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HARDWARE DESIGN FOR IOT BASED VEHICLE TRACKING AND THEFT DETECTION SYSTEM THROUGH SMS ALERT

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ABSTARCT

Nowadays everyone places a premium on the safety of their automobile. Hundreds of cars are stolen from a city every day. A mechanism to prevent car theft is essential. To ensure that an effective vehicle tracking system is developed and deployed, allowing for the monitoring of the whereabouts of any fitted vehicle at any time and from any location. The proposed solution made effective use of the common practice of integrating a microcontroller with a Smart phone app. Among the most prevalent methods for tracking vehicles is with the help of a device installed in the vehicle, and this one uses GPS and GSM/GPRS technology to do it. The GPS module is used by the vehicle's system to obtain GPS coordinates at predetermined intervals. The vehicle's location is sent to and updated from a server via the GSM/GPRS module. In addition, we create a smart phone app to track the car in real-time. The Smart phone app utilizes the Google Maps API to plot the location of the vehicle on the map. Therefore, customers will be able to track a moving car in real-time via their smart phones, calculating how far away from their destination it is and how long it will take the vehicle to get there. In order to complete the operation, the system utilizes both RFID technology and biometrics. The system takes a picture of the guest and checks the database for a match when the RFID reader at the hostel's entry reads a number. Suspicious individuals can be apprehended in this fashion.

Keywords: IoT, GSM/GPRS, GPS, Arduino Uno, alert message, location and vehicle tracking.

1. INTORDUCTION

Many businesses in Pakistan are finding that automatic identity and access control system is essential in order to combat the increasingly dangerous security concerns they face. The system can be set up in a number of strategic locations throughout the business to monitor the employee's every step and limit their access to restricted areas. The system's guiding layer and monitoring layer make up its middleware. The monitoring layer receives periodic updates on the guiding layer's location thanks to a handheld RFID reader [1]. As a result, the monitoring layer is fully informed about the ecosystem. The system's near-perfect accuracy in supplying zonal information has been demonstrated through experiments, paving the way for the development of highly reliable guidance and monitoring applications. Giving the renter an RFID card and attaching a tag to the bike eliminates the need for manual data entry—such as writing down the renter's information and then entering it into a computer [2]. The bike is equipped with a tracking device that allows its whereabouts to be monitored from the rental shop to the return shop. The stores are able to communicate and share data with one another via a central website. Effective RFID strategies are developed and implemented in this manner [3].

The term "embedded systems" refers to the digital information technology that is permanently installed in a given area. Communication, "mobile worlds" and "e-worlds," the "smart" home, clothing, factories, etc. are all included in this category, as well as safety-critical applications like automobiles and their controls, trains, airplanes, and medical devices. Security, privacy, and everyday work and life patterns are just few of the areas where society feels the effects of all of these [4]. More than 98 percent of the processors used today are embedded in systems and are therefore invisible to the end user. These 'enablers' include advancements in computing hardware and software, sensors, actuators, networks, and infrastructures [5]. They are ubiquitous because they are constantly there but rarely noticed by the user. Therefore, they serve as the foundation for a substantial economic drive. Machine-to-Machine (M2M) communication is just the beginning of what the Internet of Things (IoT) is expected to bring in terms of increased connection of devices, systems, and services across several protocols, domains, and applications[6].

Smart objects and other connected embedded technologies are predicted to bring in widespread automation, open the door to cutting-edge uses like the smart grid, and even expand into previously unimaginable domains like smart cities. Network operators have been able to pick equipment from any of the numerous suppliers implementing the GSM standard, which is beneficial to them as well as their customers (who benefit from the

ability to roam and transfer carriers without switching phones) [7]. Short message service (SMS, also "text messaging"), which GSM created, is now available on various mobile standards as a low-cost alternative to voice calls for the network provider. One other perk is that the standard contains the international emergency number (112). This facilitates communication with emergency services for foreign visitors who may not know the local emergency number [8]. The Groupe Special Mobile (GSM) was founded in 1982 by the European Conference of Postal and Telecommunications Administrations (CEPT) to design a standard for a mobile telephone system that could be utilized throughout Europe by 1987.

(i) Introduction to Embedded systems

The term "embedded systems" refers to the digital information technology that is permanently installed in a given area. More than 98 percent of the processors used today are embedded in systems and are therefore invisible to the end user. Embedded systems are typically manufactured in large quantities to take advantage of economies of scale [9]. An embedded system typically consists of a single microprocessor board with the software installed in read-only memory. Embedded systems are used in nearly all digitally interfaced devices, including watches, microwaves, video recorders, and automobiles. While many embedded systems do come with their own operating system, many others are so narrowly focused that their whole logic may be written in a single app [10].

2. RELATED WORKS

RFID is a cutting-edge wireless communication protocol with many potential uses in the future. More and more industries, including retail, banking, traffic management, exhibitions, and logistics, are incorporating this cutting-edge technology into their offerings. In this article, we offer a high-level overview of RFID's many uses and discuss the potential for smarter RFID implementations. RFID technology has a sizable domestic market in the field of ticket administration. The study presents a complete and effective solution for blind spots in the fields of electronic ticket design, RFID data integration, hardware architecture, software design, process control, and data encryption through the use of cutting-edge RFID technology [13].

Since every car needs a place to stay when it's not ferrying people around, parking is a crucial part of the transportation infrastructure. The convenience of collecting parking fees is an issue in both parking lots and on-street parking [14]. One potential answer to this issue is to adopt RFID technology. The present widespread adoption of RFID technology paves the way for novel uses. We investigate the needs for such a ubiquitous system and build the Guardian Angel middleware to support a monitoring and guidance system at an assisted living facility. In this study, we present a proof-of-concept for such a system, which employs real RFID devices for feasibility testing and RFID device emulations for scalability [15].

This study proposes a system for monitoring and controlling entry to the Parliamentary Campus using RFID and Zigbee technology. Zigbee wireless module can be trusted to provide low cost and reliable security. The RFID tag, RFID reader, Arduino Uno, and Zigbee all make up this system. In addition to residential and business HVAC closures, this technology can be used for security purposes. In this paper, we provide the outcomes of our experiments using Zigbee and RFID point-to-point and point-to-multipoint connections [16]. The use of RFID technology in door locks has become commonplace. Therefore, this paper presents a neural network-based facial recognition-based RFID access control system. If the individual carrying the RFID card does not match the face in the system's database, access will be denied. To identify legitimate cardholders, we use a Radial Basis Function Neural Network (RBFNN) and only save the network's parameters [17].

When the number of cardholders grows, this strategy may help save space. Face image data is down sampled using principal component analysis (PCA) and linear discriminant analysis (LDA) features [18]. To improve the RBFNN's ability to generalize, the Localized Generalization Error Model (L-GEM) is used during training. Several components have already been installed in a car in order to increase its safety and security. Bluetooth and RFID sensors are utilized in various systems to determine how far away an oncoming car is [19]. However, this technology can only function inside a limited area. Some methods involve the car's owner alerting a centralized controller system that their vehicle has been stolen. The security system in the car receives instructions from the central controller, which can either halt the vehicle's motion or lock the engine. One big drawback of this system is how dependent it is on the master controller. If the stolen car is not receiving the signals from the central controller, the entire system is useless. The current system has a number of issues, including those listed below [20]. When an unauthorised individual tries to open the vehicle, a loud siren will sound. All automobiles make a similar noise in the event of a theft attempt, making it difficult to tell which one is being stolen. The precise location of a car involved in a collision is notoriously difficult to ascertain. There

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hasn't been a reliable automated method for detecting vehicle theft or damage from accidents in any of the existing systems until now [21].

3. PROPOSED METHODOLOGY

In this work, a simple digital circuit is constructed using an Arduino Uno training board, a GPS receiver, and a GSM SIM 900A module, with the help of the hardware description language, C. The Arduino is a programmable microcontroller board into which the sketch must first be uploaded. Then, the Arduino Uno receives data from the satellites that the GPS receiver has tracked. After then, Arduino will transmit its data via the GSM module to the user-specified SIM card number. Short messages sent to a particular Android mobile phone can provide the precise location where a car or other moving object has arrived. Arduino is a hardware and software prototyping platform for electronics that is freely available to the public.

The GPS module and the GSM receiver are controlled and interfaced by an Arduino microcontroller. As the most popular of the three digital wireless communication technologies (TDMA, GSM, and CDMA), we examine the concept of the GSM modules utilised in this work, which is based on a variant of time division multiple access (TDM). In the context of GSM phones and the GSM network, GSM technology has become the standard. Information about a customer's account with a GSM carrier is stored on a SIM card.

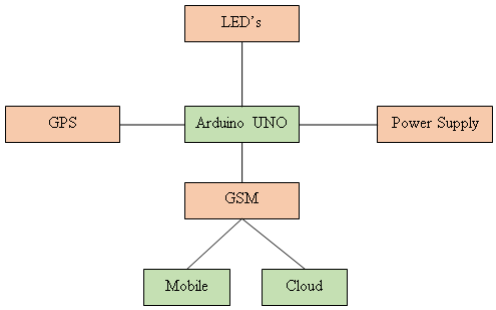

Fig. 1 Overall Structure of the proposed system

The overall structure of proposed IoT based vehicle tracking and theft detection system is shown in Figure 1. When a user makes a request for a specific vehicle's location, the system responds by retrieving that vehicle's data from the database and displaying it on Google Maps in real time via a smart phone application. This helps prevent theft because if the vehicle's owner is alerted that his vehicle is being misused, he can turn off the engine, find the vehicle via the app, and then either recover it or report the incident to the police. That is, the owner can use this facility to retrieve his car. The proposed system aids in location monitoring, meaning that whenever a user requests the location of a vehicle, the location can be retrieved from the database and monitored on Google Maps in real time using a Smart phone application. Additionally, whenever the owner receives a notification that his vehicle is being misused, he can stop the vehicle by switching off its engine and can locate the vehicle by using the smart phone application, thereby preventing theft. That is, the owner can use this facility to retrieve his car.

Arduino UNO: ATmega328 is the central processing unit (CPU) found on the Arduino UNO R3, which is a microcontroller board. It is equipped with 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analogue inputs, a crystal oscillator running at 16 MHz, a USB connection, a power jack, an ICSP header, and a reset button. Additionally, it features a crystal oscillator running at 16 MHz. Arduino can be powered up and put into operation by being linked to a computer via a USB cable, by using an AC-to-DC adapter, or by using a battery. The Arduino UNO microcontroller is shown in Figure 2.

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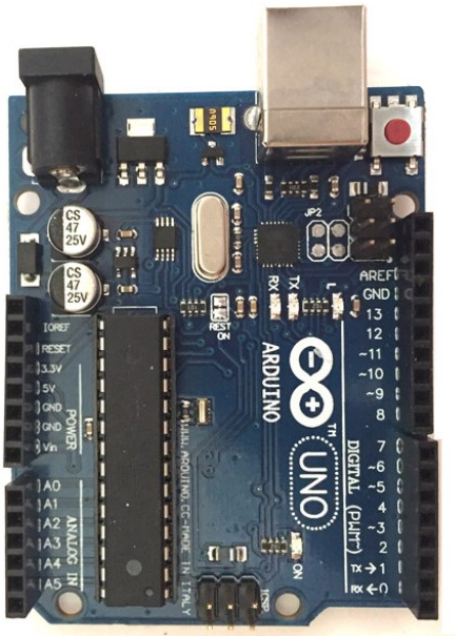

Fig. 2 Arduino UNO Microcontroller

Wi-Fi Module - ESP 8266: The ESP8266 Wi-Fi Module is a self-contained SOC that can provide access to your Wi-Fi network for any microcontroller that you choose to use. Because each ESP8266 module already has the AT command set software preinstalled, all that has to be done to enable Wi-Fi connectivity is to connect the module to an Arduino-based device. The ESP8266 module is a very budget-friendly board that is supported by a sizable community that is continually expanding.

DC Motor: The most common kind of motor is known as a DC motor, which stands for direct current motor. DC motors typically only have two leads, with one being positive and the other being negative. The motor will turn if these two leads are connected in series with a battery. Changing the orientation of the leads will cause the motor to turn in the opposite way.

Switch: This is how the full theft detection system is activated and ready to go into action. As long as the switch is in the ON position, an SMS alert along with the current location of the car will be sent to the owner as soon as the vehicle starts moving. In the event that the switch is turned off, no alarm will be transmitted, and the position details will also not be shared. By employing a switch in this manner, we are able to exercise control over the activation and deactivation of the system.

GPS (Global Positioning System): The Global Positioning System (GPS) is a navigational system that makes use of satellites. Because it is compatible with a wide range of GPS receivers, we make use of the NEO-6M GPS module. It comes with a ceramic antenna that is already installed. Compatible with a button battery rated at 3 V. As shown in Figure 3, the Global Positioning System (GPS) is designed to function reliably in any climate and location on any continent. In order to determine a two-dimensional position (latitude and longitude), a GPS receiver needs to be locked on to the signals of at least three satellites.

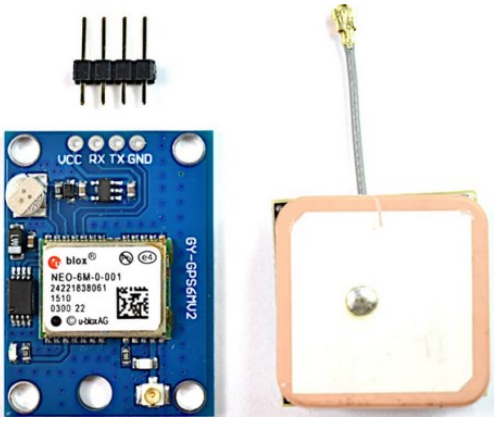

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Fig. 3 GPS Module

GSM (Global System for Mobile Communications): A GSM modem is a specialized variety of modem that functions just like a mobile phone and has a slot for a SIM card. At this time, we are working with a SIM 900A GSM module. The SIM900A Modem was constructed using Dual Band GSM. It operates on the frequencies 900 MHz and 1800 MHz. The SIM900A is an efficient and space-saving wireless module. When this happens, a notification message with the vehicle's latitude and longitude is sent to the owner via the GSM module as soon as the motor starts up. The sample GSM module is shown in Figure 4.

Fig. 4 GSM Module

The technology known as GPRS is frequently utilized for wireless data transmission. Using the GSM network and a GSM modem, the SMS technology can supply a user with information about the location of a car. Because it does not require a significant financial investment, more and more people are using internet technology. It is a method of transmitting and receiving data that is both convenient and easily available, and it has a high level of reliability. Instead of using short message service (SMS), the suggested system for tracking vehicles makes use of an application for smart phones in order to track and monitor the location of a vehicle. This location is derived using an in-car tracking device that is controlled by a micro controller.

The location of the vehicle is automatically placed on Google maps, making it easier to track a vehicle and providing users with more accurate information regarding the vehicle's location. The primary function of a vehicle tracking system is to follow and record the movement of a particular target vehicle or other object. The tracking device has the ability to communicate information to the user regarding the present location of the vehicle. The vast majority of these tracking systems are comprised of an electronic device that is often mounted within the vehicle. These systems are versatile and may be used to track automobiles, buses, and trains. The following capabilities are included in the vehicle tracking system that the project has proposed: Acquisition of geographic coordinates of a vehicle and acquisition of a vehicle's unique identification number from an in-car device in real time utilizing the GPS module. Utilizing the GSM/GPRS module to send a vehicle's identification number and location information to a web server at the conclusion of a predetermined interval of time. This database is intended to record and manage information regarding the location of vehicles that have been received.

The primary purpose of a GSM system that is equipped with a GSM module is to assess whether or not an unauthorized person has entered controlled territory and to alert the owner of the property by calling or texting the owner's phone. The protected area is outfitted with all of the essential sensors, and the control panel is fitted with a GSM module. This is the basic operating principle of a GSM alarm system.

4. IMPLEMENTATION AND RESULTS

In this subsection, we will describe the hardware and software requirements as well as implementation of hardware design for IoT based vehicle tracking and theft detection system through SMS alert system.

4.1 Hardware Requirements

The ATmega328 (datasheet) serves as the foundation for the Arduino Uno microcontroller board. There are 14 digital I/O pins (of which 6 can be used as PWM outputs), 6 Analogue I/O pins, a USB port, a power jack, an

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ICSP header, a reset button, and a 16 MHz crystal oscillator. The Arduino Uno is the latest in a line of USB development boards and serves as the platform's "gold standard." SIM800 The SIM800 is a quad-band GSM/GPRS module that operates on the frequencies GSM 850MHz, EGSM 900MHz, DCS 1800MHz, and PCS 1900MHz, making it suitable for use in a variety of countries around the world. Data transfer applications can benefit greatly from SIM800's incorporation of TCP/IP protocol and expanded TCP/IP AT commands.

The SIM900 utilized in this project is a Tri-band GSM/GPRS engine operating on the EGSM 900 MHz, DCS 1800 MHz, and PCS 1900 MHz frequency bands. GPRS CS-1, CS-2, CS-3, and CS-4 are all supported by SIM900, along with GPRS multi-slot class 10/class 8 (optional) functionality. Using the high-performance u-blox 6 positioning engine, the NEO-6 module series is a group of independent GPS receivers. As a result of their cutting-edge design and technology, NEO-6 GPS receivers are able to provide pinpoint positioning in even the most treacherous of terrains by effectively cancelling out the interference from nearby structures and reducing the impact of multipath. A global positioning system (GPS) navigation device is a tool that determines precise geographic location using data relayed by GPS satellites. The U.S. military was an early adopter, but nowadays you're more likely to find a receiver in your car or smart phone.

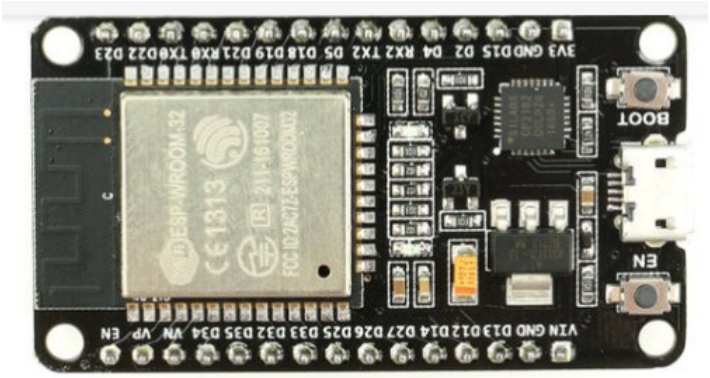

Fig. 5 ESP32 microcontroller

EPS32 Microcontroller: The ESP32 is a low-power Microcontroller with built-in wireless networking and a low price tag. It's an improved version of the ESP8266, another cheap Wi-Fi microprocessor that had very little use. It consists of a power amplifier, low-noise amplifiers, filters, and a power management module, in addition to an antenna and RF balun. The total system requires a tiny footprint on the PCB. This board is compatible with TSMC's 40nm low power technology, power and RF properties, and 2.4 GHz dual-mode Wi-Fi and Bluetooth chips, making it suitable for a wide range of uses while remaining secure and reliable. The sample EXP32 microcontroller is shown in Figure 5. There are total three ways by which you can power your ESP32 board namely Micro USB Jack, 5V Pin and 3.3VPin.

Micro USB Jack: Connect the mini USB jack to a phone charger or computer through a cable and it will draw power required for the board to function

5V Pin: The 5V pin can be supplied with a Regulated 5V, this voltage will again be regulated to 3.3V through the on-board voltage regulator. Remember ESP32 operated with 3.3V only.

3.3V Pin: If you have a regulated 3.3V supply, then you can directly provide this to the 3.3V pin of the ESP32.

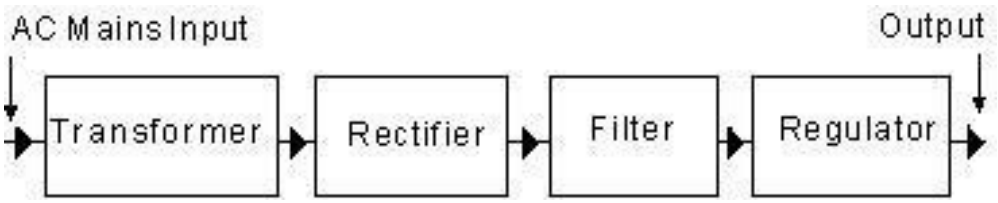

Fig. 6 Block diagram of Regulated power supply

As can be seen in the Figure 6, the main components of a regulated power supply are a regular power supply and a voltage regulating device. The final output is provided by a voltage regulating device that receives its input from a standard power source. No matter what the ac input voltage or the output (or load) current is, the

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output voltage will always be the same.

Transformer: A transformer is a tool for transferring electrical energy from one location to another. The electromagnetic induction and mutual induction principles are at the heart of a transformer's operation. Alternating current is being sent. The voltage they supply can be adjusted up or down without affecting the AC frequency in other circuits. Simply put, a transformer is a static device that facilitates the transfer of electric power from one circuit to another circuit while maintaining the original circuit's frequency. A circuit's current ratings will change in tandem with the voltage, thus you can't change the voltage without also changing the current. The working principles of transformer and sample transformer are shown in Figure 7 and Figure 8.

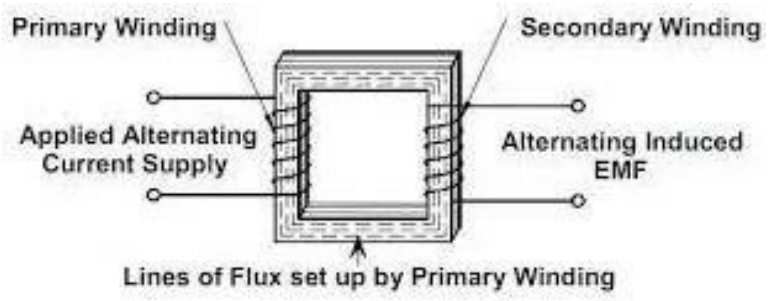

Fig. 7 Working principle of Transformer

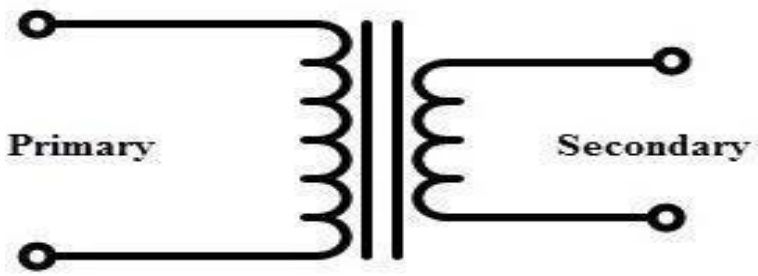

Fig. 8 Step Down Transformer

Voltage Regulator: Voltage regulators are devices that help keep electrical equipment safe from the damage that could otherwise be caused by variable voltages or power supplies. Sensitive electronic devices, like those found in vehicles, computers, and battery charging systems, to name a few, are susceptible to damage when they are subjected to disturbances like power sags and surges. Linear voltage regulators and switching voltage regulators are the two primary varieties of voltage regulators. Linear voltage regulators are utilized in a narrower range of applications than switching voltage regulators. The most straightforward form of voltage regulator is the linear voltage regulator. It is offered in two different variants, both of which are small and appropriate for usage in low power and low voltage systems.

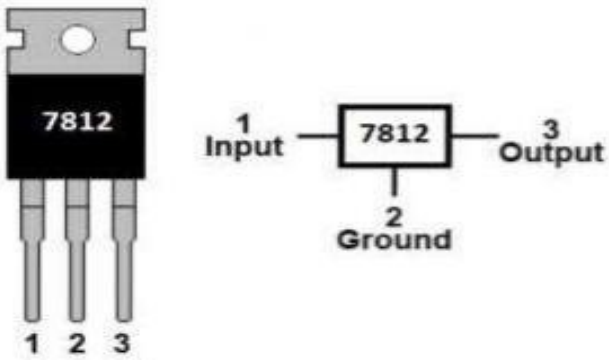

Fig. 9 12V Voltage Regulator

EM18 Reader: The EM18 is a radio frequency identification (RFID) reader that can scan RFID tags operating at a frequency of 125 kHz. After reading the tags, it sends the unique ID in serial form to the PC or the

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microcontroller using UART connection or Wiegand format on the corresponding pins. The EM18 RFID reader is capable of retrieving information from RFID tags, each of which has a stored ID that is comprised of 12 bytes. The sample EM18 reader is shown in Figure 10.

Fig. 10 EM18 Reader

RFID Cards: The RFID reader is a device that is connected to a network and can either be moved around or permanently installed. Radio waves are utilized for the purpose of transmitting signals that activate the tag. Following the completion of the activation process, the tag will then send a wave back to the antenna, where it will be converted into data. As shown in Figure 11, the RFID tag itself contains the transponder in its own circuitry.

Fig. 11 RFID Cards

Motor: The term "motor system" refers to the network of nerve cells in the brain and spinal cord that facilitates movement. Muscles of the skeleton and the nerves that control them are examples of potential peripheral structures. Motor control refers to manual or automatic methods for starting, stopping, controlling speed, reversing, and protecting a motor. These controls are achieved using a variety of circuits, connections and sensors.

A direct current (DC) motor is a type of electric machine that can change the form of electrical energy into mechanical energy. The NR-DC-ECO is a cost-effective and high-quality DC geared motor. Because it has steel pinions and brass gears, it has superior resistance to wear and tear and is designed to last for a longer period of time. A sintered bushing acts as a bearing for the output shaft's rotation. The sample motor device is shown in Figure 12.

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Fig. 12 Motor

LCD Display: As show in Figure 13, a flat panel display known as an LCD (Liquid Crystal Display) is a type of display that runs primarily on the use of liquid crystals. LEDs are used in a wide variety of consumer and commercial products, such as cell phones, televisions, computer monitors, and instrument panels. The panel is meant to project the on-screen information of a microcomputer onto a larger screen with the assistance of a normal overhead projector. This allows large audiences to access the information without having to gather around the TV display.

4.2 Software Requirements

The Arduino Software (IDE) 1.6.9 is available for free and makes it simple to create programmes and upload them to the device. It is compatible with Microsoft Windows, Apple Mac OS X, and Linux. The environment is built in Java, with Processing and other free tools serving as its foundation. RS232, RS485, and other serial communication protocols can be developed with the help of Docklight's RS232 Terminal--RS232 Monitor. Docklight lets you test a single device's serial communication or observe how two devices talk to one another. Important features include serial protocol emulation, RS-232 data logging, sequence detection, and response. Docklight lets you test a single device's serial communication or observe how two devices talk to one another. Docklight is a protocol analyzer, simulator, and tester for serial communication standards like RS232, RS485, and RS422. It can be used to test a single device's serial communication or to monitor communications between two. Docklight's compatibility with Windows 10, 8, 7, Vista, and XP means it can be used on the vast majority of modern computers.

There is an official IDE for the Android platform, and it's called Android Studio. Android Studio is a specialized software development environment built on top of JetBrains' IntelliJ IDEA. It is Google's new go-to IDE for building native Android apps, and it's cross-platform support means you can use it on Windows, macOS, or Linux. For monitoring purposes, our solution makes use of a pre-existing Google Maps sdk file. Google Maps is the company's own online mapping service. Route planning for walking, driving, bicycling (in beta), and taking public transportation are all available, as are satellite imagery, street maps, and 360-degree panoramic views of streets (Street View).

Arduino is an open-source prototyping platform with user-friendly hardware and software. A programmable circuit board (a microcontroller) and a piece of ready-made software, the Arduino IDE (Integrated Development Environment), are all that's needed to get started.

Using mobile communication, this system receives GPS data and transmits it to a predetermined mobile device or laptop computer. One of the most significant technological developments is the Vehicle Tracking System, which monitors the whereabouts of vehicles. The monitored or tracked vehicle's location is determined by the Global Positioning System (GPS), and its coordinates and location data are transmitted by satellite to the control centre. Dock light is utilised to pinpoint the location of the vehicle from the control room's perspective. This allows car owners to keep tabs on their rides in real time. Owners of high-end automobiles are rapidly adopting car tracking systems due to the convenience of real-time monitoring.

4.3 Working Principles:

As show in Figure 14a and Figure 14b, the Internet of Things-based vehicle monitoring and theft control system serves as a prototype for a vehicle tracking device by utilizing GPS receivers and a GSM modem as its components.

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Fig. 16 Message Sending and Tracking Location to User

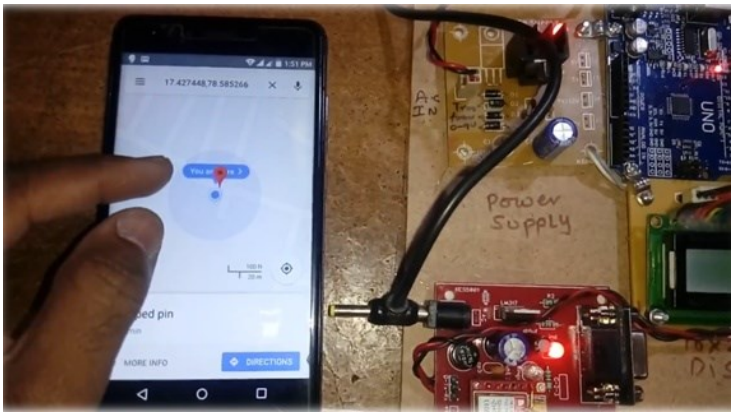

Fig. 17 Location Tracking

As can be seen in the Figure 15 to Figure 17, the GPS module gets geographical coordinates from satellites, beginning with the satellite at the top of the picture. Using GPS and GSM technologies to remotely locate and immobilize a stolen vehicle.

CONCLUSION

Using GPS receivers and a GSM modem, the IoT-based car tracking and theft control system serves as a prototype for a vehicle tracking device. Radio-frequency identification (RFID) combined with biometrics technology is used by the system to verify the identities of users. Through the use of sub-controllers, the system is able to complete the duty of security and access control. The entrance gate has an entrance monitoring controller, the exit gate has an exit monitoring controller, and the mess gate has a mess monitoring controller. These controllers can read the number from the user's RFID tag and look it up in permanent memory. The controllers will ask the computer terminal to take a picture of the user after a successful match. The controllers receive a "access granted" or "access denied" message based on the results of a facial recognition module trained using a neural network. In response to a request for access or an emergency signal, the controllers activate the appropriate action.

Investing in a Vehicle Tracking System has increased our efficiency and the efficiency of our fleet, which has increased our profitability. Managing more work in a given period of time is possible with careful scheduling and route planning. Tracking a vehicle can promote safety, security, communication, and the ability to keep tabs on performance and productivity, whether it's being used for personal or corporate reasons. An anti-theft system for cars helps keep unauthorised drivers off the road, whether they're friends or family members. As a result, it will become increasingly important to our way of life in the future year. We have finished the project per the specifications. In the end, the project accomplished its primary goals of vehicle tracking and theft prevention. Using a web server, we have created a centralised system. The web server collects data from dorm room PCs to identify a specific guest. There is potential for improvement in the reaction time of the system, but overall it is helpful in lowering security concerns to the hostels. Using specialised processors, as opposed to computer systems capable of processing the images in real time, can enhance the reaction time.

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