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SYSTEM TO REMOTE CONTROL THE VEHICLES DURING THE CHASING

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ABSTRACT

This system is based on stopping the fuel pump from working when sending a code to the cell chip in the control unit located in the vehicle. It's found that use Arduino board is more suitable to control the proposed system because it does not need a programmer device, which mean easier and faster in programming, this makes it superior to the PIC microcontroller.

Experiments shows that Cut off the fuel leads to decelerate the vehicle gradually, and then it stops after a distance does not exceed 860 meters. The flexibility of the system helps ending the chase safely, and minimizes any damage, handling a desired target, precisely.

In the case of there is an attempt for manipulation with the system such as opening the box which includes the system or any component failure, a text message "Emergency case.." as feedback is sent, at once, to the Central Traffic Department to inform about that.

KEYWORDS: Chasing, Arduino, Decelerate the Vehicle Gradually, Pursuit

INTRODUCTION

Pursuit is an event involving one or more law enforcement officers attempting to apprehend a suspected or actual violator of the law in a motor vehicle while the driver is using evasive tactics, such as high speed driving, driving off a highway, turning suddenly, or driving in a legal manner but failing to yield to the officer's signal to stop. When reviewing the reports of traffic in more countries, we may find that the causes of traffic accidents are distributed between exceeding the speed limit (35%), non-compliance with traffic signs (34%) and the rest falls, among other reasons. [2]

It is noticeable that all respect to these statistics does not address, from afar or near, traffic accidents associated with chase operations (chase between agencies concerned with the conservation order and security and people wanted justice for various reasons. But the security agencies or departments nature of work in charge of the maintenance of order imposed so (Table 1). Chases presents a conundrum and a challenge to the security services in most of the states and cities of the world (700 chase in 2002 in the city of Los Angeles alone has been detected), as this may result in the risk for all parties concerned and even to passers-by [14].

Most chases done by vehicle, usually accompanied by driving at high speeds exceed regular, without paying attention to the cause of chasing, which can be confined to one of the justifications for the following: anti-terrorism, smuggling and cross-border infiltration and theft, arrest fugitives and wanted security offenses, eluding of traffic violations.

Table 1: Accident Causes

Accident Cause	Number of Accidents	%
1. Speeding	99.602	34
2. Non-compliance with traffic signal	13.861	4.73
3. Irregular Stop	26.432	9
4. Irregular Turn	30.539	10.41
5. Irregular pass	27.001	9.21
6. Under influence of drug or drunk	325	0.11

The security agencies in all countries tend to use whatever techniques are available to end the chase with least possible losses, such as continuing to chase pending performs fuel vehicle or disable them one way or another (bumped or shoot the tires), bringing it sometimes to use helicopters.[6 ,15]

Some countries now are moving to stop the chase in the event of vehicle non-compliance with required orders, without announcing it officially, and leave the decision of chase to those maintaining the order and security [7, 8, 13, and 18]. The list will lengthen when talking about the pursuits and its endings and results, but the most important is how to harmonize the work of the various security agencies and facilitating their implementation of the tasks to chase wanted persons without sending the police to justice or without being accountable and without cause a tragedy for both parties or to a third party was preset in the chase area.

Many efforts have been made through studies and legislation to limit the damage caused by the pursuit operations [1,3 ,4 ,5, 10, ,11,16, and 17].On the other hand many researchers and inventors worked hard to find the appropriate and effective solutions to control the vehicle during the chase. The damage caused by the police chasing, affect both human and material in communities and countries around the world, So we must look for alternatives optimal solutions, through the use of technological development to reduce the damage caused by this phenomenon. This confirms that there is still a need for new approach and devices to treatment this issue.

METHODOLOGY

Many systems in the vehicle are responsible to maintain its operation; here we are talking about the basic systems that operate the engine such as fuel system and ignition system.

Fuel System

The purpose of the fuel injection system is to precisely inject a metered amount of fuel at the correct time. Based on the input sensor signals, the ECMs programming will decide when to turn each injector on and off.

Fuel Delivery System

The purpose of the fuel delivery system is to quietly deliver the proper volume of fuel at the correct pressure. Figure 1.1 shows a typical fuel system the fuel delivery system must also meet emission and safety regulations [12].

Fuel Pump

When the driver turns the ignition key on, the power train control module (PCM) energizes a relay that supplies voltage to the fuel pump. The motor inside the pump starts to spin and runs for a few seconds to build pressure in the fuel system. A timer in the PCM limits how long the pump will run until the engine starts. Figure 1 shows fuel pump, fuel is drawn into the pump through an inlet tube and mesh filter sock (which helps keep rust and dirt out of the pump). The fuel then exits the pump through a one-way check valve (which maintains residual pressure in the system when the pump is not running), and is pushed toward the engine through the fuel line and filter.

Figure 1shows fuel pump, fuel is drawn into the pump through an inlet tube and mesh filter sock (which helps keep rust and dirt out of the pump). The fuel then exits the pump through a one-way check valve (which maintains residual pressure in the system when the pump is not running), and is pushed toward the engine through the fuel line and filter.

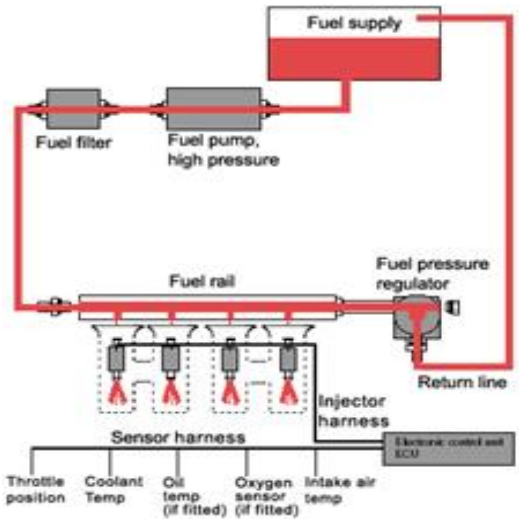

Figure 1: Fuel System

To reduce the negative effects resulting from chases, we designed a system capable for reducing vehicle speed that the police are chasing. The system can stop fuel supplying from the fuel pump to the ignition system by opening fuel pump relay (figure 2).

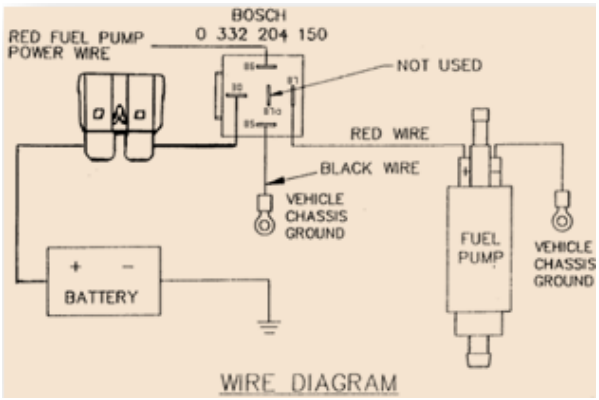

Figure 2: Fuel Pump Relay Diagram [9]

DISCUSSIONS AND RESULTS

The main principles in this research are electrical and electronics of circuits. It's all about switching high current device though a relay. The relay operates through transistor, so to reach the desired prototype and make it reliable, accurate, safe, and high fast switching need to go through the rules and operation of the transistor and making the right connections to make it works as arranged and must be. In order to implement the project into a prototype we must combine between software and hardware, so we can achieve the desired outcome.

The Software Part

In this part many computer software(s) will be used, some of this software is to write the code. The program used is: Last version of Arduino programming language, and the program used in simulation is: Last version of MikroC. Another computer simulation software used is: Proteus; this program used to connect hardware parts and software code

with each other, and simulate it as much as possible in real communications, this program can provide us with closed results . Edraw, the software we used to draw the circuit diagram, block diagram and flow chart. This program is also used to define paths and loops.

The Hardware Part

Here every IC (integrated circuit) used and external electric devices, power sources, and modules, are explained in details with full recognition for parts selection and how to use it.

The hardware part can be divided into

- Vehicle Part
- Circuit Part

Vehicle part contains a group of relays and wires, connected in specific manner to deliver the current to the main operational devices of the car, like: ignition system, injection system, and fuel pump or fuel pump relay.

The main technology used in the device is Arduino board, which can drive the relays directly, so no needed an interface circuit to drive the relays.

Proposed Solution

In order to achieve reliable, accurate, and safe system operation, we are going to control the switching of the electrical connection by controlling a normally closed relay connected to fuel pump. The relay is controlled by Arduino development board which received signals and commands by a message from GSM modem, then analyze signals for ordering the relay. Figure 3 shows the block diagram of proposed system using Arduino Development Board.

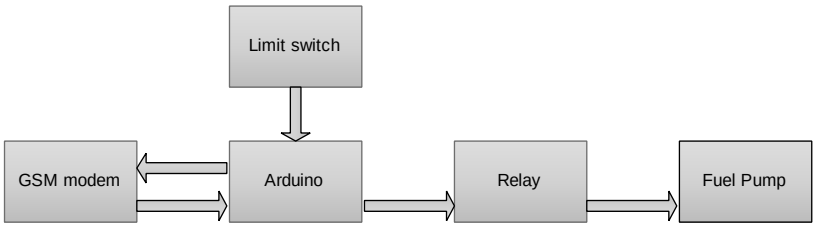

Figure 3: Block Diagram of the Proposed System

SIMULATION AND SYSTEM DESIGN

Simulation is a try to know the system's behavior in conditions similar to actual system's condition. This can show the future results before the practical experiments.. This system was simulated by Proteus engineering design program, on a PIC microcontroller processor using MikroC Programming language.

We simulate the control system on 12-volt motor and connecting it to an operating circuit which consists of a transistor and a relay, and connecting the microcontroller to LCD screen. The virtual terminal should be connected to the microcontroller to display the message we are writing. When the following code "At+CMGR=1" appears on the virtual terminal, then the system is ready to simulate.

The Code Used in Simulation

The simulation code was written in MikroC. In this simulation, the message which by receiving it the motor stopped working is ("""""""""OFF), and the message which by receiving it the motor return to work is ("""""""""ONN). In simulation the results were as following:

The First Mode

The default state of the system is pump (or motor) working, from figure (4) we note that pin 19, which connects operating circuit of the pump with the microcontroller, appears in red, this means that the pump is working at this time.

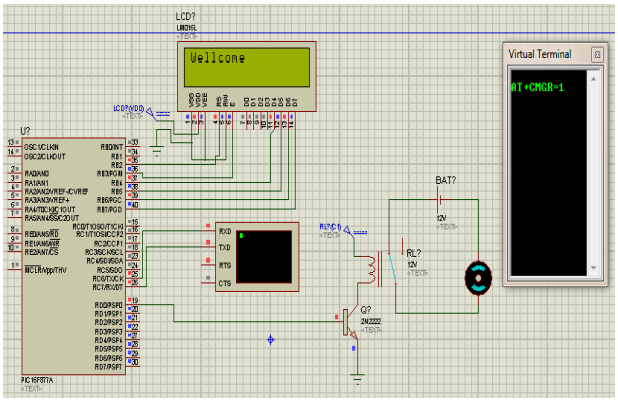

Figure 4: Pump is Working Normally

The Second Mode

The system stops when sending a message. We note that pin 19 appears in blue, this means that pump stopped working (Figure 5).

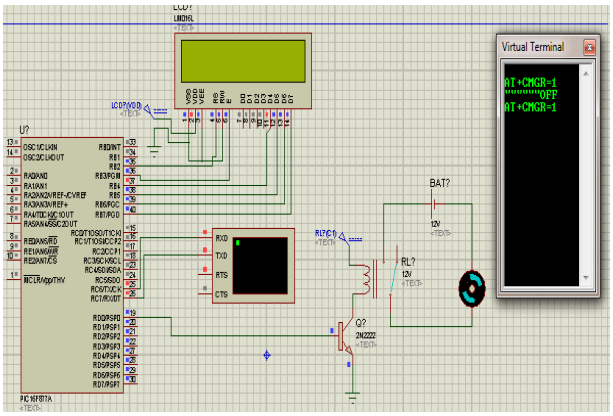

Figure 5: Pump is Switched off

The Third Mode

Restart the pump stage appears in figure 4. After printing (“”””””””ONN) on the virtual terminal pin 19 appears in red, so the pump new works (Figure 6).

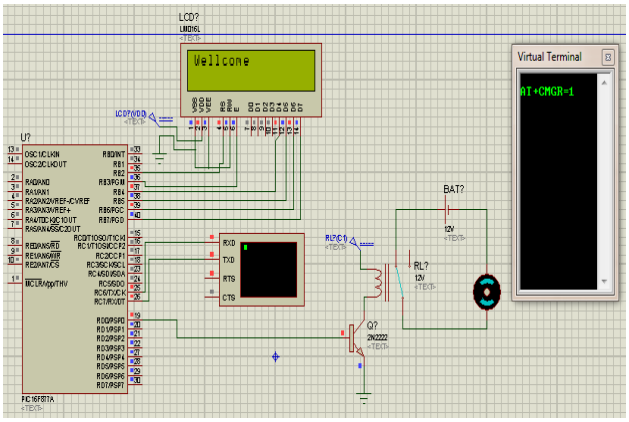

Figure 6: The Result of Simulation (Pump is Working Again)

After insuring of the effectiveness of the system through the success of simulation, we start the designing process of the system, using Arduino control unit. It's more suitable, because it does not need a programmer device, which mean easier and faster in programming, this makes it superior to the PIC microcontroller. The work principle of this system is when a text message "#a0" is sent from any telephone number to the number of the GSM modem, the message is received by this modem, and later on, it will be sent to the Arduino which deals with the signal for the purpose of stopping the fuel pump from work through the relay, therefore stopping the fuel delivery to the injectors.

In addition, a text message "Done.." will be sent to the central traffic department to ensure process. This process takes only ten seconds from the moment of sending the message until the pump is stopped. After the pump is stopped from work, the vehicle becomes slow because the fuel cannot reach the injectors, after a while, the pump will be stopped.

When we want to switch on the pump again, we should send a text message "#a1" to the same number. Consequently, the pump works again, and a message "Done.." will be sent to the central traffic department to ensure process. The driver has the ability to control the speed of the vehicle now. The flow chart of the proposed system can appear in figure 7.

When there is an attempt for manipulation with the system such as opening the box which includes the system or any component failure, a text message "Emergency case.." is sent, at once, to the Central Traffic Department to inform about that (Figure 6).

As shown from figure 7, the system consists of the following main parts: GSM, Arduino and relay. In addition, there are electric resistances, capacitors, and oscillator, most of which are located in the Arduino unit. There is no need to use a transistor in the final circuit because the type of relay used is (3-5 v) relay, so we don't need to the transistor's function of amplifying signals or its mechanical control function. But it is necessary to add it in simulation circuit because the relay used in this circuit is (12-v) relay, so it needs to amplifying signals to be able to deal with them.

The Circuit Diagram of the System

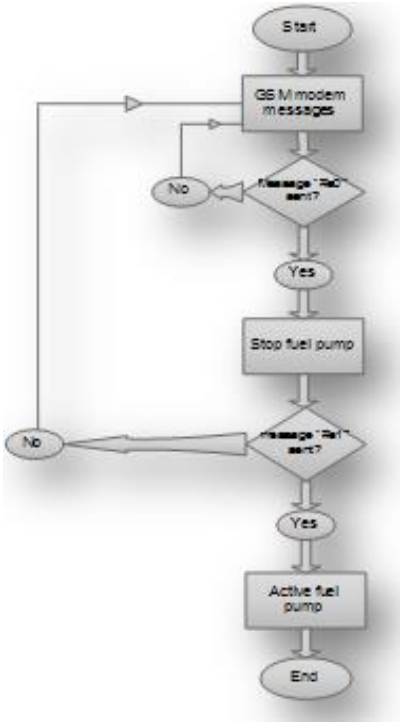

Figure 7: Flow Chart of the Proposed System

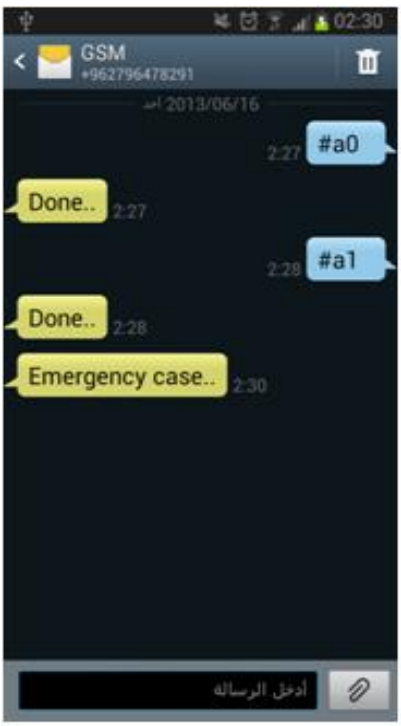

Figure 8: Check the Readiness of the System to Work

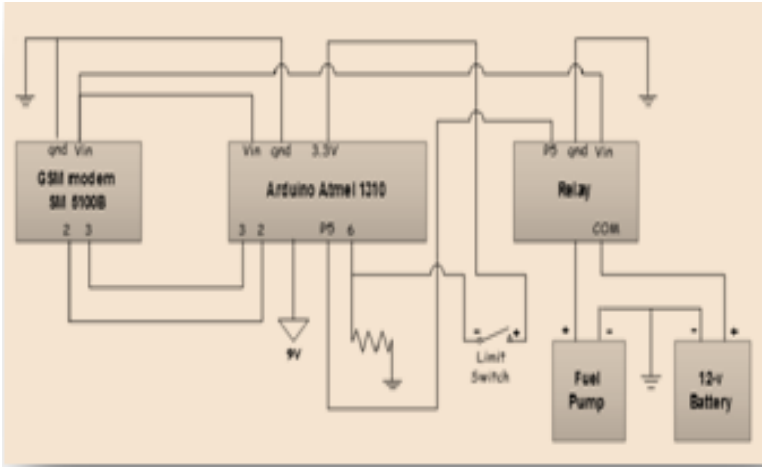

Figure 9: The Circuit Diagram

This circuit (Figure 7) consists of the following components: GSM (Global System for Mobile) modem type SM 5100B, Arduino development board with microprocessor ATMEL 1310,5 volts relay, power supplies (9V, 12V), Limit switch, and Pull down resistor (5.6 Ω).

EXPERIMENTS

Experiments were conducted to ensure that the sudden stop of a vehicle will not cause any damage. This is done by reducing pressure of the fuel pump gradually and calculating the flow to test whether the fuel will arrive to the sprays or not.

First Experiment: the experiment was conducted on a vehicle type Hyundai - ELANTRA2005, with engine 1.8/2 DOHC-3.85, to determine how the flow and pressure changing when fuel pump voltage change (Table2).

Table 2: Fuel Pump Pressure and Flow Rate with Pump Voltage Change

The Voltage of Pump ,Volt	The Pressure of the Pump, Kpa	The Flow Rate ,ml
12	140	75
9	120	57
6	40	38

Second Experiment: after assembling the device, we test the control system practically. The experiments were in four stages

- Operating pump under normal conditions to know fuel pump specifications when it pumps fuel and delivers it from fuel tank to a laboratory tube
- Testing system when we stop the pump by sending the deactivation message, and calculating: Flow time, Flow amount, and distance the vehicle can go after stopping the pump in (m)
- Testing system when operating pump again
- Testing system if anyone tries to tamper with the system

Apparatus used in experiments: mobile phone, fuel tank, fuel line, laboratory tube, barometer, and stop watch, in addition to the designed control system.

This experiment was conducted as follows

- A fuel line which connected with fuel pump is faced to flow in laboratory tube, to measure time, pressure and flow amount of fuel. The pump is operated and the readings were listed in table 3.

Table 3: Readings of Time (T_1) Needed to Pump One Liter of the Fuel

No. of Reading	Time Needed to Pump the Fuel (T_1 ,Second)
1	18.74
2	19.66
3	19.32
4	19.38
5	20.16
6	19.79

It's found that the average value of T_1 equals to 19.51 seconds; the fuel pressure is 11.5 kPa, and the average volumetric flow rate is (volume of fuel/average time) equal to 0.051 Liter/ second.

- After knowing the specifications of the fuel pump, we tested the control system by sending a text message to the phone number of GSM modem, after 10 seconds, the pump will be deactivated, but the fuel remained flowing for a period of time less than one second. The time of flow after deactivating pump (T_2), is listed in table 4
- Find the distance that vehicle can travel after deactivating the pump (Table 5)

Table 4: Flow Time of the Fuel after Deactivating the Pump

No. of Reading	Flow Time of the Fuel after Deactivating the Pump,T_2 Second
1	0.68
2	0.81
3	0.66
4	0.75
5	0.72
6	0.76

Table 5: The Distance that Vehicle Can Travel after Deactivating Pump

No. of Reading	Amount of Flow when Deactivating Pump (ml)	Distance that Vehicle Can Traveled after Deactivating Pump (m)
1	78.1	859.1
2	78.5	863.5
3	76.4	840.4
4	77.5	852.5
5	77.4	851.4
6	77.1	848.1

Third Experiment: were done to find the distance that vehicle can travel when it operated with no Load-ideal speed. The vehicle traveling at velocity of 120 km/h on a straight road (Table 6).

As shown from table 6, when the fuel has been cut off (vehicle is operated with no load -ideal speed), the vehicle continued travel for a distance not exceeding 860 meter.

The distance that the vehicle can travel after deactivating the fuel pump (For Chevrolet- Malibu, 2013, ECOTEC Engine, 4 cylinders, 2.4 liter, the consumption is 8.4 liter/100 km) will be 922.25 meter. This value increases slightly (6.7%) for what has been reached through practical experiences on the device, which can be considered as a normal result.

Table 6: Travel Distance When Vehicle is Operated with no Load (Ideal Speed)

Number Reading	Traveling Distance, Meter
1	830
2	800
3	810
4	860
5	850
6	800

- To test the part about sending a massage if there was an attempt for manipulation with the system, open the acrylic box. When the box was opened, a message showing “emergency case..” will be sent to the central traffic department at once.

OPERATION OF THE SYSTEM

As shown in the figure 10 the Arduino is connected to the GSM modem to analyze signal receiving by GSM modem through a message. The Arduino is also connected to the relay to give it (switching off, switching on) orders. The GSM modem is connected to the relay to supply it with power.

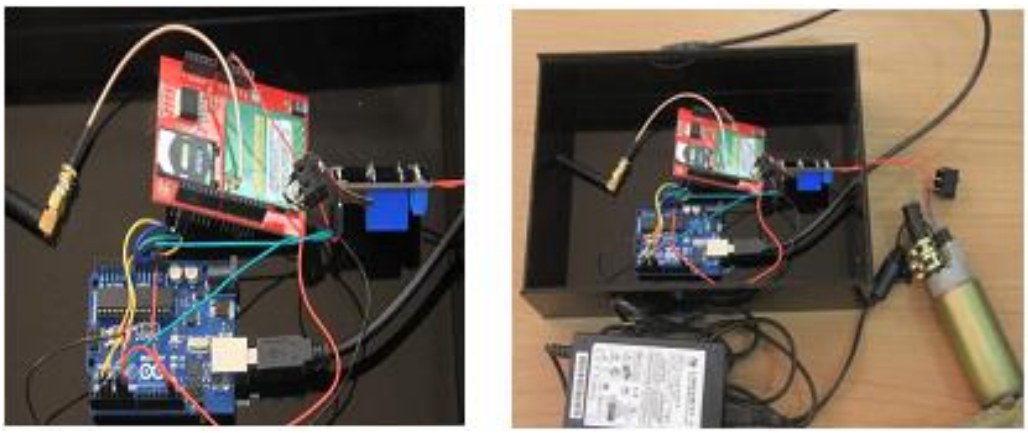

Figure 10: The Device Assembly

The sequences of steps to test the system are as follow

- Connect Arduino to a (9 or 12) volt power supply.
- Connect the relay to a 12 volt power supply or vehicle battery as shown in figure (circuit diagram).
- Reset Arduino, by pressing the button located in Arduino, specified for this purpose.
- Send an SMS to the phone number of GSM modem. The text of the message to switch off the fuel pump is “#a0”. And the text of the message to restart the fuel pump after switching off is “#a1”. During 10 seconds the pump will be switched off in case of the text of message was “#a0”, and the pump will be switched on again in case of the text of message was “#a1”.

CONCLUSIONS

- The successful implementation in the system’s hardware and software components contribute in controlling the vehicle gradually during a chase.
- The flexibility of the system helps ending the chase safely, and minimizes any damage.

- Stopping the vehicle refueling (cut off fuel, changing pump voltage) is the optimum solution to control the vehicle, as it ensures a gradual stop after a short period of time that is equivalent of decreasing the speed of the vehicle for a distance which does not exceed 860 meters.
- The most important characteristic of this system:
- Does not deal with a targeted pursuits or chases for one reason, it chooses the right timing and place to stop the vehicle.
- Helps various security agencies carrying out the tasks entrusted to it when chasing, without causing a tragedy for both parties, or for a third party marking its presence in the area of the chase.
- Handling a desired target, precisely.
- In the case of there is an attempt for manipulation with the system such as opening the box which includes the system or any component failure, a text message "Emergency case.." is sent at once, as feedback, to the Central Traffic Department to inform about that.
- It's found that use Arduino is more suitable of because it does not need a programmer device, which means easier and faster in programming, this makes it superior to the PIC microcontroller.

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