supplying a timely ordered sequence of location data for further processing. Such tracking system is very important in modern world which can be useful in monitoring, tracking of stolen vehicle and other applications [2,3,4]. In this paper, a microcontroller-based tricycle tracking using Global Positioning System (GPS) and Global System for Mobile Communication (GSM) is presented. This tracking mechanism is a sub-system of a microcontroller and Internet of Things (IoT)-based tricycle revenue collection system. It is made up of a microcontroller, GPS and GSM modules. It utilizes one GPS device and a two-way communication process with a GSM modem. The GPS module gets the location information from satellites in the form of latitude and longitude, where a GSM module provided with a SIM card uses the same communication process as used in mobile phones. The system is installed on a tricycle (keke) such that its position and speed can be tracked remotely. The keke's information can be viewed on a smart mobile phone. The essence of the tracker mechanism presented in this paper is to integrate such automated mechanism in the IoT-based revenue collection system for commercial tricycle operators. This will enhance the efficiency of the revenue collection system.

2. METHODOLOGY

The tricycle tracking device shown in Figure 1 consists of the Power supply (P.S.U), the Microcontroller unit, the GPS and GSM Modules, the Actuator (Relay) and the Cloud IoT server. The dotted lines indicate wireless connections, where continuous lines represent physical connection between blocks.

The P.S.U supplies power to the system. The powered is obtained from the tricycle (keke) engine where the tracker is embedded. The GPS module is mainly used for positioning, timing, navigation and other purposes. Its antenna receives the location values from the satellite, which it provides in the form of latitude and longitude. The

GSM module is used for transmitting and receiving data. SIM 800L is used in this work, it is a miniature GSM module, which is integrated into the IoT circuit. It supports quad-bands GSM 850, EGSM 900, DCS 1800 and PCS 1900 [5].

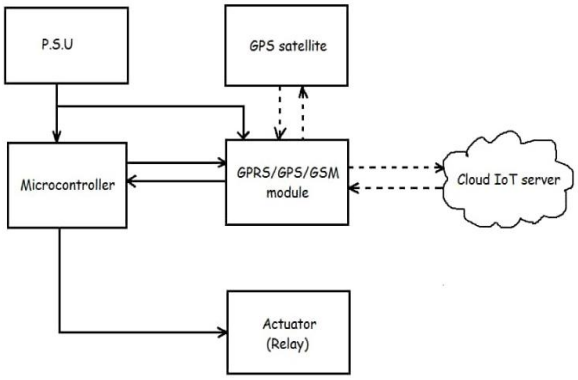

Figure 1: Tricycle Tracker Block Diagram

The system uses Atmega8 microcontroller is based on Reduced Instruction Set Computer (RISC) architecture. The microcontroller comprises of 1K byte internal SRAM, 8Kb of flash program memory and 512 bytes of EEPROM. The actuator is used as a switch for possible shut down of tricycle (keke) engine. The cloud IoT is basically a communication framework where different discrete devices can connect via some form of networks and communicate with each other. Tracked tricycles information is stored in the cloud sever for future use. The monitoring unit consists of a smart mobile phone and an application program. The smart phone acquire the position of the target tricycle in form of latitude and longitude, and by inputting those coordinates in the mobile application, the exact location of the target tricycle can be spotted. However, before this, the target information must have been linked and shared between the server and the GPS/GPRS satellite.

2.1 The tricycle tracker circuit and operation

The circuit diagram of the tracker embedded in the tricycle engine is shown in Figure 2. The circuit diagram consists of three major components which include the microcontroller (Atmega8), the NPN transistor (2N2222) and the GSM/GPS module (A7) biased with a resistor and diode. The microcontroller (M2) serves as the brain of the tracker system which processes and coordinates all incoming and outgoing information. The GSM/GPS module is a transceiver that receives and also sends information. It has six terminals, where terminal (5, 7) connects to the microcontroller, terminals (3, 6) are connection used as Vcc and ground, where terminal (1, 2) acts as transmitter and receiver antennas. The most important function of the transceiver is that it provides information in terms of position (longitude/latitude), distance and time.

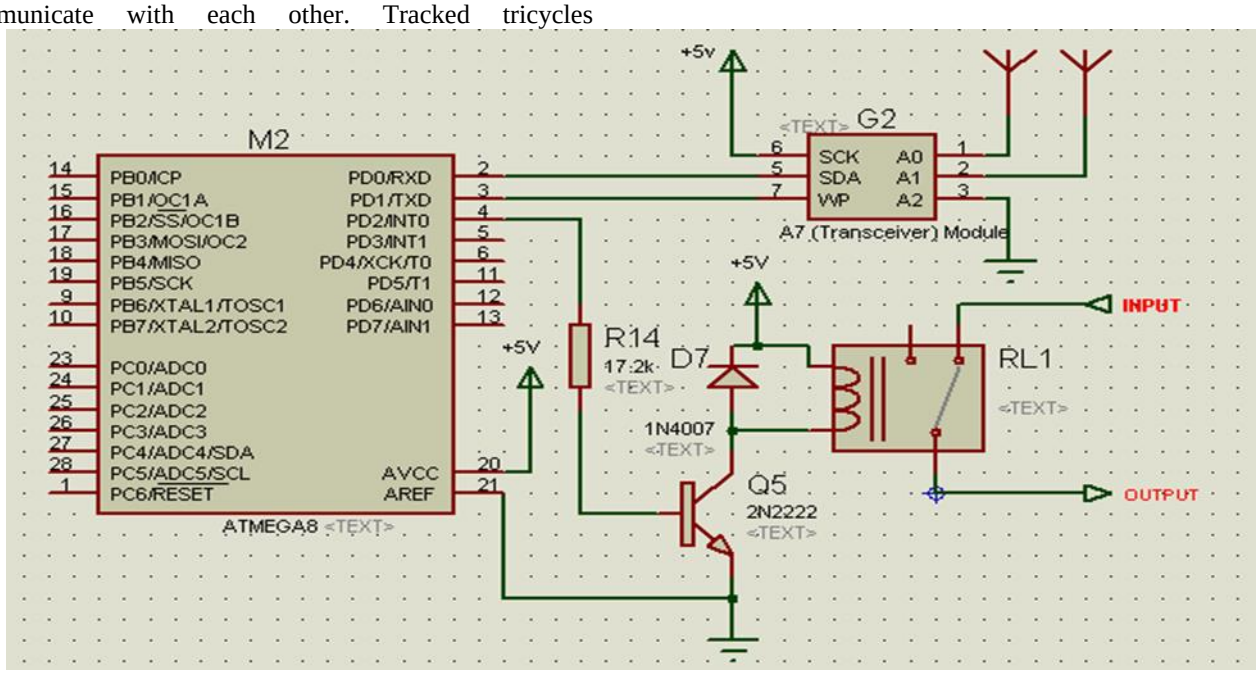

Figure 2: Tricycle tracker circuit diagram

The microcontroller (M2) is programmed to send signal to the relay switch (RL1) via an NPN transistor (Q2) when the tricycle goes beyond the limit. It entails that, the tricycle tracker can turn off the engine immediately whenever the tricycle goes out of the geofenced environment and possibly provide the instant location and time to the android cell phone. The NPN transistor (Q1) provides sufficient current for effective switching the relay (RL1).

2.1 The Tracking Mechanism

The tracking is based on the sensor/devices that can gather information, send information back or both [6], that is IoT communication. These information sharing is achieved without the aid of human being. The primary aim of this tracker system is to ensure that a tricycle have covered a certain predetermined distance within a geofenced area before it count that the tricycle operator has operated on that day. In order to achieve this aim, a method called "triangulation" is employed. Triangulation is a way by which location of a radio transmitter can be ascertained by

measuring either the radial distance, or the direction, of the received signal from two or three different base transceiver station (BTS) points [7]. Triangulation is applied in cellular communications to locate the geographical position of a mobile owner. To determine the distance (d) covered by a tricycle within a geofenced environment of length (l), the following expression is applied [8].

$$d = l \frac{\sin\alpha \, x \, \sin\beta}{\sin(\alpha + \beta)} \quad (1)$$

With the aid of the coordinates of existing communication masts owned by network providers on the Google satellite, the distances between three masts can be determined. To track a tricycle embedded with tracker (IoT module), region of interest (RoT) is detected by three masts using GPS information. The detected RoT by the masts is used by approximated radio maps algorithms [9], to calculate the various distances, which values a server aggregates to triangulate the precise position of the tricycle. All these processes are achieved by a set of pre-programmed instructions installed in the IoT device. This process of triangulation is as presented in Figure 3.

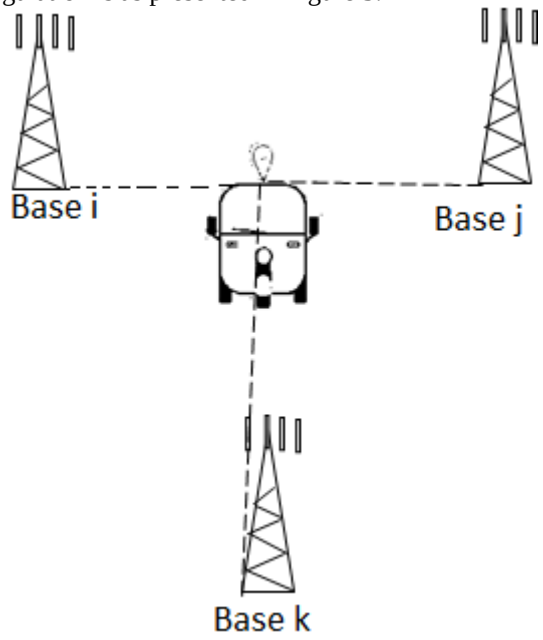

Figure 3: Triangulation location of tricycle

2.2 The Tricycle Tracker Operation

The flowchart that describes the operations of the microcontroller-based tracker device attached to the tricycle is as shown in Figure 4. The embedded system program flowchart indicates the sequence of operations of the tracker which is based on the embedded microcontroller program that controls its operations. Primarily, the program begins when the microcontroller-based tracker is connected via wireless network to the IoTs web server, as well as to the GPS/GPRS satellite. At this point, all the tricycle and the tricycle operator's information are shared between the tracker and the web server. The information availed by the server includes operator's registration status (i.e tricycle registered ?), daily payment (subscribed daily ?) and range of operation (distance). The shared information is used to manage the revenue collection and tracking of levy invaders based on the flowchart of Figure 4. The Atimega8 microcontroller integrated circuit is programmed using embedded C-language.

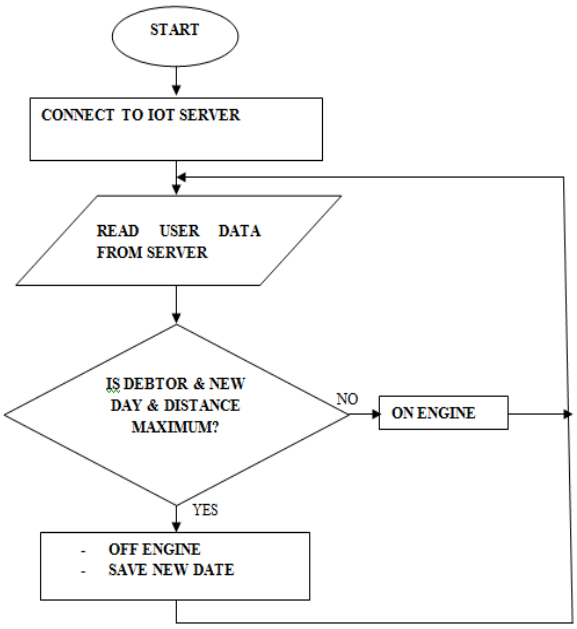

Figure 4: Flowchart diagram of tricycle tracker

2.3 Implementation of the microcontroller-based tracker system

The implemented tricycle (keke) tracker circuit is shown in Figure 5. Specifically, the microcontroller-based tracker circuit is the remote control circuit that is embedded inside the tricycle. The tricycle tracker circuit is constructed with GSM/GPRS and GPS modules where both are fixed on a Vero board which is coupled with antenna.

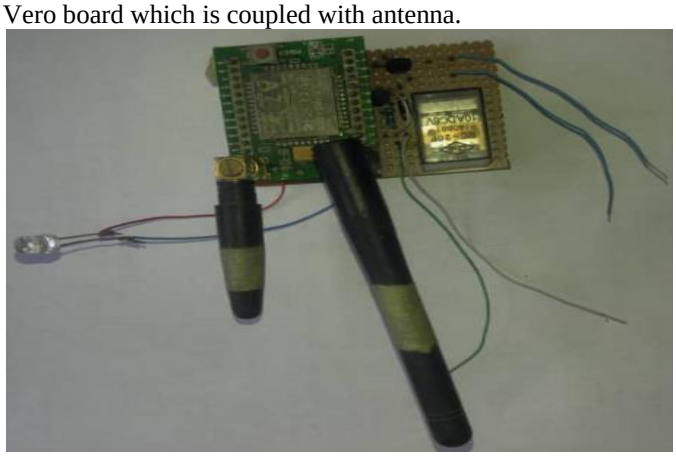

Figure 5: The Tricycle Tracker

Apart from the tracker circuit, the system also has android app which runs on mobile phone and enable the collection of information on the location geo-coordinates of the tricycle in real-time.

The information as displayed in Figure 6 provides sample geo-coordinates and other salient information about the location and speed of a tracked tricycle. Also, Google map-based visualization of the tracked tricycle is shown in Figure 7. This tracking information is obtained when the tracker point on the application page (application installed on an android cell phone) is tapped.

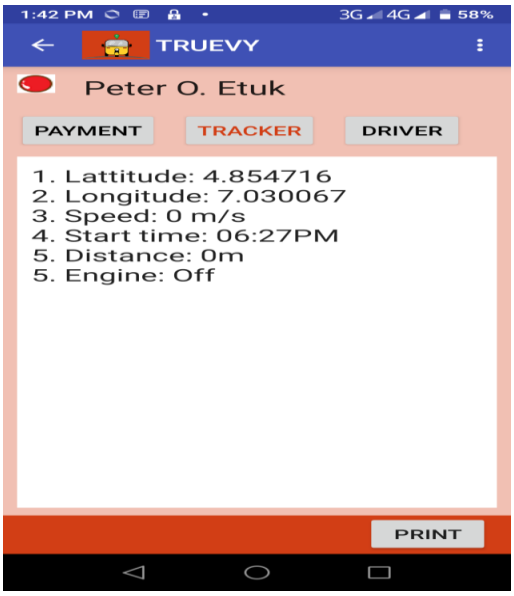

Figure 6: Screenshot page of the Tracker

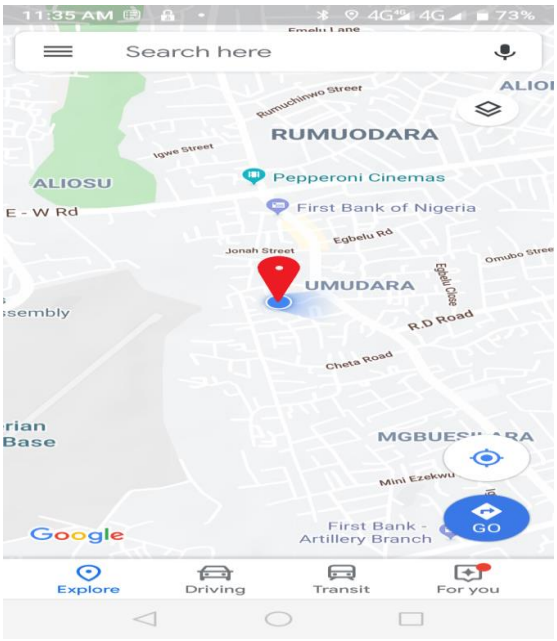

Figure 7: Screenshot page of the tracker Google map

The application retrieves the information the GPS/GSM module embedded in the tricycle generates. This information comprises of the tricycle's operator's position in terms of longitude and latitude, the speed of the tricycle, tricycle distance and tricycle condition. To get the tricycle location/position, the latitude and longitude displayed on the application as shown in Figure 6 is transferred through Google map API (application program interface) so that the present location/position of the tracked tricycle is displayed on the Google map, as shown in Figure 7. The distance covered by the tricycle prompts the application to identify if the tricycle operated or not operated for the day, with reference to the pre-determined distance a tricycle must cover each day before it is counted that it has operated for the day.

In all, the entire tracker mechanism is packaged in a box shown in Figure 8 which is installed inside the tricycle's engine to record the speed, movement and location, as also shown in Figure 6.

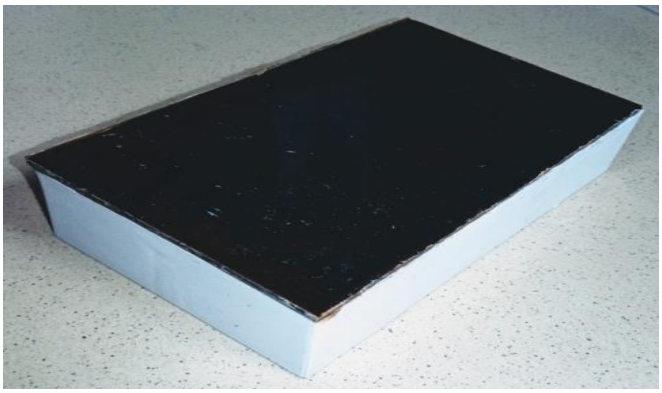

Figure 8: Tricycle tracker brain box

3. Conclusion

The huge amount of money lost by Governments due to intentional refusal to pay daily levy of operation by tricycle operators in the various State across Nigeria can be addressed by the adoption of automated revenue collection system that has real-time tracker mechanism. In this paper a microcontroller-based tricycle tracker system, a sub-system of a microcontroller and Internet of Things (IoT)-based tricycle revenue collection system is presented. The tracker mechanism is meant to address the flaws prevalent in the existing tricycle revenue collection procedure.

Specifically, the circuit diagram of the tracker system is presented along with the triangulation method used to implement the GPS/GSM tracking of the tricycle goe-coordinates in real-time. Also, the other subsystems such as the android app and GPS/GSM modules are presented. Sample outputs from the smart phone showing the information obtained from the tracked tricycle are presented.

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