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Design of an Electronic Toll Collection-Based Intelligent Transportation System

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Abstract*: The project's central topic is avoiding human presence, which also functions as an automatic action that accepts payment and allows the car to move or stop. These days, this project is crucial, and we are developing the application by combining RFID technology with GSM. RFID plays a part in identifying the vehicle. The RFID will activate, the reader will read the tag, the microcontroller will check the database, and the balance inquiry will be processed if the vehicle is entered. If there is sufficient money on the card, the gate will open; if not, it will automatically close after two minutes when the automobile passes. If there is no balance on the card, the gate will not open it. This also serves as a GPS to find the car. We are aware that GSM is utilised to determine the precise location of the car. Longitude and latitude (GPS) information are returned by the controller when it receives it. The vehicle system portion uses a high-end 32-bit ARM7 CPU, and the transmission system section uses a PIC microcontroller because of how quickly its instructions are executed.*

Keywords*: GSM, GPS, 32 Bit Microprocessor, ARM7 Processor, RFID Technology*

I. Introduction

Vehicles can pay their highway tolls online thanks to the Electronic Toll Collection (ETC) technology. E-Z Pass is the first toll collection system in the country. However, live attendants who manually collect fees at toll stations have been supplanted by technological automation. The idea of electronic toll collection is becoming more and more well-liked globally. In order to pay intrastate and interstate tolls, they also have some tags that can communicate with various types of roadside readers. Because they can streamline the tolling system, creating these tags and readers' interest in them attracts toll agencies. ETC systems have changed from Single Lane Free Flow (SLFF) to Multi Lane Free Flow (MLFF), and an integrated MLFF road pricing system for the entire area is currently being developed. The area-wide integrated road charging solution will be the next step in the evolution. RFID, a vehicle location system that uses the global positioning system (GPS), and mobile communication techniques are used in the existing ETC installations.

II. Objective of the Concept

Easy toll collection, traffic reduction, and service provision are the primary goals of this idea. An RFID card with a digital code is given to the user, and the same information is kept in a centralised database system that is available in the appropriate office as needed. Any setting can use the ETC. To cut down on manpower at the toll gates, where someone counts the number of cars entering, we can instead implement an automated system. A radio frequency identification system is used to identify the vehicle. The controller will then check the card balance if they are able to identify the vehicle. This implies that the gate opens automatically if there is balance on the card, allowing vehicles to move. If not, the gate is closed and cars are not permitted. GPS and GSM are used in this project to track the vehicle. With the cooperation mentioned above, this actual criterion can be supplied. This is due to the fact that the message is sent via the GSM (Global Standard for Mobile Communication), which takes the GPS's longitude and latitude information. It can therefore use GPS data to determine the location of the car.

RFID A few years ago, RFID—an evolving automatic identifying technology—was regarded as a specialist technology. RFID became widely used as a result of declining hardware costs and data management standardized codes. the potential for it to serve as the competitive core of business systems by powering them. Some tags are readable from far away, out of the reader's direct line of sight. The majority of RFID tags include two components. An integrated circuit for information processing and storage, RF signal modulation and demodulation, and possibly other specialized tasks. The second is an antenna for sending and receiving the signal. Since the circuit is an advanced

automatic identifying technology, tags can be printed directly onto assets without incurring the expense of a conventional tag.

ETC Transmitting Module: Low-cost tags affixed to individual items would be used in a standard RFID-based ETC system. A unique electronic product code is given to a transponder that has a digital memory chip in the tag. In order to activate an RFID tag that could read and write data, an interrogator with its own transceiver and decoder would be bundled with an antenna. The RFID tag detects the activation signal from the reader as it passes across the magnetic zone. The reader transfers the data to the host computer, which decodes the information stored in the silicon chip that makes up the tag's integrated circuit. Vehicle Module: In this case, a GSM modem is used to transmit the vehicle's position (latitude and longitude) from above to a remote location. The GPS modem will continuously provide the data, which includes the latitude and longitude of the vehicle's position. Although the GPS modem has a lot of output characteristics, we merely read and show the NMEA data that comes from it on our LCD. The cell phone at the other end receives the same data from the location where the car is claimed.

Initial working of ETC In ETC, the gates at the tollgate will open after the tollgate has been closed for the initial payment. When the moment arrives for the car to be identified, the RFID will retrieve its unique identification number and transmit it to the microcontroller. The microcontroller continuously monitors the RFID reader. The controllers will verify the details of any data they receive before adding it to the database. However, if the car is in good enough condition. The gate opens when the controller determines the amount in accordance with the norms, and the microcontroller closes the gate after two minutes. It will be completed automatically. GSM and GPS technology, such as in the ETC system for tracking the location and sending and receiving data. When we want to know the location of the vehicle, this is quite helpful.

Satellite navigation system for the world A global navigation satellite system (GNSS) is a satellite navigation system that provides temporal and geographic location data in a navigable area, either on its own or in combination with other positioning systems. It is the world's only GNSS that is completely operational. GPS receivers use a constellation of 24–32 medium-earth orbit satellites that send precise microwave signals to identify their current location, time, and velocity. NAVSTAR GPS is the system's official name. GPS is used by civilians to navigate. By sensing the exact moment that the signals from GPS satellites orbit high above Earth, the GPS receiver somehow determines its position. Typical and typical GPS satellite orbits. The receiver measures the transit time of each message before calculating the distance to each satellite. To determine the receiver's location, these distances are merged with satellite locations using geometric trilateration. The position may be shown, for example, on a moving map display, or the elevation may be shown alongside the latitude and longitude. Many GPS units provide derived information, such as speed and direction (from position change).

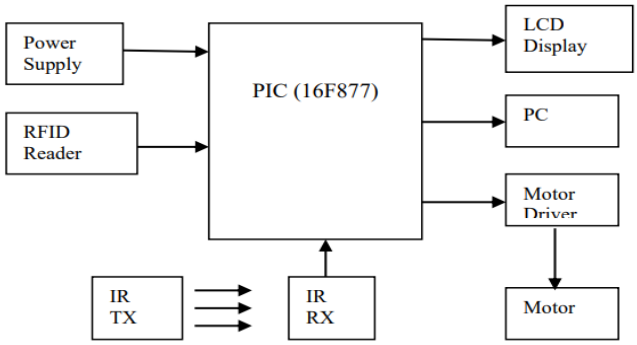
Introduction to tracking system: A GPS tracking unit is a gadget that records the position of an object at regular intervals and uses the Global Positioning System to pinpoint the exact location of a person, power lines, or other object to which it is attached. A cellular (GPRS), radio, or satellite modem included within the tracking device can either transfer the recorded location data to a central location database or an internet-connected computer, or it can be stored within the device itself. This enables the location of the asset to be shown against a map backdrop in real-time or when using specialized software to analyze the track afterward.

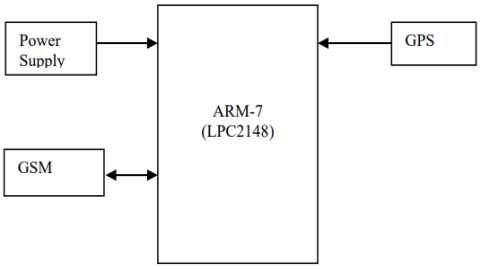
RFID Radio frequency identification (RFID) is a form of automatic identification that stores and retrieves data using both active and passive transponders and an inductive coupling to an external reader device. A certain amount of cooperation is required because RFID tags and readers need to communicate with each other. An RFID tag is any kind of device that may be inserted or affixed to a person, animal, or item in order to identify and track it via radio waves. Meters can be read from a meter's distance and sometimes even outside the reader's line of sight by using specific tags. The majority of RFID tags are usually made up of two parts. An integrated circuit with a modulation system, information processing, and storage is the first gadget, in addition to other specialist duties like demodulating radio frequency (RF) signals. Antennas are among the second instruments for transmitting and receiving signals.

III. Design of the System

The modular approach served as the foundation for the system's development. An identification module that uses RFID hardware to read tags when cars go through the tollgate is part of the installation's basic unit. A software module receives the data from this module via an RS232 serial connection. In order to give the vehicle a physical identity and determine whether or not to open the boom gate, the software module uses data from the identification module and the car's EPC code. The boom gate system is the mechanical element.

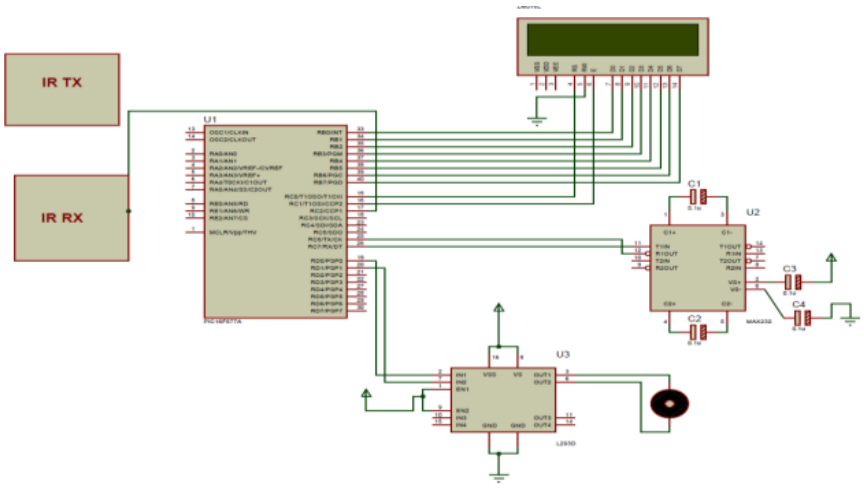
Toll Section:





III. Hardware Design

Then, a mechanical part was created with a stable, affordable, lightweight, and reliable design. Aluminium is utilized for the actual boom, whereas wood is used for the prototype. Following the successful construction of the gate system, the entire system was integrated for testing. The RFID, PIC control, power supply, server (computer and database), and gate system were all combined.



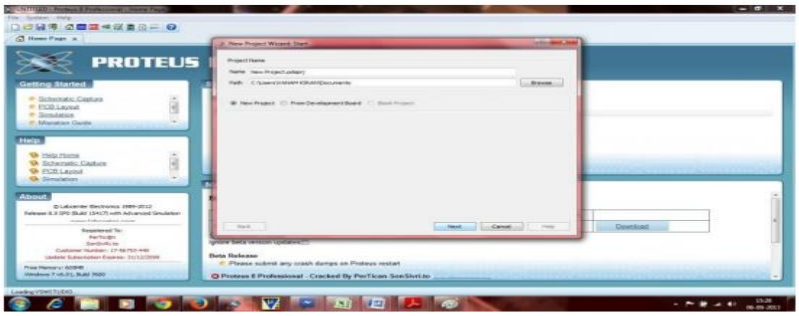
Hardware Design for Toll Plaza collection

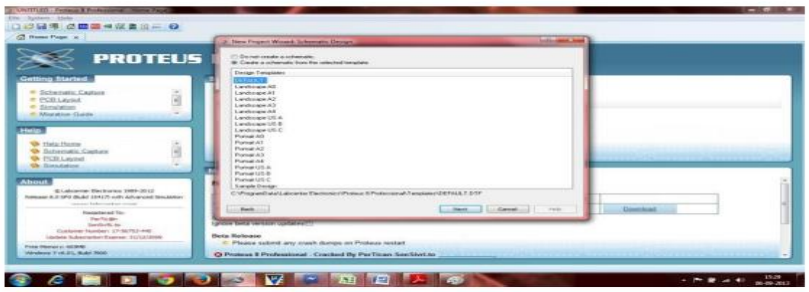
IV. ETC Circuit Diagram

Software Module For the microcontroller task, we utilised the C programming language, and for the serial communication task between the computer and the RFID, we utilised Visual Basic together with the PIC. The development of Microsoft Access was prompted by its ability to store up to 32768 records of objects.The demonstration's limit is 2GB of memory space. To demonstrate that information may be shared between 5.2 APPLYING PROTEUS program: The first window will open on your screen when you double-click the Proteus Simulation program icon. To create a new project, we simply click on "New Project" in the "Start WINDOW."

Electronic System Design (a)

Clicking "New Project" will bring up the window you see above. We must choose the project name and the directory (where we wish to save the project file). Click next after selecting the "new project" radio choice.

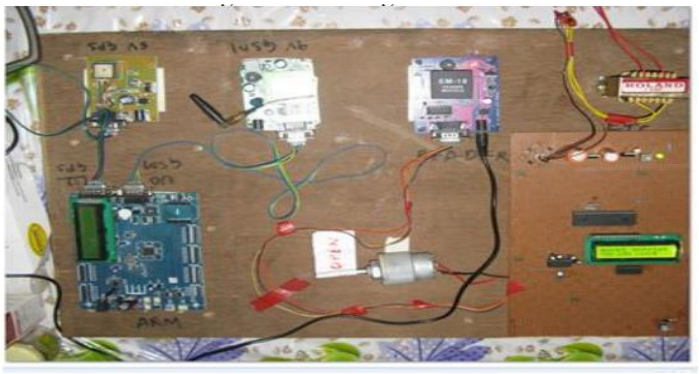


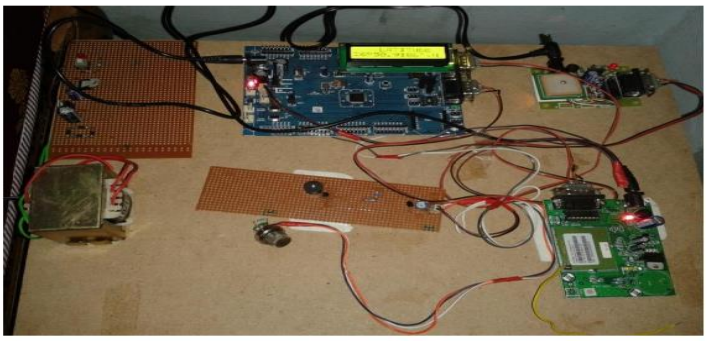


Electronic System Design (b)

IV. Results

An electronic toll gate system's hardware comprises an MCU control module, a stepper motor, a signal processing module, a GPS module, and a GSM communication module, as depicted in Figure





IV. Conclusion

Described the active RFID system platform's comprehensive design and execution, which included the tags and reader. The active RFID system's features include a dependable energy budget and a high rate of multiple tag identification. The tag and reader work well for developing and testing prototype applications because of the versatility of hardware and software design. As a result, a wide range of items can be managed by the platform.

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