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Design and Manufacturing of Smart Car Security System with IoT-Based Real-Time Tracking

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Abstract: In the past few years, many cases of car theft cases have been recorded to utilise them in suspicious operations. In this paper, a low-cost, effective, and intelligent system is introduced to protect cars against theft. The proposed configuration consists of pair of principal parts the primary part is responsible for the car security based on the infrared sensor, Bluetooth, and Arduino NANO kit. With this part a unique Android app is employed to communicate with the Bluetooth module wirelessly; in order to operate the car usually the user should send a specific command from the mentioned app and switch ON the traditional car switch, otherwise, the alarm system will be turned ON. The following part of the proposed work is the real-time car tracking system based on IoT technology. This part uses the GPS module and the built-in Wi-Fi of the NodeMCU microcontroller board. The real-time tracking part provides the location information and the car position on the google map. The proposed system is tested in practice and good functioning is observed.

Keywords: *Arduino NANO, Bluetooth, Car theft, Car Tracking, GPS, NodeMCU*

1. Introduction

The car-related robberies are one of the most common offences calling for a fast security systems response. Whereas, in recent years many of cars have been stolen whether in the parking garages or in private parking that is present in homes or other institutions [1]–[3].

The stealings operation for the cars comprises stealings for the short period (i.e., joyriding), stealing for protracted car service, and stealing for the export or "chopping", in other words, the dismantling of cars for the purposes of the spare tolls). Often, the first category of car stealing that is including the short and permanent usage of the stolen cars is easy to recover by the police. While the second category seems to be impossible because the car is converted into many pieces or recycling. Sometimes the stealing of cars includes stealings of the things that are departed in cars, stealing internal elements of the car such as radios or batteries, and stealing of external elements such as tires [4]–[6].

Due to the potential for greater loss or the utilization of the stolen cars to make dangerous or suspicious acts, it is necessary to limit such cases. Where it is noted that stealing from inside cars is the highest and largest, which represents about 85% according to the published reports [7].

The hazard of stealing is higher per hour parked when cars are in parking garages, but the majority of stealing happens once cars are in the steady state mode on the roads or on the property of their owner [8].

Most cars lack modern and sufficient protection systems to protect them against advanced means used by thieves, as it takes a few seconds to steal cars or shops and others [9], [10].

The best way to reduce thefts is to persuade car manufacturers to develop car security systems because current systems in cars suffer from some of the flaws that have been reported in security techniques designed to protect cars from theft cases; thus, it is necessary to develop a different and complete compact security system capable of embedding into the cars [11]. Besides the development of embedded systems such as the Arduino microcontroller boards with compatible shields and sensors, it becomes simple to design an advanced system for car security and tracking [12]–[14].

Some of the systems that have been reported in the literature including the vehicle tracking system, in this work the authors employ a tiny GPS board to communicate the positioning satellite and specify the location data which in turn transmitted to the car owner by the means of the

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SMS service that are supported by the GSM module [15][16].

The authors in [17] have reported the utilization of the Arduino microcontroller board to build a compact low-cost system for car security. The designed system detects the vibration that resulted from the car engine at un-normal operation and transmits a warning message via the GSM to the car's owner for alarm purposes.

Another work is done on the basis of radio frequency identification (RFID) technology. The authors in this work proposed an additional method for the car security which is by the means of the RFID tag instead of the traditional car switch. When the car owner would switch on his car, he just places the tag on the RFID reader, this will enhance the security of the car [18].

In this work, an intelligent low-cost system is designed and manufactured for the purpose of the anti-theft for cars. The proposed system employs the infrared (IR) sensor to detect the presence of the thief inside the car and the real-time tracking of the car based on IoT and GPS. In addition, the proposed system introduced additional security based on near-distance Bluetooth for the safe mode of car operation that will be done via the command from the mobile app and the traditional switch.

The parts of this paper are organized as follows: Section 2 presents the general architecture for the Internet of Things (IoT) and its applications in the real-time tracking. Section 3 exhibits the definition of the hardware components that are used to implement this work such as Arduino NANO, NodeMCU, IR sensor, GPS, and Bluetooth module. Section 4 exhibits the process of the system design, Also, presents the obtained outcomes after making the practical test. Finally, Section 5 demonstrates the conclusion of the deigned system.

2. IoT Technology

The IoT represents the communications and interaction of the connected internet network with the physical things which are usually sensors, actuators, and other machines [19]–[21]. The IoT network can be employed for domestic or industrial applications to exchange data by the means of the internet wirelessly and from any area at worldwide [22]–[24]. Today, there are more than 7 billion linked devices on the IoT, and as stated by specialists, there will be 10 billion by 2020 and 22 billion around 2025. Fig. 1 presents the building blocks for the IoT network [25], [26].

Fig. 1. Structure of IoT network.

3. Utilized Hardware and Software

This section of the paper presents the hardware components that are used to construct and develop the proposed system. The used software in this work is the Arduino Integrated Development Environment (IDE) which is responsible for the code preparation and compilation. While the hardware components are presented in Fig. 2 and listed as follows:

a) Arduino NANO: Is a small-sized microcontroller kit used to translate the data of the connected sensors and shields. This kit is made up based on the ATmega328P microcontroller chip which supports 22 digital and 8 analogue pins that are used as the input/output ports [27]–[29].
b) IR Sensor: The IR sensor is a small sensor that works on the basis of emitting infrared in order to detect the human presence or the other things in its surrounding area. The IR sensor can be used for the detection of the motion and can estimate the temperature of the objects. This sensor is made up of a transmitter and a receiver; the transmitter sends out IR radiation, and the receiver receives reflected IR radiation [30].
c) NodeMCU: The NodeMCU modern microcontroller board is based on open-source software and hardware. This board is similar to the functions that can be done by the Arduino or the other microcontroller board, the main difference is summarized by the containing a built-in esp8266 Wi-Fi that supports the IoT projects [31]–[33].
d) GPS Module: The GPS modules are utilized for the purpose of providing position information by the means of the satellite. This module contains miniature processors for the data preparation/management and microstrip antennas that are responsible for receiving the position data that is transmitted by the satellites through the radio frequencies [34]–[36].
e) The HC-05 Bluetooth module is intended for the short-range wireless communication. This module can be practiced as either a master or a slave, whereas it can be used in the variety of the consumer applications such as the wireless headsets, game controllers, wireless

computer mice, wireless keyboards, and many more [37]–[39].

(a) Arduino NANO

(b) IR sensor

(c) NodeMCU microcontroller

(d) GPS module

Fig. 2. Utilized hardware components.

(e) HC-05 Bluetooth module

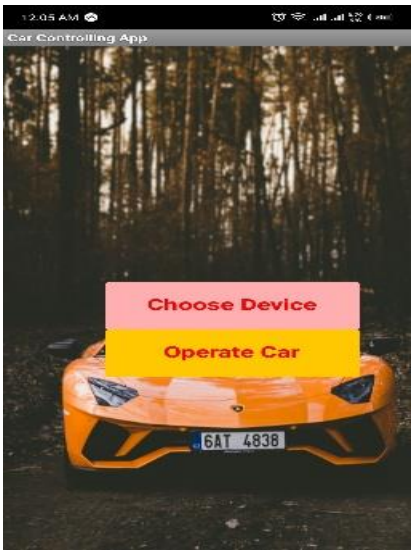
Fig. 2. Utilized hardware components.

4. System Design and Construction

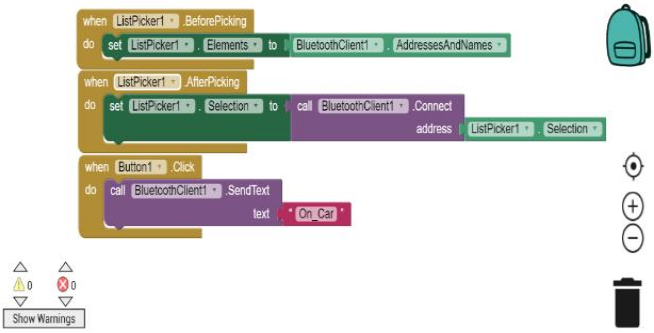
In this section the necessary steps for the design and implementation of the proposed system. The proposed system consists of two major parts. The foremost part is responsible for the car security based on the Arduino NANO, IR sensor, buzzer, and Bluetooth module. The following part is responsible for the real-time car tracking system based on the GPS and NodeMCU microcontroller board.

4.1. Car Security Subsystem

In this part of the proposed system the Arduino NANO, the IR sensor, and the Bluetooth module are used. The aim of using the IR sensor is to detect the presence of the robber inside the car. Once the robber is entering the car the IR sensor will send logic (1) to the Arduino NANO which will be switched ON the warning buzzer. For this part, we programmed a smart Android App by practising the MIT APP inverter that is based on the block programming, as shown in Fig. 3.



(a) Installed app in smartphone



(b) App code

Fig. 3. Programmed app for car controlling.

In order to operate the car normally, the user must be entering a certain code from the created Android app and switch ON the car via the traditional switch. Once the sent code is right and the switch is ON then the car will be operated. The block diagram, the flowchart, and the fabricated circuit are illustrated in Figs. 4-6, respectively.

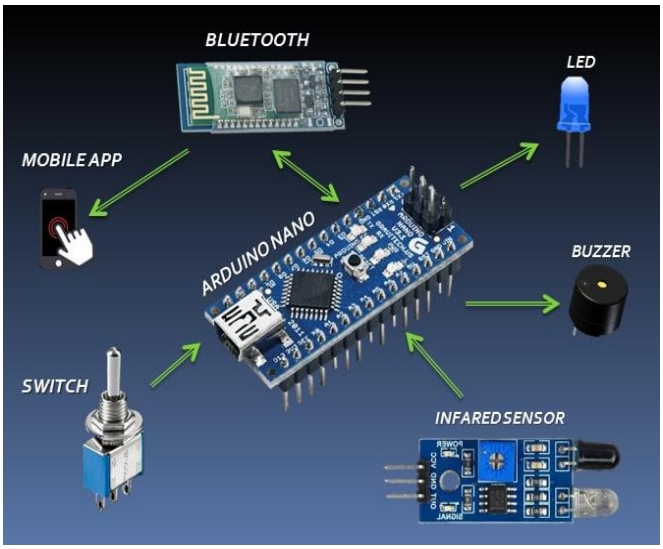


Fig. 4. Graphical block diagram for car security part.

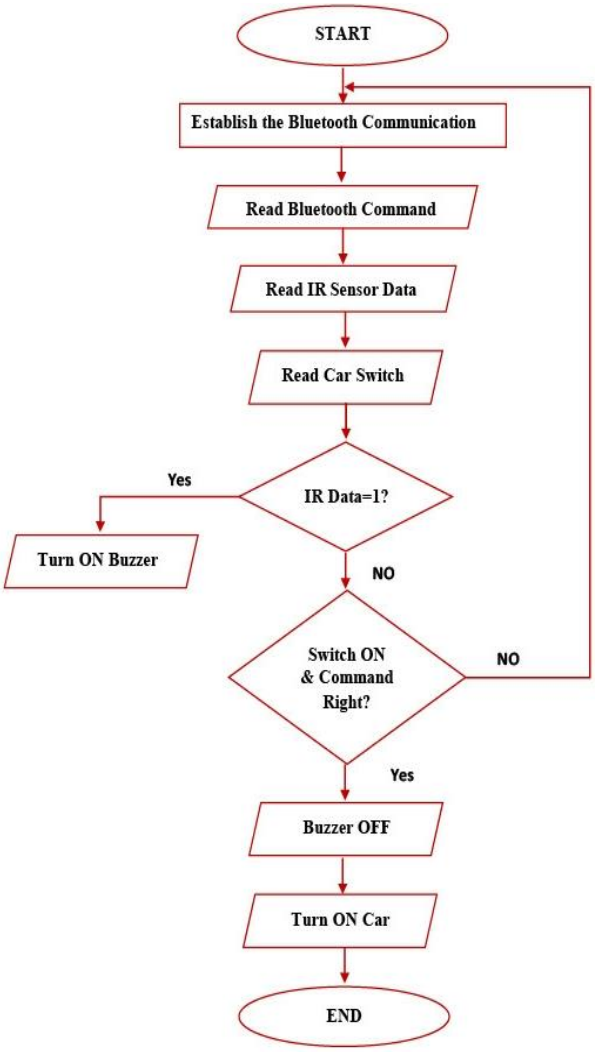


Fig. 5. Flowchart for the car security subsystem

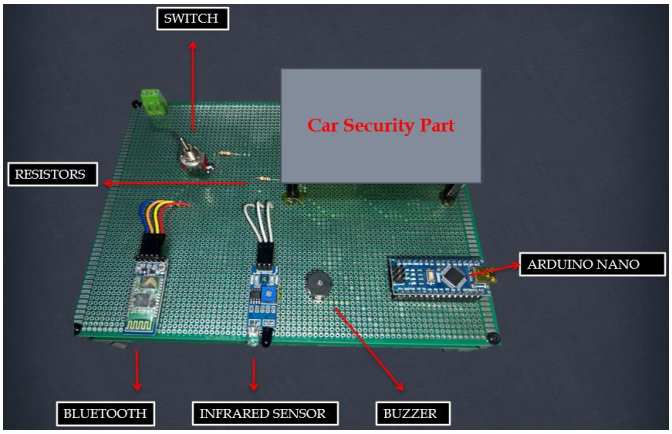


Fig. 6. Photograph for the created car security subsystem.

5. Real-Time Car tracking System

In this part of the proposed scheme, the IoT technology is employed to implement a real-time tracking system which helps the user to track his car in the case of stealing. This part uses the GPS module as a tracking method and the NodeMCU. Whereas, the position information is received by the antenna of the GPS module from the satellite and transferred to the NodeMCU which in turn sends this information to the Google Cloud APIs that help to specify the position on Google Maps. The reason for choosing this type of microcontrollers board is because it's small sized and it contains a built-in Wi-Fi chip which supports and is useful for IoT enforcement. Figs. 7-9 illustrate the block diagram, the flowchart, and the implemented circuit for this part of the proposed configuration, respectively.

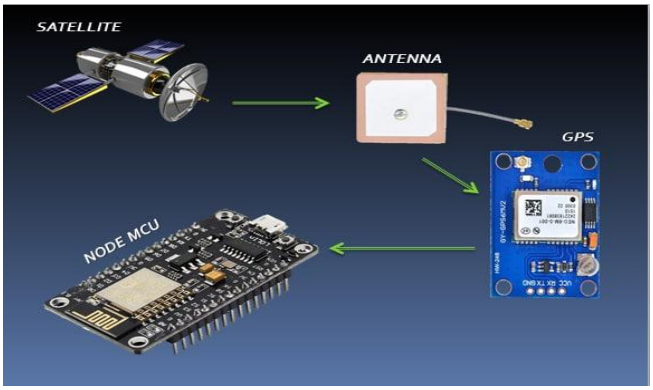


Fig. 7. Graphical block diagram for the real-time car tracking.

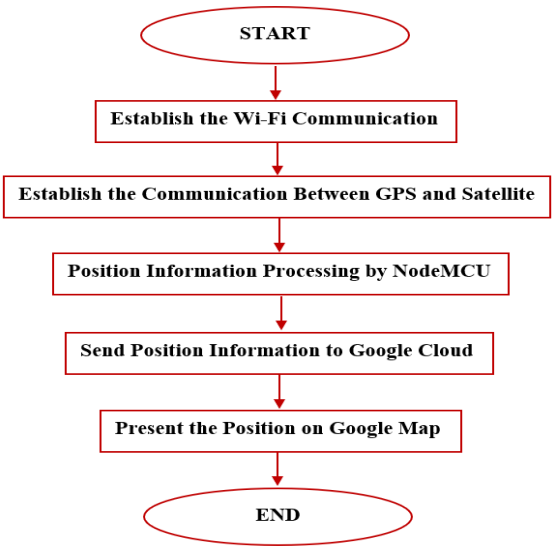


Fig. 8. Block diagram for the real-time car tracking.

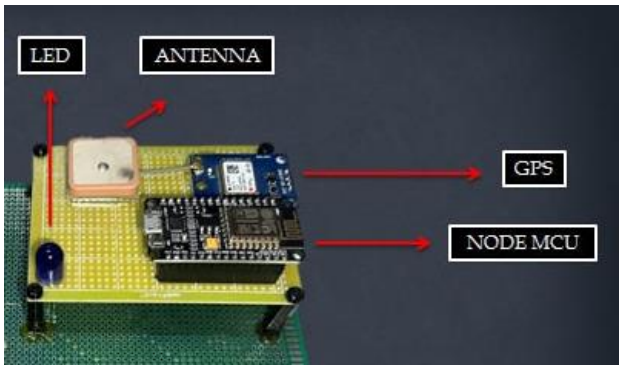


Fig. 9. Photograph for the created real-time car tracking subsystem

After completing the connection procedure, the programming step is starting by employing the Arduino open-source IDE with the necessary libraries. After that, the NodeMCU will generate a specific and unique IP address which helps us to reach the position information from the Google Cloud on the google map, as shown in Figs. 10 and 11.

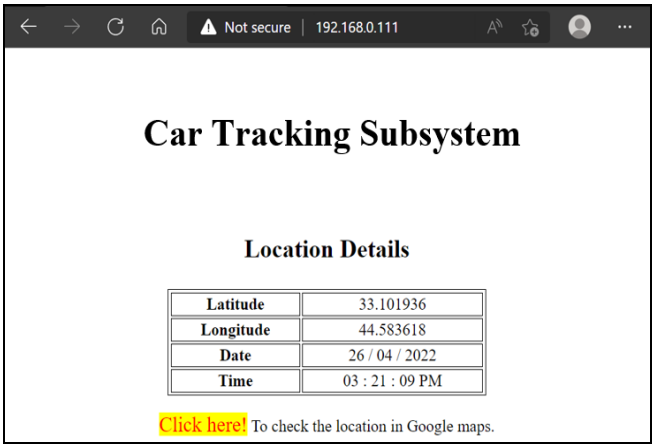


Fig. 10. Position information on the GUI.

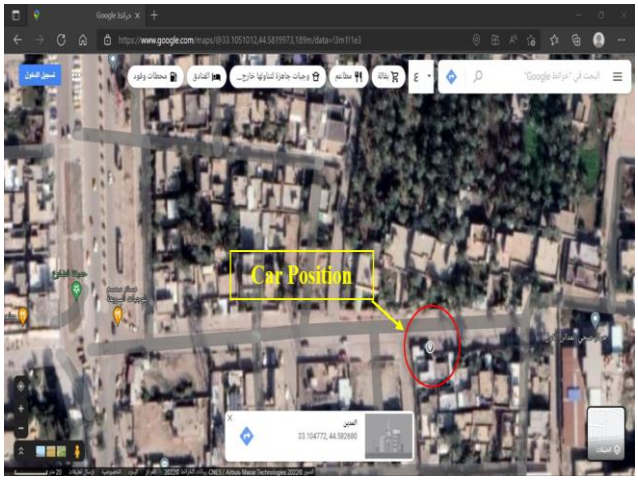


Fig. 11. Position location on google map

6. Conclusion

In this paper, a novel miniaturized and low-cost smart system has been proposed for car protection and security purposes. The implemented system has been introduced to do two major functions, one of which is complementary to the performance of the other. The first function of the system aims to protect the car from stealing, which was built utilising an Arduino NANO, IR sensor, Bluetooth, and buzzer. The second part is created for the real-time car tracking system based on GPS and NodeMCU microcontroller kit. In order to ensure the best security, a special procedure has been introduced in this work to protect the car from stealing which is summarized by connecting the Bluetooth with a special created Android app. When the user tries to operate his own car normally, he/she sends an ON command from the Android app and switches ON the traditional car switch, otherwise, the alarm system is ON. The system has been tested practically and good performance has been observed.

Author contributions

The tasks for completing this work have been assigned to the authors. The first author, **Asaad Hussain Mukalaf**, drew up the initial blueprint for the proposed system, the second author **Hamzah M. Marhoon** built the system, the third author **Iswanto Suwarno** and the fourth author **Alfian Ma'arif** assembled the system. Then the authors gathered to write the final version of the paper and submit it for publication in the journal.

Conflicts of interest

The authors declare no conflicts of interest.

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