GPS BASED TOLL COLLECTION SYSTEM WITH DISTANCE TRACKING AND LICENSE PLATE RECOGNITION

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Abstract - **A GPS Based Toll Collection System with Distance Tracking and License Plate Recognition aims to automate toll collection using advanced technology. The system utilizes GPS to track a vehicle's location and calculates toll charges based on the distance traveled. License plate recognition technology is employed to identify vehicles, enabling seamless and cashless toll payments. As vehicles pass through predefined checkpoints, their positions are logged, and charges are automatically deducted from the associated accounts. This approach eliminates the need for traditional toll booths, reduces traffic congestion, and minimizes human intervention, leading to a more efficient and user-friendly toll collection process. Proposed system make use of the GPS to mark 2 coordinates. The first coordinate is the place where the vehicle with the GPS and GSM modules attached, enters and the second coordinate is the place where the vehicle leaves the highway/taxable road. Here, transparency is also ensured as a driver can know the distance he traveled and the charge he pays is according to it, unlike the current system wherein he pays an amount, preset by the authorities. Manual intervention is completely eradicated in this system, leading to more accurate results, by reducing possible errors.**

These approaches and methods differ depending on factors such as image quality, the vehicle at fixed locations, light conditions, single image, etc. The differences in license plates from various nations and states should also be able to deal with it. The method should also be able to work smoothly with the number of characters in the captured images that differ in plate size or plate size.

Key Words: **Embedded, Global System for Mobile Communication, Module, Global Positioning System, module, GSM Module, ESP32 SIM800L**

1.INTRODUCTION

In the modern era, people have got used to live along with technology, and it would be very difficult to live in the absence of it. Inventions and discoveries are made to make our lives easier, calm and more agreeable. The main goal of advancement has been to increase the easiness of doing work. The world has started to automate almost everything. Automation uses various managerial systems for running industrial instruments such as machinery in factories, heat treating ovens, boilers, change on telephone networks, craft and different applications and vehicles. This reduces human interventions and provides result with better accuracy. Highways are meant to provide safety, speed and connectivity. Speed is greatly affected due to excessive congestion of vehicles, in the toll gate. Moreover, people keep paying the same amount of charge in toll gates, irrespective of the distance they travel, in taxable roads. Since waiting also is a disadvantage of the existing system, waiting alone leads to fuel consumption, manual involvement, which may lead to errors. Using the proposed system, will drawbacks of the existing system can be reduced effectively. It is discussed above. Our findings suggest an efficient way of toll payment Since number of vehicles are increasing year after year, the time spent waiting at the check post/toll gate has increased exponentially over the years. It can be overcome by automation. Automatic check post and E-Toll will eradicate the said problem. It is very evident that heavy traffic congestion, especially in big cities can be solved using this method. Every user must have their bank account linked with the GPS attached.

The GPS-Based Toll Collection System with Distance Tracking and License Plate Recognition automates toll payments using modern technology. It leverages GPS for tracking travel distances and license plate recognition for vehicle identification, enabling seamless and cashless toll transactions. This system aims to replace traditional toll booths by calculating toll charges based on distance traveled and using license plate recognition for automatic vehicle identification. It reduces traffic congestion, minimizes manual intervention, and enhances the efficiency of toll collection processes. Computer vision is certainly one of the most popular applications when we talk about AI. Hype aside, we were ever captivated by it since it is the most significant organ of human sense that concerns the human sight [8] [22]. We found plenty of computer vision projects with people's faces and/or bodies. As a result, we have decided to instead undertake a project on auto registration plates [9] [6]. Another reason why we've worked on this topic is that it makes it possible to recognize, extract and display the license plate number, immediately after detection of the license plate, in the usage of Optical Character Recognition (OCR).

Category	Statistics
Efficiency and Usage	
- Processing Time	1-2 seconds per vehicle.
- Usage Rates	20-50% of toll transactions are electronic in many regions.
Revenue and Cost	
- Revenue Growth	98% accuracy in revenue collection.
- Cost Savings	40-60% reduction in operational costs compared to traditional systems.
Distance-Based Tolling	
- Accuracy	Error margin of less than 5 meters for GPS tracking.
- User Acceptance	70% find it fairer than flat-rate tolling.
License Plate Recognition (LPR)	
- Accuracy Rates	95-99% in clear weather, 85-90% in adverse conditions.
- Processing Speed	Plates identified in under 500 milliseconds.

Fig.1. Statistics about the Efficiency and Usage

2. LITERATURE REVIEW

As per Goutham K, Gowtham M and Megalan Leo.L, GPS based E-Toll Gate Collection systems around the world make use of Internet. Here, a mobile application is used for sending transaction details. An automated toll gate system is present in this system. Here message is sent to the vehicle owner. In this proposed system make use of GPS [1]. Automated toll collection has always helped in improving traffic flow's efficiency. This has also been proven to be the easiest way to clear traffic. This reduces human interventions and provides result with better accuracy. Highways are meant to provide safety, speed and connectivity. Speed is greatly affected due to excessive congestion of vehicles, in the toll gate. Moreover, people keep paying the same amount of charge in toll gates, irrespective of the distance they travel, in taxable roads. Since waiting also is a disadvantage of the existing system, waiting alone leads to fuel consumption, manual involvement, which may lead to errors. Using the proposed system, will drawbacks of the existing system can be reduced effectively. It is discussed above. Our findings suggest an efficient way of toll payment Since number of vehicles are increasing year after year, the time spent waiting at the check post/toll gate has increased exponentially over the years. It can be overcome by automation. Automatic check post and E-Toll will eradicate the said problem. It is very evident that heavy traffic congestion, especially in big cities can be solved using this method. Every user must have their bank account linked with the GPS attached. When travelling on taxable roads, people often pay up the entire price, set up by the government. Usually, this fee collected is a random amount. The proposed system allows a traveler to pay according to the distance he or she travels. This apart from eliminating the construction of a tollgate, this also reduces the congestion at toll plazas. Usually, while toll plazas are congested, vehicles are turned on and emission is also inevitable. This is also an additional advantage. All the disadvantages of the existing system is entirely wiped out in this newly proposed system. The block diagram shows how receiver antennas on the surface of the Earth are used to gather positioning data from GPS satellites. After being encrypted, this data is subsequently sent to a microcontroller for additional processing. When a vehicle enters a taxable road and when it departs, the system is set up to capture location data twice. The distance the vehicle went is determined using the difference between the beginning and final coordinates. The total charge is then computed and shown on Message based on a predetermined amount per kilometer. The Global Positioning System (GPS), a satellite-based navigation system that gives position and time information everywhere on or near the Earth, is not complete without receiver antennas on the planet's surface. The GPS relies on a system of satellites in orbit to send signals to GPS receivers on Earth. The signals are used by these receivers to determine their specific position and time. The GPS data is encrypted and sent to a microcontroller, a tiny computer that manages several

aspects of the system. To calculate how far the car went on the taxable route, the microcontroller analyses the data and makes the relevant computations. The length between two locations in space is known as distance, and it is a basic idea in physics. In this scenario, computing the difference between the beginning and end coordinates yields the vehicle's journey distance. The amount that the vehicle owner is expected to pay for using the taxable road is referred to as the charge under this system. The term "charge" is used in the context of taxes. The fee is determined using a predetermined sum specified by the government per kilometer, a unit of measurement for distance equivalent to 1000 meters. The fundamental working of the system depends on the GPS. When the vehicle reaches the highway (on taxable road), the GPS records the coordinates and stays active throughout the journey. At one point, the traveler, soon after leaving the highway, the GPS coordinates are again recorded.

As Per Milan Samantaray, Anil Kumar Biswal, Debabrata Singh, Debabrata Samanta, Marimuthu Karuppiah, Niju P Joseph ,License Platform Detection is a computer technology that enables us to identify digital images on the platform automatically. Different operations are covered in this system, such as imaging, number pad locations, alphanumeric character truncation and OCR. The final objective of the system is to construct and create efficient image processing procedures and techniques to position a licensing platter on the Open Computer View Library picture. It was used and implemented the K-NN algorithm and python programming language. The technology can be used in different industries such as security, highway speed detection, lighting violations, manuscript documents, automatic charging system, etc. Auto plate recognition is an integrated technology which identifies the auto licence plate. Auto plate auto recognition. Multiple applications include complex safety systems, public spaces, parking and urban traffic control. Automatic Vehicle License Plate Recognition (AVLPR) has undesirable aspects because of many effects, such as light and speed. This work presents an alternative technique to leverage free software for the implementation of AVLPR systems including Python and the Open Computer Vision (openCV). Computer vision is certainly one of the most popular applications when we talk about AI. Hype aside, we were ever captivated by it since it is the most significant organ of human sense that concerns the human sight [8] [22]. We found plenty of computer vision projects with people's faces and/or bodies. As a result, we have decided to instead undertake a project on auto

registration plates [9] [6]. Another reason why we've worked on this topic is that it makes it possible to recognize, extract and display the license plate number, immediately after detection of the license plate, in the usage of Optical Character Recognition (OCR) [7] [3].
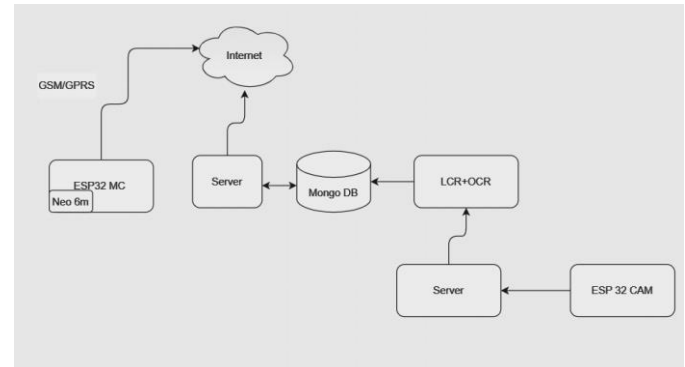

Fig .2. Block Diagram for Proposed System

3. EXPERIMENTAL METHODS

When travelling on taxable roads, people often pay up the entire price, set up by the government. Usually, this fee collected is a random amount. The proposed system allows a traveler to pay according to the distance he or she travels. This apart from eliminating the construction of a tollgate, this also reduces the congestion at toll plazas. Usually, while toll plazas are congested, vehicles are turned on and emission is also inevitable. This is also an additional advantage. All the disadvantages of the existing system is entirely wiped out in this newly proposed system. The block diagram shows how receiver antennas on the surface of the Earth are used to gather positioning data from GPS satellites. After being encrypted, this data is subsequently sent to a microcontroller for additional processing. When a vehicle enters a taxable road and when it departs, the system is set up to capture location data twice. The distance the vehicle went is determined using the difference between the beginning and final coordinates. The total charge is then computed and Message sent to Registered Mobile based on a predetermined amount per kilometer. The Global Positioning System (GPS), a satellite-based navigation system that gives position and time information everywhere on or near the Earth, is not complete without receiver antennas on the planet's surface. The GPS relies on a system of satellites in orbit to send signals to GPS receivers on Earth. The signals are used by these receivers to determine their specific position and time. The GPS data is encrypted and sent to a microcontroller, a tiny computer that manages several aspects of the system. To calculate how far the car went on the taxable route, the microcontroller analyses the data and makes the relevant computations. The initial coordinates and the final coordinates are made used to calculate the distance travelled [16]. Initially set an

amount per meter or per kilometer. So basically, this preset amount multiplied by the distance gives an exact amount that the traveler should pay. This system not only makes a traveler pay proportional to the distance he travels, but also help one to keep one posted why he/she pays the amount. This system is much transparent and logical than the existing system. This eliminates the need to have toll gates. One should also understand the fundamental working of the components used for this proposed system's implementation, which is discussed below.

Global positioning system (GPS) module is global satellite system, used extensively for navigation. So, whenever this module is successfully installed in any vehicle or a moving object, the vehicle's real time location can be identified by looking at the screen which is connected to it. Only when there is no obstacle in the line of sigh, do any of these things occur. All information is provided to the GPS receiver, which is present on the Earth's surface. The NEO-6M module series, a family of standalone GPS receivers with the powerful u-box 6 positioning engines, is used in this instance. Because of its small design and flexible power and memory options, NEO-6M modules are compatible with practically any device. Its sensitivity is around -167dBm and has a Restrictions apply. All these characteristics help us achieve ideal and accurate results. Any other earlier configuration of the GPS takes time to connect (takes around 13 seconds to connect). This disadvantage is overcome by using this latest module The GPS is basically a series of satellites. They revolve around the Earth's Atmosphere, and travel at the same speed as that of rotation of Earth (Geosynchronous), that is, they take twentyfour hours to revolve the Earth. So, the region on Earth it covers, remains the same. Radio signals are transmitted by the GPS satellites above to the GPS receivers on Earth. satellites are required to locate anything. Basically, each satellite calculates four dimensions, that is, X(latitude), Y(longitude), Z(elevation) and time. It is the duty of the GPS receiver to convert the received signals to useful information such as distance travelled or any other useful information, based on the need and application. The amount that is been to debit and location at the point of entry and exit is sent to the registered mobile the, total distance and total amount paid in the toll, top up the wallet amount can be added up to the database with payment and the GPS tracker will enabled for the others who are logged in the app that been built for the tracking of vehicle and many other uses for the app users. The co-ordinates are fixed for each a kilometer and the charges are allocate. Python is one of the leading contributors to this scientific realm by the open source community [21] [11]. Intel's Computer Vision research bores fruit, the Open Computer Vision (openCV) library that supports the growth of computer vision.

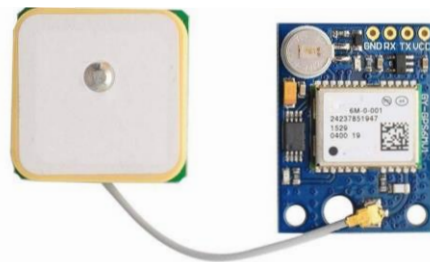## 4.HARDWARE SETUP

Fig.3. GPS Antenna for active Connection.

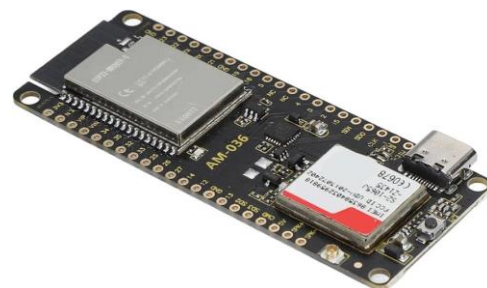**Fig.4**. GPS Module for the GPS Positioning.

Fig.5. ESP32 SIM800L for the receiver of data and transmitting of co-ordinates to the database.

Fig.6.ESP32 Cam Module for the license Plate Recognition.

TTGO T-Call is an ESP32 development board that combines a SIM800L GSM/GPRS module. Besides Wi-Fi and Bluetooth, you can communicate with this ESP32 board using SMS or phone calls.

The ESP32-CAM is a small size, low power consumption camera module based on ESP32. It comes with an OV2640 camera and an ESP32-CAM-MB Micro USB to serial port adapter.

UBLOX NEO-6M GPS module is a well-performing complete GPS receiver with a built-in ceramic antenna, which provides a strong satellite search capability. The status of the module can monitor with power and signal indicators. This board has high precision binary output and high sensitivity for indoor applications.

A GNSS or GPS antenna is a device designed to receive and amplify the radio signals transmitted on specific frequencies by GNSS satellites and convert them to an electronic signal for use by a GNSS or GPS receiver. The output of the GNSS or GPS antenna is fed into a GNSS or GPS receiver that can compute the position.
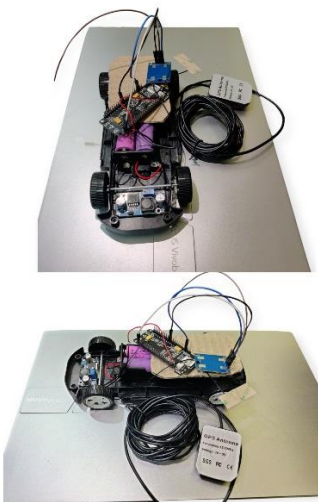

Fig.7.: Hardware setup of the proposal Model

Fig.8. Hardware Setup for the license Plate Recognition

5. CONCLUSION

The Integrated GPS-LPR Toll Collection system revolutionizes toll management, combining GPS and License Plate Recognition technologies to enhance efficiency, accuracy, and customer experience. This innovative solution automates toll collection, enables real-time vehicle tracking, reduces congestion and operational costs, and improves security and data protection. Implementation will transform toll collection, providing a seamless and modern experience for drivers while optimizing revenue collection for authorities. Scalable, secure, and compliant, this integrated solution is the future of toll management, promising increased efficiency, reduced costs, and enhanced customer satisfaction, ultimately setting a new standard for intelligent transportation systems. The proposal is about the automation in the toll collection system with distance tracking and the license plate recognition, as the tax are in the form as charges, The charges are allocated as the person or the vehicle travelled in the highway the entry and exit co-ordinates are taken and based on the distance we calculate the charge .The license plate recognition is an optional for the proposal and the term charge may increase, So we fix the Camera location and we just get the number and allocate the charges with some increased and the fine for the vehicle owners who doesn't have the GPS device fitted in the vehicle so the main aim to calculate the charge using the GPS devices in vehicles.

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