

GPS-BASED ANTI-THEFT SYSTEM

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Abstract. *Tracking a vehicle as an anti-theft measure has been a necessity since the first vehicles were invented. But up to this day, there is no technological solution that is convenient to use and not break the bank. Most of the solutions are costly, because of the components used, and also, inconvenient, due to the lack of integration of user interaction. In this paper, we introduce a new solution, a theft-prevention GPS-tracking system that is accurate, user-friendly, and that is affordable. We describe the steps of planning and developing such a system, deciding upon the right hardware and software components and the way of integrating them into the product. We expect this new approach to result into a highly usable GPS-tracking system, which will be an efficient theft-prevention tool, which will keep the user up to date with the state of the tracked vehicle.*

Keywords: *tracking, vehicles, monitoring, control.*

Introduction

Automobiles are one of the most precious types of property with high mobility. Given this mobility, car theft is a common type of crime around the world [1]. Safety of this property is a complex problem because it is a hard process of searching stolen cars, preventing and detecting car theft [2]. Existing solutions on the market are either inconvenient or costly for the user [3]. As a result, it turns out that there is no effective solution to this problem, despite its relevance and importance. Given all the above factors, the creation of such a solution can be a profitable investment, since there will be a high demand for it.

From one point of view, there is a need for detecting car theft and informing the owner about the location of his/her vehicle, which can be useful for further car search, even if it was hijacked. Both can be made via a GPS tracker that will get information about the current position of the car and a mobile application for the smartphone that will send all required data. Such a system can be built using cheap and effective components.

Sensors and actuators

A GPS (Global Positioning System) module is the main sensor in the system, given that a sensor is a device that detects input/change of the physical environment. GPS obtains information about its current position using signals sent by satellites in space and ground stations on Earth.

Incoming satellite's signal contains a timestamp when it was transmitted providing opportunity for calculating speed/acceleration of the vehicle. This information can be used for predicting the movement of the vehicle. This information can be transmitted using a GSM/GPRS module for further use to any device.

Given the principles of work for the system, the GSM/GPRS module is an actuator that performs data transmission.

Devices

The device is a very important thing in the IoT system because the application's flexibility depends on its type. For example, if there is a web application on which the software is installed and the app cannot be made for the mobile device due to its complexity, the user is bound to his/her workplace's PC. On the other hand, if there is a mobile app, the respective person can use it anywhere. Another important factor is the possibility to use the app only if connected to the internet or not. In case of the GPS tracking, the offline mode does not make a lot of sense, since the data from the satellite is not so precise if there is no connection.

In this case, the device used will be a smartphone and it will be mandatory for the user to be connected to the Internet, so he/she can receive the most precise data possible about the tracked device. There will be built a mobile application, so the user could set different parameters and have a mobile tracking unit.

Network

The MCU will have to be connected to the network, and the most convenient way is to do so through Wi-Fi, but there is one more approach - using a GPRS/GSM module. The cloud should be able to work with more trackers.

In order to send data, specialized application layer packets can be constructed with all the necessary information, for example, a packet with the fields: packet number, tracker status, location, MCU identifier (if the cloud works with more trackers). The cloud should be able to work with more trackers.

Some of the transport layer protocols are TCP, UDP, DCCP, SCTP, RSVP. In this case, most probably, the TCP will be used, and inside it, there will be created a new kind of protocol that will work with the datagrams defined by the authors. The datagrams will be wrapped in simple TCP datagrams and transmitted.

Cloud

Information from the GPS sensor should be easily accessible and inform the user if needed, performing the necessary calculations and actions. The most efficient way to solve this problem is to make the application cloud-based, where calculations and some specific actions would be made by cloud. It means that the GPS tracker must be connected to the server and send all data to it, receiving information about the user's lock (owner of the system tells location where the vehicle must be) and unlock (owner tells that car can be moved). If the vehicle was moved while being locked, the owner gets a message from the server with a warning of possible car theft and current coordinates of the car, that can be used for finding the car on a map.

The decentralized operation of the system will effectively protect property regardless of attempts to penetrate or disrupt its work.

The use of the cloud makes possible further system improvements, its cooperation with other devices/systems, making it adaptable to the cross-platform, and integration into the Internet of Things.

Security

If the user wants for the server to react only to the known devices, not to the "hacker's" ones, then he/she can set a global recognition key for all the tracker's, this key will be known by the server and the trackers. A more secure way is to use trackers as subscribers to the server. When a new tracker is going to be introduced, it should be registered into the server's registry of trackers and there will be more information about each tracker, like the identification number, the recognition key, availability time of the tracker, etc. In order to hide the travelling data, the user will be using to see where the tracker is, between the tracker and the server, and also between the server and the application, it is needed to encrypt the packets. For encryption, there can be used either a public-key encryption or a symmetric key encryption. A more efficient way would be the symmetric key encryption because it is faster to encrypt and decrypt the data. For the symmetric key encryption, there can be used the keys used to identify the trackers.

User Interface

The user interface (UI), in the industrial design field of human-computer interaction, is the space where interactions between humans and machines occur. The goal of this interaction is to allow effective operation and control of the machine from the human end, whilst the machine simultaneously feeds back information that aids the operators' decision-making process [4].

As said before, there will be built a mobile application and the user will have to be connected to the Internet if he/she wants precise data. On the main page, there will be a map of the current city location. In the left corner, there will be a hamburger menu so the user can set his/her preferences: the number of tracked vehicles, frequency of the received location, information about the application etc. The interface will be menu-driven and touch and as user-friendly as possible, so anyone can use it and track his/her vehicles.

Generally, the goal of user interface design is to produce a user interface which makes it easy, efficient, and enjoyable (user-friendly) to operate a machine in the way which produces the desired result. This means that the operator needs to provide minimal input to achieve the desired output, and also that the machine minimizes undesired outputs to the human [4].

Conclusions

All things considered, a vehicle tracking system is a suitable tool for theft prevention. Due to the lack of efficient solutions that are both user friendly, and affordable, there has not been any steady decrease in the number of vehicle thefts or theft attempts, in the last decades. In this sense, there is a high demand of a solution that complies to the stated criteria. In order to develop such a system, the range of hardware and software components must be analysed and compared, by the specifications needed to be met. This paper unified the researching phase of the project, whose aim is to result in a GPS-tracking product that is an efficient tool for theft-prevention, is highly usable, and is not costly. The components that were decided upon, have been chosen in the detriment of unfit solutions, as of applicability, necessity, and financial value.

First, the information about the GPS sensor was gathered, which proved that, in order for such a solution to be developed, there is a need of a GPS module that will take location information from GPS satellites and ground stations on Earth, along with a GSM/GPRS module which is needed to perform the data transmission.

Further, the types of devices on which the system will be integrated were studied, finally stating that the most suitable solution will be a mobile phone, thus the application will provide a mobile version, in order to offer flexibility to the user. Also, for accuracy purposes, the device will have to have an Internet connection, so that the received data will be updated and correct. Moreover, the application is best to be cloud-based, which will allow further improvements, cross-platform integration and an Internet of Things product unit.

Finally, the importance of User Interface design could not be neglected, since the final product needs to be enjoyable and easy to use. It must be clear and let the operator provide minimal input in order to achieve the desired output.

The final solution will be a highly functional product that will be adaptable to any vehicle. It will result in a great gadget for any driver who wants to ensure a way of theft prevention for an automobile. It is hopefully a solution that will not be costly but will be worth of anyone's investment.

References:

1. Crime > Auto theft: Countries compared. [online]. [accesat la 26.03.2020]. Disponibil: <https://www.nationmaster.com/country-info/stats/Crime/Auto-theft>
2. ELVIA, What to Do When Your Car Is Stolen — Top 10 Fast and Effective Ways [online]. 18.07.2019. [accesat la 26.03.2020]. Disponibil: <https://reolink.com/what-to-do-when-car-is-stolen/>
3. EDSALL, N. The best anti-theft devices if your alarm isn't enough [online]. 09.09.2019. [accesat la 26.03.2020]. Disponibil: <https://www.digitaltrends.com/cars/anti-theft-devices-cars/>
4. User interface [online], [accesat la 26.03.2020]. Disponibil: https://en.wikipedia.org/wiki/User_interface