Arduino Based Car Sentinel Device

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With the increase on the number of vehicles on the streets comes the need for more parking spaces. Many car owners decide its best to leave their car unattended in public areas, but this decision contributes to the growth in the occurrences of vehicle theft. This paper proposes the development of a sentinel device based on the Arduino platform that will be able to detect movement inside a vehicle and send a warning to the owner through the GSM network using any Android based phone.

Keywords: Mobile technology, Smartphone, movement sensor, car monitoring

I. INTRODUCTION

The number of vehicles in Brazil has presented a significant growth in the last few years. According to data by the National Traffic Department[1] there has been an increase of 50.2 million cars, 19.9 million motorbikes and 5.9 million of other vehicles.

Associated with the speed, the private transport is a promising alternative when considering the quality of the Brazilian public transport. However, it is important to consider the lack of security involving vehicles nowadays. Not only when these vehicles are in movement but also when they are parked in public areas. The car owners usually park their cars in areas far from their final location and in the case of an emergency happening these owners will not be able to know what happened. If the car alarm is activated, the user will not be able to turn it off either.

Around 229 thousands of vehicles were stole in Brazil in 2013 and this figure grows almost 13% every year[2]. Associated to this, there's been an increase in the number of car alarms purchased as a security item.

There is an actual need for the owner to know the current state of their vehicle. The system proposed by this paper will inform the user of any unusual activity happening with their vehicles in real time. The driver will receive a message informing about the state of the vehicle, moreover the device will not need to be installed like other security systems. It can work alongside the ones already installed, therefore it can be used by any vehicle no matter which brand/type.

The movements inside the vehicle will be detected by movement sensors connected to the device, as well as a microphone which will be responsible for detecting when the car alarm is activated. The device can be installed anywhere inside the vehicle and the activation of any of these sensors will inform the user of a suspicious event.

II. DEVICE CHARACTERISTICS

The device was developed aiming to keep the cost low. At first, handy modules have been used to ease the testing and assembling, but our aim in the future is to make all parts of the device into a single board. The device is composed of the following parts:

- Arduino UNO board – The board specifications can be found in [3]
- Movement sensor - DYP ME003
- Bluetooth module - RS232
- Microphone module - KY-038

Further to that, the user will need to dispose of an Android phone in order to enable the device to use the GSM network to send and receive messages from the board and the user's phone.

In the Arduino board we used the serial input/output and two analogue inputs. In each analogue input we connected the movement sensor and the microphone module.

The movement sensor works as follows: after detecting a movement within the sensibility configured area the output of the module is set to high. Two working modes [4] can be configured changing jumpers in the module: one trigger, only a pulse is set in the output when a presence is detected; trigger locked, the output remains high while there is movement in the area.

The serial connection is used to communicate with the Bluetooth module. This module converts messages sent through the RS-232 serial connectors to Bluetooth messages to a paired device and also messages received from the Bluetooth connection to RS-232 messages. The Bluetooth module will exchange messages with the smartphone to configure the sentinel.

Finally, the microphone module changes its output according to the sound intensity detected. Under normal circumstances the sound detected in the inside the vehicle is kept at minimum level, but with the activation of the alarm a change can be detected.

III. CONFIGURATION APP

An Android application was also developed to enable the board configuration as well as communication between the board and the Android phone. This system was chosen due to the number of users being higher than 1.4 billion[5]. The application is responsible for:

- Indicate the contact method chosen by the user: SMS or regular call.
- Store the user contact number.
- Start, pause and stop the sentinel.

The phone will send configuration packages to the device and will receive information about the state of the vehicle informing the user of anything unusual through the GSM network.

III. COMMUNICATION PROTOCOL

The communication protocol developed is based on an 18 byte package where all requests are embedded. Each byte in the package holds some information regarding the configuration of the device. Figure 1 shows an overview of the package.

Byte 1 holds the information about what type of request the package carries. Bellow we summed up the possible kinds of packages that can be sent between the device and the smartphone:

The packages sent by the device are:

- Keep Alive: Byte 0x01. Keeps the connection activated.
- ACK: Byte 0x02. Acknowledgement package.

- Movement Detected: Byte 0x0B. A movement has been detected on the surroundings of the sensor.
- Alarm activated: Byte 0x0C. The car alarm has been activated.

The packages sent by the smartphone are:

- Start Watch: Byte 0x03. Starts the sentinel.
- Pause Watch: Byte 0x04. Pauses the sentinel.
- Stop Watch: Byte 0x05. Stops the sentinel.
- Change Password: Byte 0x06. Changes the configuration password. The new password will be sent in bytes 4 and 5.
- Change Contact Method: Byte 0x07. Changes the method by which the device will communicate with the user.
- Change Sensor Sensibility: Byte 0x08. Changes how sensible the movement sensor is.
- Change Phone Number: Byte 0x09. Changes the contact phone number. The new number will be sent in bytes 6 to 11.
- Connection OK: Byte 0x0A. A connection has been established.

0	AT COMMAND
1	REQUEST/RESPONSE
2	PASSWORD MSB
3	PASSWORD LSB
4	NEW PASSWORD MSB
5	NEW PASSWORD LSB
6	CONTACT PHONE NUMBER BYTE 1
7	CONTACT PHONE NUMBER BYTE 2
8	CONTACT PHONE NUMBER BYTE 3
9	CONTACT PHONE NUMBER BYTE 4
10	CONTACT PHONE NUMBER BYTE 5
11	CONTACT PHONE NUMBER BYTE 6
12	SENSOR SENSIBILITY
13	DATA 1
14	DATA 2
15	SPARE
16	CRC
17	CRC

Fig. 1 – Configuration package

IV. DETECTION POLICY

The detection policy was implemented according to the following algorithm: if there is any change in the movement sensor signal, there will be an interruption in the microcontroller informing that there has been movement in the surroundings of the sensor. This will be the first confirmation, if there is another change in the sensor within one minute from the first change this will be enough confirmation of the presence of a person. A warning routine will be activated and the user will be informed of this event.

The same principle applies to when a change in the sound levels inside the vehicles happens. A sudden change in the sonority implies that the car alarm has been activated.

V. RESULTS AND FUTURE WORK

Prototype and app

A prototype has been developed using the modules. The Arduino firmware and the android app were developed using the prototype mounted on a protoboard and connected to a computer.

The app was developed targeting the android version 2.3 Gingerbread, this will guarantee that the app will be compatible with over 99%[6] of all android devices currently activated. Figure 2 shows images extracted from the app:

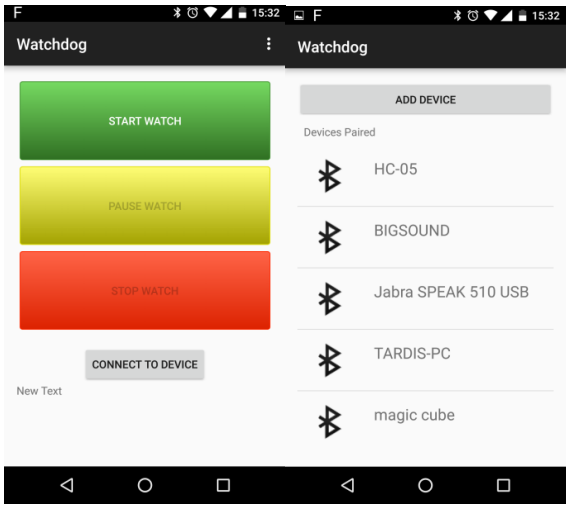

Fig. 2 – App screeshots

Communication

The communication protocol was implemented as follows: firstly the smartphone verifies if there is a pairing with the board, if not it will start paring. After the paring the device is ready to be connected to. When connecting to the board the phone sends a connection package to the board and the latter will respond with an Ack package. Once the connection has been established the smartphone will be able to send packages to request the start, pause and cancelation of the sentinel as well as the configuration of the device. After each request the smartphone waits for an Ack package. Moreover, the device can send Keep Alive packages in order to keep the connection active.

After the final adjustments with the prototype, another device will be built using all modules in a single board and replacing the spare phone with a GSM module therefore guaranteeing the complete autonomy of the system.

REFERENCES

[1] DENATRAN, Available in: < http://www.denatran.gov.br/frota2016.htm> Accessed in 12 February 2016.

[2] Sistema Nacional de Informação de Segurança Pública. Available in: <https://www.sinesp.gov.br/estatisticas-publicas> Accessed in 15 January 2016.

[3] Arduino Datasheet. Available in: <http://digital.csic.es/bitstream/10261/127788/7/D-c-%20Arduino%20uno.pdf> . Accessed in 27 February 2016.

[4] Specifications of DYP-ME003. Available in: <http://elecfreaks.com/store/download/datasheet/sensor/DYP-ME003/Specification.pdf> Accessed in 27 February 2016.

[5] Google shows off new version of Android, announces 1 billion active monthly users. Techspot. Available in:< http://www.techspot.com/news/57228-google-shows-off-new-version-of-android-announces-1-billion-active-monthly-users.html> Accessed in 30 march 2016

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