ISSN(Online): 2320-9801
ISSN (Print) : 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 3, March 2016

Intelligent Anti-Theft Tracking and Accident Detection System for Automobiles Based on Internet of Things

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ABSTRACT*:* An efficient automotive security system is implemented for anti-theft and accident detection, using an embedded system consisting of a Global Positioning System (GPS) and a Wi-Fi Module. The system in the event of theft will send predefined message to the owner of vehicle. The user (if he feels his vehicle is getting stolen) can start tracking the position of targeted vehicle on Google Earth on a dedicated vehicle tracker app. Using GPS locator, the target's current location is determined and sent, along with various parameters received by vehicle's data port, via Internet through Wifi module that is connected to PC or smartphone. Since the main medium of communication is internet (system to user and vice versa), the term IoT or 'Internet of Things' is implemented here. The owner will have the choice of cutting the supply of fuel to the engine if he wants to take immediate action apprehend the thief. This feature will be present on the vehicle tracker app. The other aspect of the project is the accident detection. The process is same as in theft detection, i.e., when accident does take place; the accelerometer's readings will trigger the system to start sending coordinates of the accident site to the law enforcement authorities and hospitals, in response to which emergency action can be taken by them immediately.

KEYWORDS: Tracking system, Anti-theft, Internet of Things, Accident detection, Law Enforcement Authorities, Vehicle Tracker app

I. INTRODUCTION

In the last few decades, India has progressed at such an enormous rate that many companies have strongly established themselves here. These companies bring a huge amount of workforce with them. Arranging transportation to such a huge mass is a cumbersome task involving many intricacies. Generally, this transport is arranged through the local transport vendors on a yearly contract basis, with increasingly happening mishaps such as burglary, accidents etc. posing a bigger concern the development of satellite communication technology is easy to identify the vehicle locations. Vehicle tracking systems have brought this technology to the day-to-day life of the common person. Today GPS used in cars, ambulances, fleets and police vehicles are common sights on the roads of developed countries. All the existing technology support tracking the vehicle location and status. The GPS/IoT based system is one of the most important systems, which integrate both GPS technology and upcoming IoT or Internet of Things terminology. With the help of GPS, the vehicle can be tracked on a continuous basis which in conjunction with law enforcement authorities or hospitals can be used to track the vehicle if it gets stolen or if the vehicle gets involved in a serious mishap. The IoT term is a relatively new and upcoming term. According to Wikipedia, The Internet of Things (IoT) is the network of physical objects or "things" embedded with electronics, software, sensors, and network connectivity, which enables these objects to collect and exchange data.

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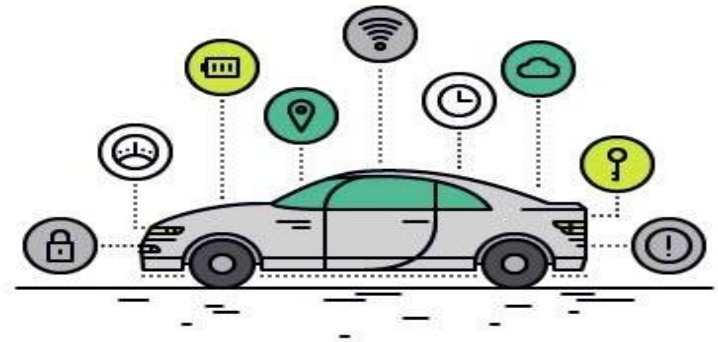

Fig 1: Internet of Things in automobiles aspect

The Internet of Things allows objects to be sensed and controlled remotely across existing network infrastructure, creating opportunities for more direct integration between the physical world and computer-based systems, and resulting in improved efficiency, accuracy and economic benefit. Each thing is uniquely identifiable through its embedded computing system but is able to interoperate within the existing internet infrastructure. The term "Internet of Things" was coined by British entrepreneur Kevin Ashton in 1999. Typically, IoT is expected to offer advanced connectivity of devices, systems and services that goes beyond machine to machine communication (M2M) and covers a variety of protocols, domains and applications. The interconnection of these embedded devices including smart objects is expected to usher in automation in nearly all fields, while also enabling advanced applications like a smart grid, and expanding to areas such as smart cities.

II. REVIEW OF RELATED LITERATURE

A review of existing security systems implemented in automobiles was done and below are some of the findings found. Based on this review some solutions were proposed to improve certain functional security aspects of the anti-theft system that we are going try to implement in this project.
A number of developments have taken place in anti-theft systems for vehicles and some of the relevant ones are as follows:

1) The utilization of ARM 7 microcontroller, GSM and GPS module together with an accelerometer and temperature sensor is carried out by Joshi and Mahajan [6]. The GPS and GSM module is being utilized for following the area of vehicle. The extra part is being included is the accelerometer which essentially contains the MEMS sensor offering a low pass filter and is fundamentally utilized for Shake Detection, Orientation Detection and Tap Detection. The utilization of temperature sensor is additionally being carried out with a specific end goal to acquire the vehicle engine temperature which changes over the estimation of temperature into electrical signal.

2) A hybrid GPS-GSM localization of vehicles Tracking System has been developed by Al-Khedher [7] that portrays an incorporated GPS-GSM framework to track vehicles utilizing Google Earth application. The remote module has a GPS mounted on the moving vehicle to recognize its present position, and to be exchanged by GSM with different parameters procured by the car's information port as a SMS to a beneficiary station. The received GPS directions or coordinates are sifted utilizing a Kalman filter to upgrade the precision of measured position. After information processing, Google Earth application is utilized to view the current area and status of every vehicle. This objective of this framework is to oversee armada, police cars dissemination and auto burglary alerts.

3) Shaikh [8] describes arm7 based smart car security system. The principle point of this undertaking is to offer a development security framework in automobile, which comprises of a face detection subsystem, a GPS module, a GSM module and a control stage. The face location subsystem can discover confronts in vehicle amid the period in which no one ought to be in the auto, and make an alert uproariously or soundlessly.

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Alternate modules transmit vital data to clients and help to keep eyes on vehicle constantly, actually when the vehicle is lost. This framework model is based on the base of one inserted stage Arm7 which controls all the processes.

4) J.M. Hu [9] describes vehicles against robbery framework utilizing GSM and GPS module. The framework is created utilizing fast blended sort single-chip C8051f120 and stolen vehicle is discovered by the utilization of vibration sensor. The framework stays in contact with auto holder through the GSM module, for the safety and reliability of car.

III. PRESENT SCENARIO

Despite the various Anti-theft systems that exist in present automobiles, the cases of automobiles getting stolen everyday have reached astronomical numbers. According to a 2012 TOI post, nearly 40 vehicles were stolen everyday in Delhi which accounts for 9.7% of total motor vehicle thefts in the country second only to Uttar Pradesh (14.1%) and Maharashtra (12.7%). According to the grey market estimates, the stolen car industry could be generating a turnover of close to two billion. Thieves are ever devising ingenious ways to steal that precious piece of machinery dear to every household who owns them. The stolen automobile numbers have somewhat decreased presently but their concern still remains a challenging issue to address.

Some of existing security systems that are implemented in automobiles are given below:

1) Presently most of the vehicles use the traditional remote locking vehicle security system which in a number of ways hardly provides any decent security.

2) Some advanced systems are developed which use sensor networks to achieve security but if the sensor network fails the entire system fails.

3) Some other security systems employ some specific sensors which activate the emergency alarm when a person is in its close vicinity. They largely suffer from repeated buzzing of alarm even when a person who is just passing by the said vehicle thereby activating the alarm.

IV. SYSTEM DESCRIPTION

A. *Block Diagram:*

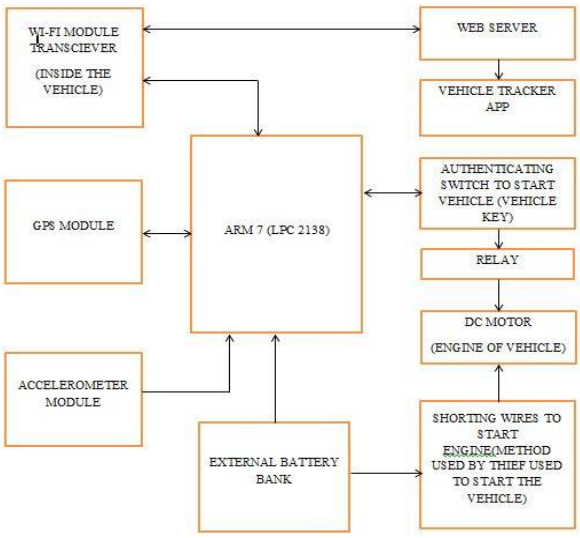

Fig 2: System block diagram

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B. Hardware requirements and their role:

1. Microcontroller - It the heart of the system and performs almost every function of the system. For this system the ARM v7 (LPC 2138) microcontroller is used.

2. GPS module – The GPS module will get location data (co-ordinates in latitude and longitude) of the vehicle from the satellites and will send it to the vehicle tracker application or law enforcement or hospital authorities so that exact location of the vehicle which might be stolen or met with an accident be found out. The ELS GPS 1100 module is used in this system.

3. Wi-Fi module – The main task of this module is to provide connection medium for sending location data obtained from GPS module to vehicle tracker app. The ESP 8266 Wi-Fi module will be connected to hotspots situated in surroundings which will enable the system to send data through Internet to the owner (Vehicle tracker app).

4. Accelerometer module – This module measures changes in g (acceleration) values in three axes viz. X, Y and Z and gives corresponding electrical voltage signals to the deviations in the said axes. This module is responsible with accident detection feature of the system. Whenever the vehicle meets with an accident, the sharp changes in g values occur and the corresponding digital values (digitization of electrical voltage signals is carried out by ADC built in microcontroller) are compared with predefined threshold values, if the values exceed those predefined threshold values, the GPS module is triggered and coordinates will be sent to law enforcement and hospital authorities through Internet. For this system the ADXL 335 accelerometer module is used.

5. Battery Bank – The battery bank suffices the power requirements for the entire working of the system. Although the system will originally use the power supply from the vehicle's battery pack but having an auxiliary power supply will help in uninterrupted functionality of system in the event of vehicle battery pack failure or in case it gets damaged thereby maintaining the security of the vehicle at all times.

6. Power supply – The power supply allows AC signal to DC signal which is required to run the system components (Prototype model only). It consist of step down transformer which reduces the 230V mains supply to just 12V which is then applied to Bridge rectifier and filtering circuits. At the output of said circuits pure DC (without ripples and constant amplitude) is obtained. This DC signal is further applied to two voltage regulator ICs. One of them is fixed voltage regulator IC 7805 which provides a constant 5V and the other IC is LM317 which is variable voltage regulator. IC LM317 output voltage can be adjusted by using 20 kilo ohm potentiometer. The potentiometer is adjusted to obtain 3.3V required by the microcontroller.

7. DC motor – Used to represent engine of vehicle for initial prototype model. The supply to the motor comes from the power supply described earlier.

C. Software requirements:

1. Kiel u-vision IDE version 5.16 is used for programming purposes. It contains editor, debugger, assembler, compiler etc and many features which help in code development.

2. MIT APP Inventor tool for creating the 'Vehicle Tracker App' which will have the 'Tracking' and 'Engine Immobilize' options.

3. Flash Magic tool for burning/ downloading program code onto the microcontroller.

4. Cloud server (an online storage place) provided by App Inventor tool which is used to store the GPS data (coordinates) and then send it to the vehicle tracker app (owner of vehicle) or to law enforcement / hospital authorities in case of accident detection.

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V. SYSTEM OPERATION

- The security system (present in owner's vehicle) will always be online 24x7. That is the system will receive continuous power from an external battery bank. This is because theft or accident can happen anytime and the system should be working continuously without any hiccups.

- Now consider the scenario where the owner is starting his vehicle, on turning the ignition (with authentic key), the system senses that the vehicle's engine has started and sends a predefined message to the owner that the vehicle has been started. Also the GPS module starts sending coordinates to the cloud server so that they can be used finding the location of the vehicle in case it meets with an accident.

- But since the owner himself is using the vehicle he/she will ignore the message as this is clearly not a case of vehicle getting stolen.

- Now consider that a thief somehow gets entry into the same vehicle and somehow manages to start the vehicle (say by shorting wires to start ignition), the same predefined message will be sent to owner of that vehicle. The owner will off course realize that his vehicle is in the process of getting stolen. At this point the owner has two options:

    1. Either immediately press the 'Engine immobilize' feature present on the 'Vehicle tracker app' installed on owner's smart phone to stop and apprehend the thief from getting away with the vehicle if he/she wishes to.

    2. Or start tracking the vehicle's position based on the coordinates sent by the GPS module (the coordinates are already stored in cloud server and are sent to app on owner's request) present in the vehicle, initiate location tracking on maps and contact the law enforcement authorities immediately to apprehend the thief and recover the vehicle.

- The same process is applicable in case the vehicle gets involved in an accident. To achieve this, the accelerometer present on system on sensing sharp or heavy movements (if the module gets upside down i.e., when deviations in g values exceed the threshold limits) will trigger the GPS to start sending the coordinates received from satellites (The coordinates are already stored in cloud server) to nearby hospitals and law enforcement authorities so that they can take emergency measures immediately. The utmost important thing is that all the devices (system, smart phone, institutions etc.) must be connected to internet at all the times.

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A. System operation flowchart

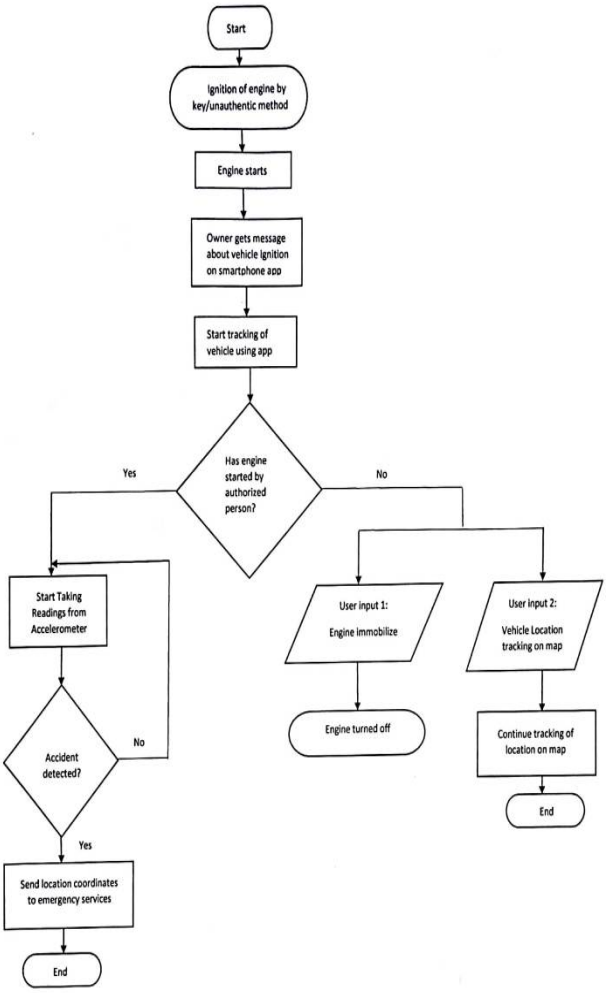

Figure 3: Operational flowchart

VI. SIMULATION RESULTS

The system was first tested using step down transformer instead of a battery which was as intended before (Later on a 12V 1 amp battery was used to power the system). The step down transformer down converts the 230 V, 50 Hz AC supply to 12 V DC which is then applied to rectifier and filter circuits and eventually is used to power the individual components of the system. A Wi-Fi hotspot (100 Mpbs broadband connection to router) was created for the system to connect to it so as to simulate it as one of the 'Things' in IoT concept. The vehicle tracker app was installed on one of the Smartphone (acting as owner of vehicle) and other phone was set up (acting as law enforcement authority) which will receive GPS coordinates in a SMS whenever accident is detected. The four scenarios namely continuous tracking, theft detection, engine immobilize (fuel cut off in model) and accident detection was simulated in sequence. There was some delay between the actions taking place for ex:

1. When the system was first started, the app got the status of the system model about theft and accident status after some 15 second delay.

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2. When eventually the theft got detected (after some seconds), the engine was shut off (after activating the immobilize feature on app) after quite a time (nearly 30 seconds) which isn't that great.
3. When the accident detection scenario was simulated (placing the accelerometer module upside down or tilting it through 90 degrees) the accident status on the app was updated after a delay of nearly 25 seconds which isn't desirable at all.

Off course had the internet speeds be faster, the delay between the said actions could have reduced to some degree. It's clear that the vehicle tracker app does need some optimizations so that it updates as quickly as possible but the inherent internet speed problem is the major factor here. Except the delay problems, the simulation results were promising and there is room for improvements in the project.

VII. COMPLEXITIES INVOLVED

Since the main aspect of the project is IoT (Internet of Things), which is the foundation on which the project is implemented upon, there are many issues associated with IoT. While IoT is yet to become mainstream at least in India (It has been established well in other countries like US, Korea, Europe), the project which will be largely dependent on Internet and connected devices ,is still not possible to become a full fledged product. Indeed IoT will be well established in coming years, Google Inc recently announced that nearly 400 WiFi hotspots will be set up starting this year, it will still take some time for IoT phenomena to happen. IoT itself has some cons of its own, some of them are stated below.

- As devices from different manufacturers will be interconnected, the issue of compatibility in tagging and monitoring crops up. Although this disadvantage may drop off if all the manufacturers agree to a common standard, even after that, technical issues will persist. Today, we have Bluetooth-enabled devices and compatibility problems exist even in this technology! Compatibility issues may result in people buying appliances from a certain manufacturer, leading to its monopoly in the market.

- The IoT is a diverse and complex network. Any failure or bugs in the software or hardware will have serious consequences. Even power failure can cause a lot of inconvenience.

- The unskilled workers and helpers may end up losing their jobs in the effect of automation of daily activities. This can lead to unemployment issues in the society. This is a problem with the advent of any technology and can be overcome with education. With daily activities getting automated, naturally, there will be fewer requirements of human resources, primarily, workers and less educated staff. This may create Unemployment issue in the society.

- Our lives will be increasingly controlled by technology, and will be dependent on it. The younger generation is already addicted to technology for every little thing. We have to decide how much of our daily lives are we willing to mechanize and be controlled by technology.

Now for the vehicle to be secured from getting stolen or reporting to concerned authorities in the event of accident, it is imperative that the both system(present in vehicle) and user's smart phone have access to internet 24x7, which might not always be the case. For example for a user present in a remote area where internet access is limited or negligible, the vehicle could not be monitored continuously, so if accident occurs and no one is nearby to report it, the accident will go unnoticed, also in case of a theft event the system won't be able to send coordinates to user if the system doesn't have a consistent internet access.

A solution to some of the above problems is to use GSM/GPRS technology but implementing an algorithm to send and receive commands for the said technology is in itself a very complicated task and doing it in limited budget and timeframe was not possible. Hence this project has some pros and cons and in future efforts will be put to minimize some of the cons if possible and maybe some solutions could be found out to improve the upon the original idea.

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VIII. CONCLUSION

Although no vehicle can be fully secured, this project aims to bridge the gap between flexibility and security. This paper provides a reasonable idea to achieve and improve security and preventive measures in the events of thefts and accidents. IoT while still in its infant stage has tremendous potential to automate a variety of functions to a certain degree and ensure that processes continue to operate without human intervention. This project also tries to improve upon existing security systems which though provide reasonable security but have certain shortcomings. There are areas in which the idea can be improved upon and further improve the robustness and capabilities of the system.

IX. ACKNOWLEDGEMENT

We are deeply honoured in expressing our sincere gratitude to Prof. A. V. Deshmukh for providing valuable insights and helping us through thick and thin. We are thankful to the HOD (E&T.C. Department), MIT College of Engineering, Pune, Prof. (Dr.) V.V. Shete, who has extended us a helping hand in all possible ways. We are also deeply indebted to all the teaching and non-teaching staff for the facility provided and their timely advice and guidance.

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