AUSTERE THEFT PREVENTION SYSTEM

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DECLARATION

I hereby declare that this thesis is based on the results found by myself. Materials of work found by other researcher are mentioned by reference. This thesis, neither in whole nor in part, has been previously submitted for any degree.

Signature of
Supervisor

Signature of
Author

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Lastly, the Department of Electronics and Communication Engineering deserves to be thanked for being behind the scene and selflessly guide and align our work till its completion.

ABSTRACT

Bangladesh is a third world country and the crime rate here is abominable. Plenty of car thefts are taking place every year and there needs to be a car Anti-theft system that can stop a car when the owner is alarmed that it is not in supervised possession. The device will also help to locate a rough position of the car anywhere in Bangladesh.

The device can aid the prevention of attempted crimes, such as committing armed robbery, hit and run, using a stolen car to transport illegal goods and of course stealing the car itself. About 1000 cars are being stolen in Bangladesh every year (source: DMP - internet). Plenty of attempts have been made to equip Bangladesh with anti-theft devices, many of which did not succeed because of the lack of existing resources for the implementation of innovative ideas, or the devices just failing to capture the market with their outrageous costs of installation and maintenance.

Our device attempts to gradually slow the car stolen car down and ultimately deactivate the power required to keep the car running. Hopefully this shall help eradicate cars being stolen and save Bangladesh enormous national revenue by curbing many crimes related.

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Chapter 1

1.1 Introduction And Motivation:

With the invention of automotive vehicles, mankind has witnessed the advent of a completely new era. But with it, the scope for crimes has increased as well. Especially in a country like Bangladesh, where most of the populace has to struggle to make ends meet, the increase in the rate of crimes is significant, particularly over the last decade.

A car is a valuable asset, both in terms of utility and status. A lot of people struggle for a long while until they can afford such a vehicle and yet, quite a few of them have to undergo the disappointment of losing it to the hands of thieves or robbers.

Security systems to prevent car theft, though available in the market, are extremely rare on the streets due to their high installation and subscription charges. These costs make it impossible for an average citizen of Bangladesh to equip their hard-earned vehicles with the necessary protection against such mishaps.

To overcome these problems, the idea of the Austere Theft Prevention System (henceforth referred to as ‘ATPS’) was borne. ATPS is an effective car security system that is efficient and economical at the same time (a combination that is rare). This device is essentially a remotely activated security system which not only relays the whereabouts of the car to the concerned authorities, but also halts the car physically and shuts it down on the spot.

Two of the highest priorities of a victim of car theft are that

i) he/she retrieves the car as soon as possible and
ii) he/she retrieves it as unscathed as possible.

Our device comfortably fulfils both these priorities as the car location would be uncovered as soon as the device is activated and is physically halted to prevent any harm to the car or innocent pedestrians nearby. The alarm systems also activate which will make it virtually impossible for the thief to stay near the stolen vehicle in order for him to avoid capture.

Chapter 2

2.1 Project Overview:

The defining feature of our device is that it can be activated from any remote location. We aim to do this by making use of mobile communication technology. Our device will consist of a cell phone, embedded in the car, which is connected to a microcontroller. From this microcontroller, the device will manipulate two major systems in the car to immobilize it; the braking system and the ignition system. Firstly the microcontroller will send out a signal to an audio system that will give an audible warning to the driver of the car, and then another signal will be sent to the headlamps that will cause them to blink continuously. After the warnings have been given, the braking module (installed with the device) will be activated which will automatically make the car brake over a period of maximum 3 minutes. Considering the car is stopped after 3 minutes of calling on the phone, the microcontroller will cut off the ignition via a relay installed in the ignition circuitry of the car. This entire process is illustrated in the diagram.

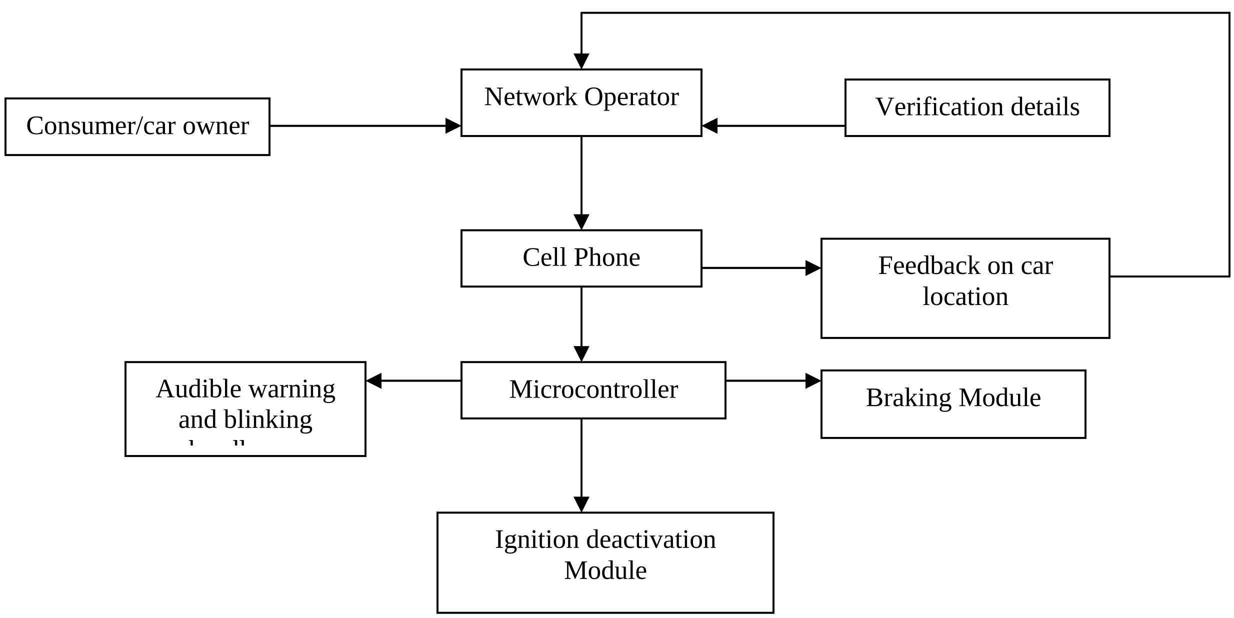

Fig 1: Data Flow Diagram for the project

2.2 The Car

The car is defined as a motor vehicle with four wheels; usually propelled by an internal combustion engine [1]. In the engine, fuel and air is combined and ignited to produce energy in the appropriate form for the automotive vehicle to run. This vehicle is a combination of multiple systems working simultaneously to function. There is the engine, the ignition system, the cooling system, the steering system, the braking system and many more. However, only the ignition system and the braking system would be elaborated upon for purposes of this thesis.

2.21 The Ignition System

The ignition system would have to work in perfect synchronization with the engine; the goal is to ignite the fuel at exactly the right time so that expanding gases can do the maximum amount of work. If the timing is not right, then it will lead to power failure, excess gas consumption and increase in the level of emissions.

One important component of the ignition system is the spark plug. The spark plug forces electricity to jump across a space.

The voltage of this spark varies between 40,000 volts to 100,000 volts. For such a high voltage to travel down to the *electrode* an insulated passageway is required. From the electrode, the spark jumps the gap into the engine block and gets grounded.

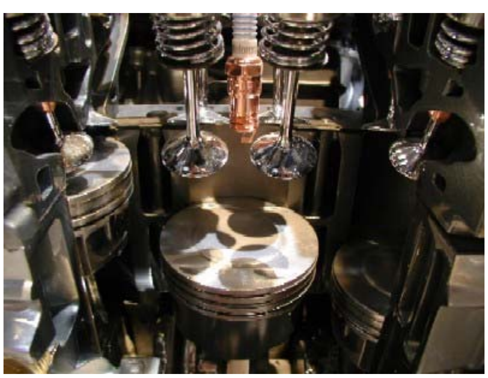

Fig 2: External view of spark plug

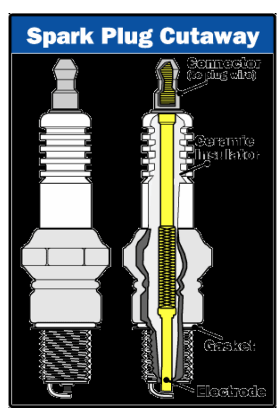

Fig 3: The spark plug

This spark or voltage is generated by the *coil* which is essentially a high voltage transformer made up of two coils of wire and it receives the current from the car battery.

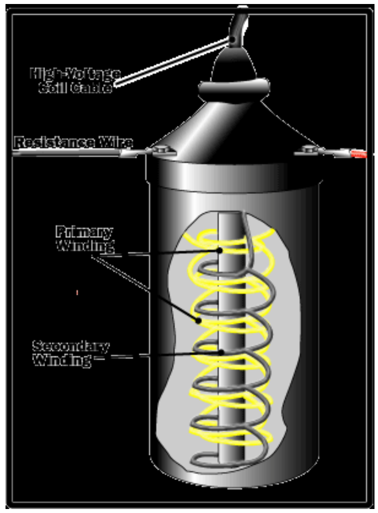

Fig 4: The Ignition Coil

The *distributor* then distributes the high voltage from the coil to the right cylinder. The **cap** and **rotor** does this. The coil is connected to the rotor, which spins inside the distributor cap. The rotor spins past a series of contacts, one contact per cylinder. As the tip of the rotor passes each contact, a high-voltage pulse comes from the coil. The pulse arcs across the small gap between the rotor and the contact and then continues down the spark-plug wire to the spark plug on the appropriate cylinder. [2]

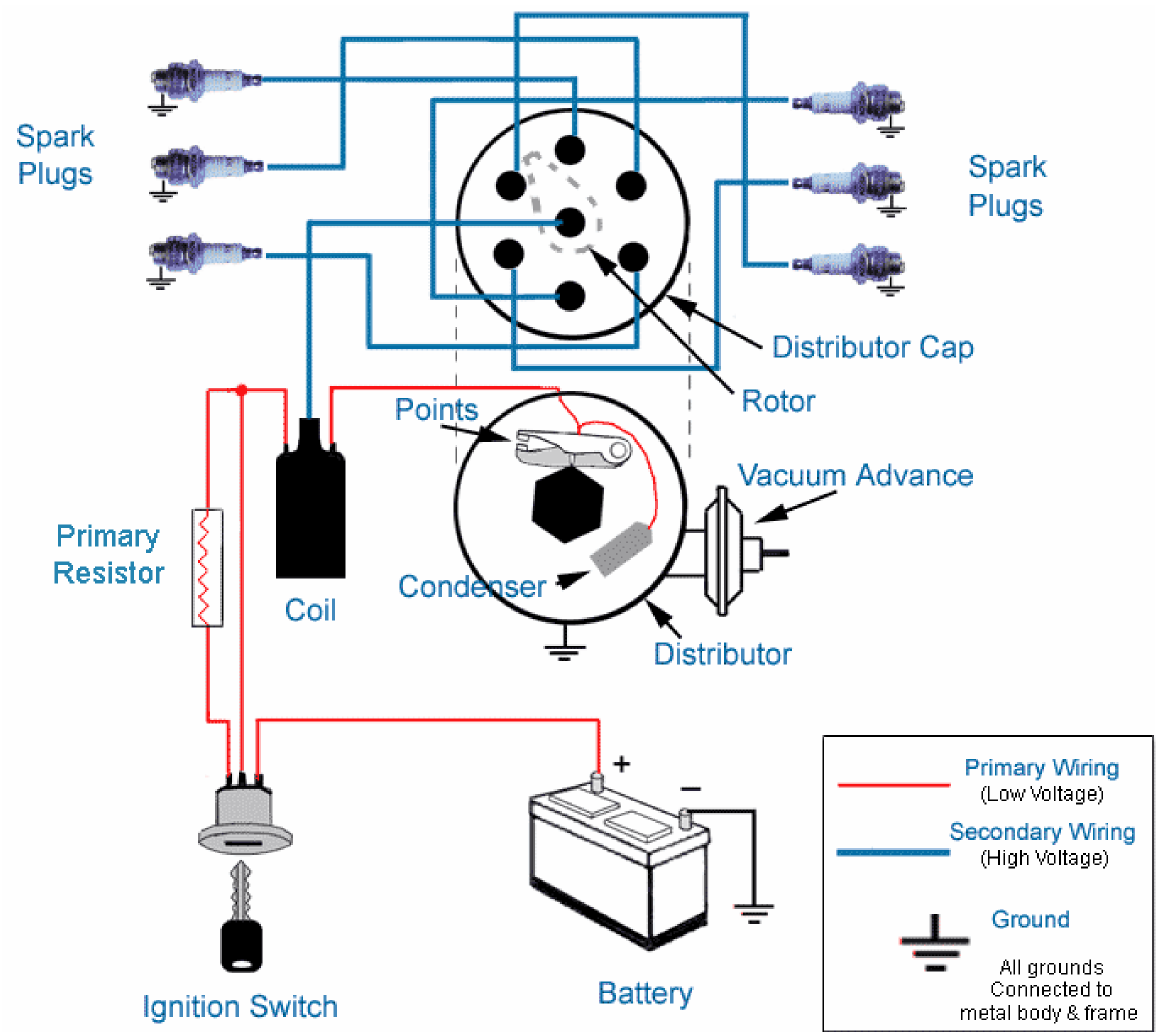

Fig 5: The Ignition System Diagram

This is a diagrammatic representation of the complete ignition system.

2.22 The Braking System

The braking system is another complex yet crucial part of the automotive system. For purposes of this thesis, the explanation is limited to the mechanical and spatial aspects of the brakes.

The most critical function of the brakes is to multiply the force exerted by the leg on the brake pedal sufficiently to oppose the significant force of the car and hence, slow it down or stop it.

This is achieved in two ways; a mechanical advantage due to leverage and force multiplication by a hydraulic system. [3]

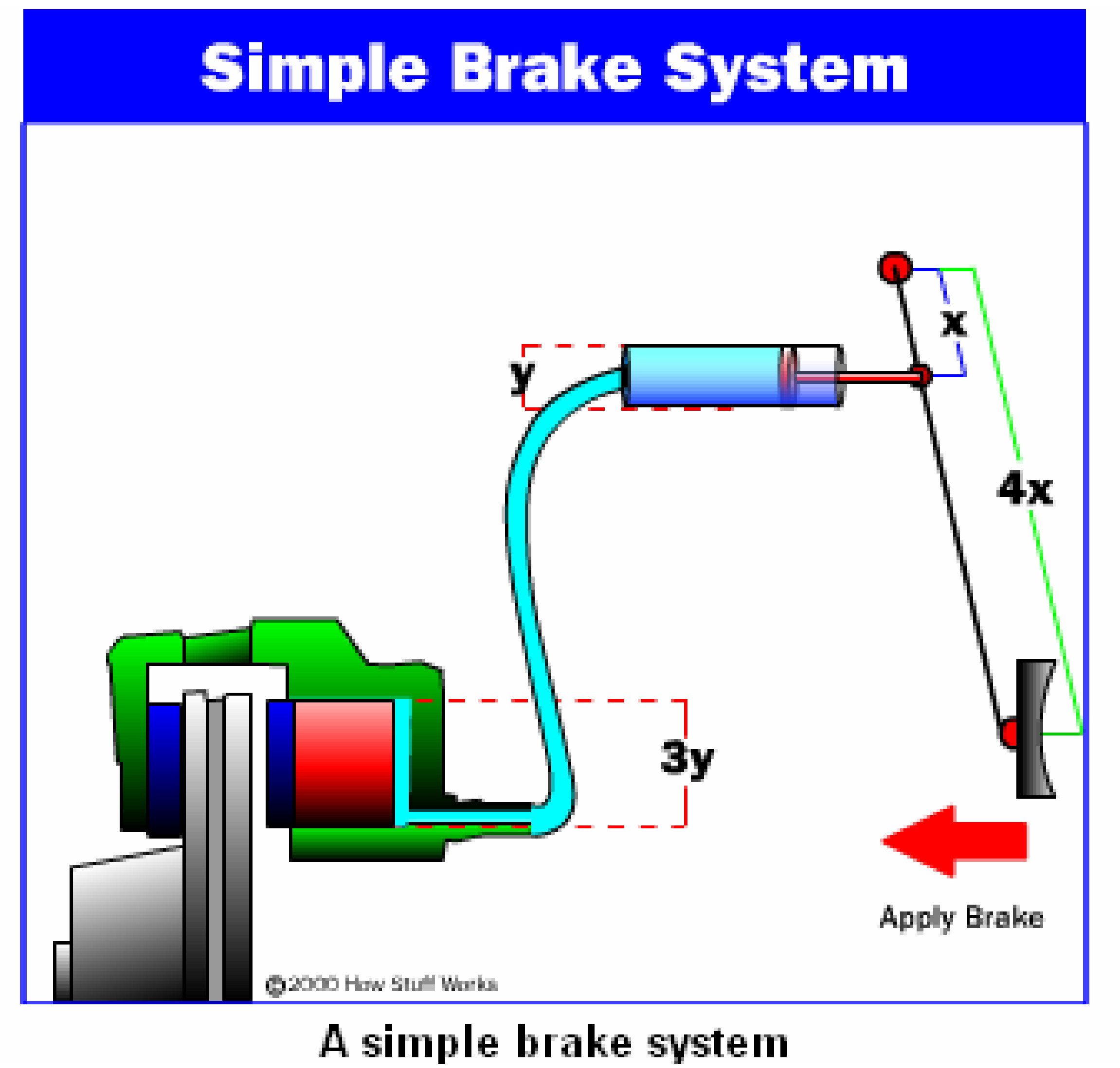

Fig 6

The above diagram shows the external brakes in a simplified manner. Due to the leverage, there is a significant mechanical advantage that allows magnifying the force applied on the pedal by the leg considerably.

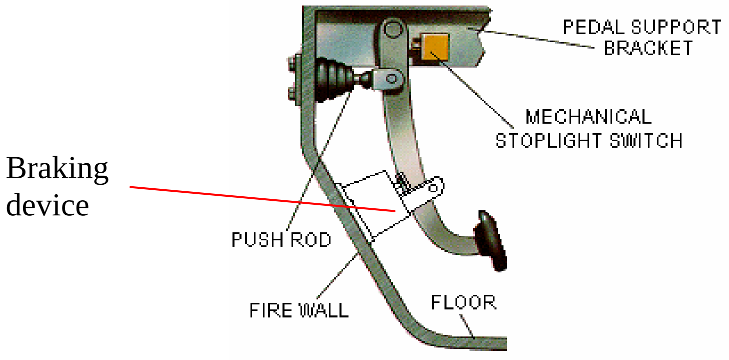

Fig 7: Side view of the brake pedal

From this diagram, we can estimate that for the car to stop completely, the shaft should move approximately an inch.

Chapter 3

3.1 Austere Theft Prevention System:

The device that we intend to create is a set of electromechanical equipments designed to take over the control of some peripherals of the car as mentioned in the previous chapter.

ATPS has the following components:

1. Cell phone
2. Main circuit
3. Braking module
4. External Audio-Visual alarm
5. Internal Alarm

The above mentioned have their unique features and are discussed in details later in this chapter.

The cell phone was acquired and a pair of wires was connected to the vibration motor input while the motor was removed. This enabled us to receive a short pulse of around 3.5V and some mA of current. The primary pulse is taken to be the input of our whole system.

Fig 8: Cell phone

3.2 The Main Circuit and its Components:

The **main circuit** has been developed on a bread board with a microcontroller named ATMEGA32 mounted. Along with the microcontroller are the Darlington pairs and the relays. The purpose of the ATMEGA32 is to store the instructions and operate as programmed.

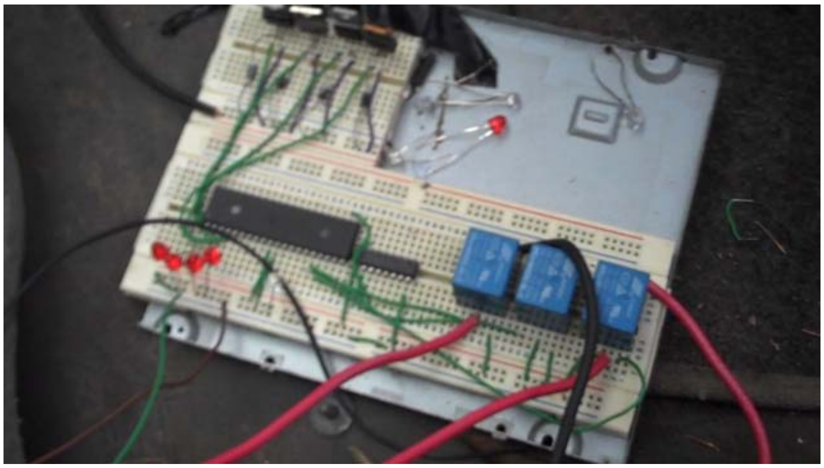

Fig 9: Main Circuit

The ATMEGA32 looks like this from the top and the pin orientation are shown below. The pin configuration is an important factor because the programming must be done according to the designated input and output pins.

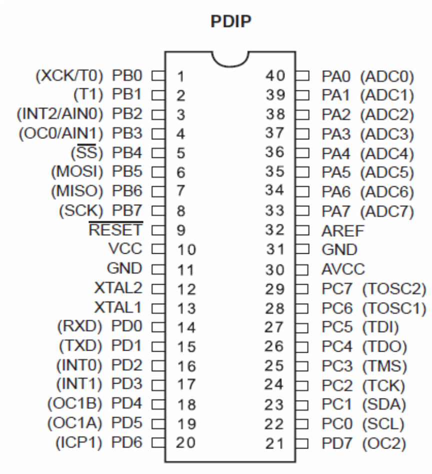

Fig 10: The ATMEGA32

3.3 The Microcontroller, ATMEGA32:

Features:

• High-performance, Low-power AVR 8-bit Microcontroller

• Advanced RISC Architecture

  – 131 Powerful Instructions – Most Single-clock Cycle Execution

  – 32 x 8 General Purpose Working Registers

  – Fully Static Operation

  – Up to 16 MIPS Throughput at 16 MHz

  – On-chip 2-cycle Multiplier

• High Endurance Non-volatile Memory segments

  – 32K Bytes of In-System Self-programmable Flash program memory

  – 1024 Bytes EEPROM

  – 2K Byte Internal SRAM

  – Write/Erase Cycles: 10,000 Flash/100,000 EEPROM

  – Data retention: 20 years at 85°C/100 years at 25°C(1)

  – Optional Boot Code Section with Independent Lock Bits

  In-System Programming by On-chip Boot Program

  True Read-While-Write Operation

  – Programming Lock for Software Security

• JTAG (IEEE std. 1149.1 Compliant) Interface

  – Boundary-scan Capabilities According to the JTAG Standard

  – Extensive On-chip Debug Support

  – Programming of Flash, EEPROM, Fuses, and Lock Bits through the JTAG Interface

• Peripheral Features

  – Two 8-bit Timer/Counters with Separate Prescalers and Compare Modes

  – One 16-bit Timer/Counter with Separate Prescaler, Compare Mode, and Capture Mode

  – Real Time Counter with Separate Oscillator

– Four PWM Channels

– 8-channel, 10-bit ADC

8 Single-ended Channels

7 Differential Channels in TQFP Package Only

2 Differential Channels with Programmable Gain at 1x, 10x, or 200x

– Byte-oriented Two-wire Serial Interface

– Programmable Serial USART

– Master/Slave SPI Serial Interface

– Programmable Watchdog Timer with Separate On-chip Oscillator

– On-chip Analog Comparator

• Special Microcontroller Features

– Power-on Reset and Programmable Brown-out Detection

– Internal Calibrated RC Oscillator

– External and Internal Interrupt Sources

– Six Sleep Modes: Idle, ADC Noise Reduction, Power-save, Power-down, Standby and Extended Standby

• I/O and Packages

– 32 Programmable I/O Lines

– 40-pin PDIP, 44-lead TQFP, and 44-pad QFN/MLF

• Operating Voltages

– 2.7 - 5.5V for ATmega32L

– 4.5 - 5.5V for ATmega32

• Speed Grades

– 0 - 8 MHz for ATmega32L

– 0 - 16 MHz for ATmega32

• Power Consumption at 1 MHz, 3V, 25°C for ATmega32L

– Active: 1.1 mA

– Idle Mode: 0.35 mA

– Power-down Mode: < 1 µA

The ATmega32 is a low-power CMOS 8-bit microcontroller based on the AVR enhanced RISC architecture. By executing powerful instructions in a single clock cycle, the ATmega32 achieves throughputs approaching 1 MIPS per MHz allowing the system to optimize power consumption versus processing speed.

3.4 The Downloader:

The **Downloader** is a device through which all the required instructions are downloaded to the microcontroller for it to function as desired.

We acquired a downloader circuit (previously designed) which will be used to convey instructions (written in C programming language) to the ATMEGA32 microcontroller and thus run the entire device.

Fig 11: The downloader Circuit

3.5 The Driver Component on the Main Circuit:

The Darlington Pair Transistors used in the **Main Circuit** is for the purpose of amplifying the current given out by the ATMEGA32 which helps drive the stepper motor. As can be seen in the figure below there are Darlington Pairs (TIP122). These were used for current amplification for the stepper motor used in the braking system. The current that the ATMEGA gives out is insufficient to drive the stepper motor.

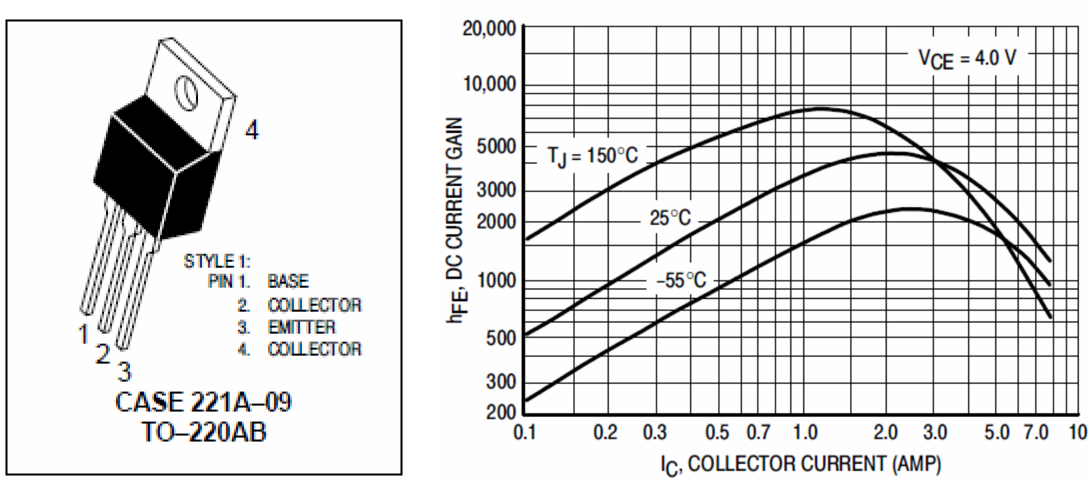

Fig 12: Transistor

Some useful characteristics of these transistors are:

• High DC Current Gain —

hFE = 2500 (Typ) @ IC

= 4.0 Adc

• Collector–Emitter Sustaining Voltage — @ 100 mAdc

VCEO(sus) = 100 Vdc (Min) — TIP122, TIP127

• Low Collector–Emitter Saturation Voltage —

VCE(sat) = 2.0 Vdc (Max) @ IC = 3.0 Adc

= 4.0 Vdc (Max) @ IC = 5.0 Adc

• Monolithic Construction with Built–In Base–Emitter Shunt Resistors

3.6 The Relays:

The purpose of the Relays in the Main Circuit was to work as switches between the ATMEGA32 and the car environment. Since the microcontroller does not handle a high current to drive heavy-load components such as the car horn, the head lamps and the engine coil made the use of relays necessary. The controls to the head-lamps from the microcontroller are interfaced through the relays from pins 14, 15, 16 in port D.

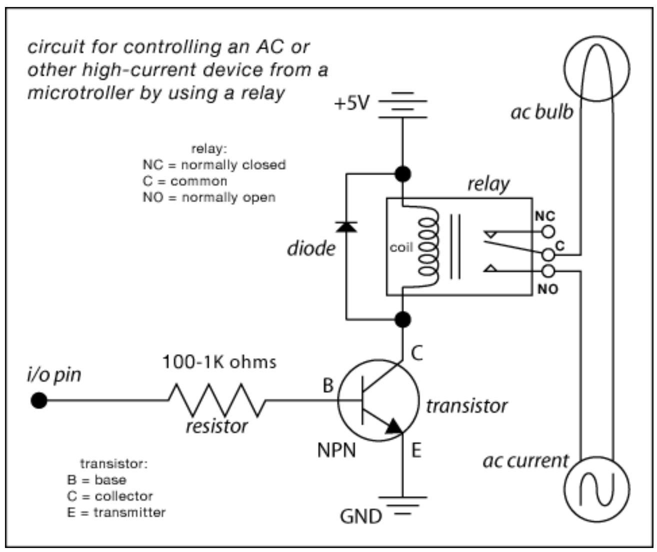

Fig 13: Relay

3.7 The Braking Module:

The braking module is the most unique aspect of ATPS. It is a separate device created using the VEXTA stepper motor mounted on a steel base and the rotor is welded with a slider and a pulley at the head. This device is set at the base of the brake pedal and the brake shaft is placed at the gap beside the arm of the slider. The picture is given below:

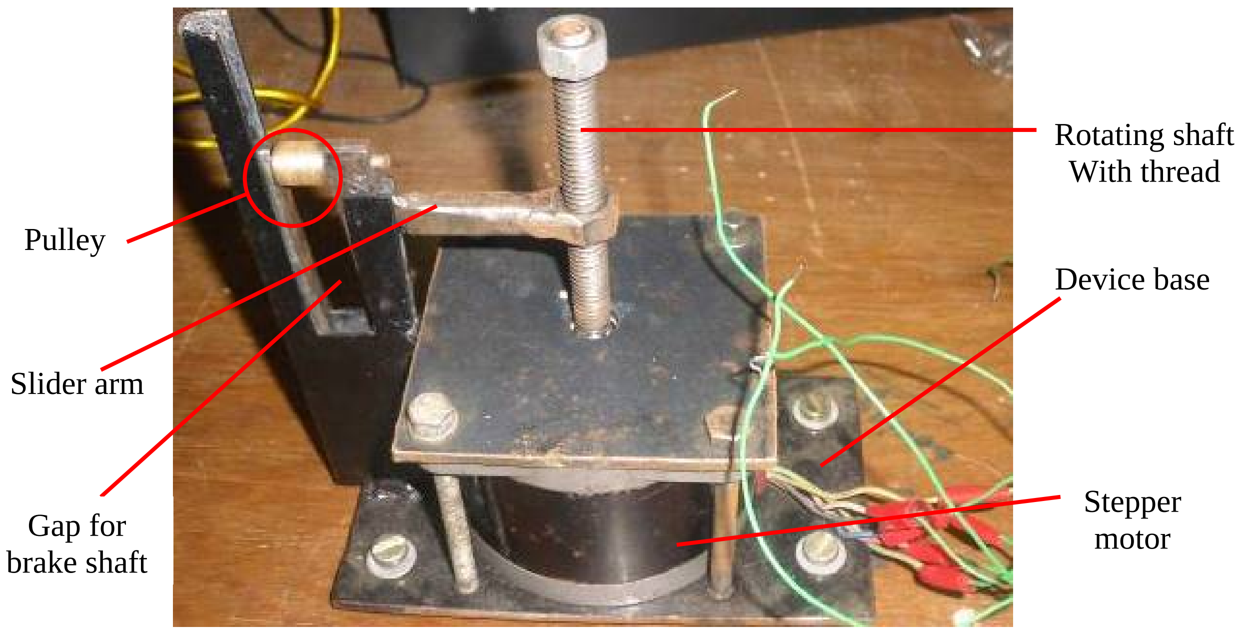

Fig 14: Braking Device

A relation was set up between the rotating shaft and vertical displacement of the Slider.

- The Rotating shaft has 44 turns in total and is 80mm vertically end to end
- 80mm/44turns=1.81mm vertical slider displacement per turn
- Shaft radius is 4.5mm
- This gives us 28.27mm travel in one rotation
- So motor rotates 28.27mm to bring brake shaft 1.81mm downwards
- Given motor torque is 174oz-in or 123N-cm

- Established gear ratio is 15.62, or about 1:16 (mechanical advantage achieved)

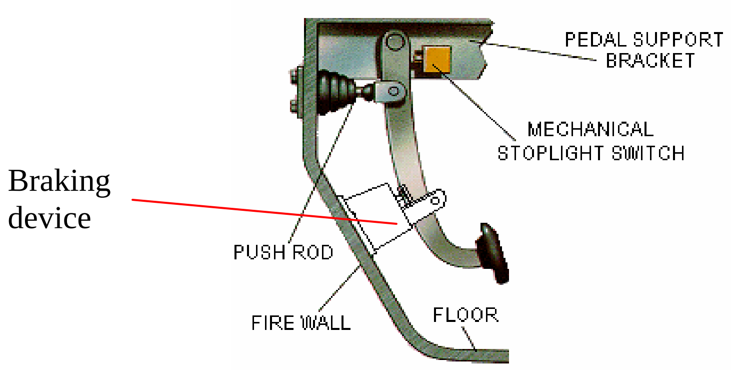

Fig 15: Mounting of the braking device

3.8 The External Audio-Visual Alarm:

Apart from successfully immobilizing the car, which is the chief purpose, our device also sends out an audio-visual alarm to alert those nearby that the car is in the wrong hands. After the device has braked successfully, the microcontroller sends two simultaneous signals to the car headlamps and the horn which starts functioning continuously at small intervals. This will attract a lot of attention and may ultimately force the car thief to leave the car, out of nervousness or otherwise.

The signals for the horn and the headlamps are configured to be received from the 15^{th} and the 16^{th} pin of the microcontroller respectively. The microcontroller is programmed to send out pulses continuously to make the horn honk and the headlamps blink accordingly.

3.9 The Internal Alarm (VP1000A):

The Voice Alarm was designed to contain a Digital Sound Processor chip known as the VP1000A. The acquisition of the chip was difficult due to its high cost and unavailability. However, with the chip and the rest of the circuit components in our hands, it would be simple to make an audio announcement inside the car so that the passengers are alerted of the presence of the system and its state of taking over specific controls of the car. The time allocated for the pre-recorded voice signal as shown in the timeline figure is 20 seconds. Within this time either the driver of the stolen car decides to pull over, or wait for a surprise. Although we could not make the VP1000A available in our project, here are some descriptions including circuit configurations that we have collected from the data sheet.

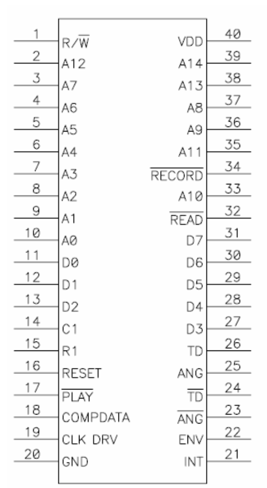

Fig 16: The VP1000A pin configuration

Features:

- High quality voice & sound generation
- Record & playback with external SRAM
- Playback-only with external EPROM or ROM
- Stand-alone operation
- 32K x 8 direct memory addressing, expandable
- Single 5V DC supply voltage
- Low power consumption
- Continuous Variable Slope Delta (CVSD) modulation
- Sampling rate from 24Kbps to 128 Kbps

- Message digitization with the VP-880 or the VW-1000A
- Pin to pin compatible with UM5100
- 40-pin DIP (VP-1000A) or 48-pin QFP (VP-1000AF)

3.91 General Descriptions:

The VP-1000A is an advanced CMOS LSI chip for general purpose voice/sound record and playback applications. It can be interfaced with external SRAM to construct a real time recording circuitry, or with external ROM or EPROM for playback only applications. When ROM or EPROM is used, the sound must be digitized by using Eletech's VP-880 Voice Development System or VW- 1000A Voice EPROM Writer.

The VP-1000A is totally self-contained. It can access the external memory all by itself without the help from any microprocessor. Although the chip provides only 15 address lines, an external counter can be easily added to extend the memory addressing to virtually no limitation. Therefore very long message length can be achieved easily. Overall, the VP-1000A offers high voice quality and flexible memory addressing that no other chips can.

3.92 Applications:

- Voice memo recorder
- Sound effects generator
- Digital announcer for consumer, industrial, security and telecommunication products [4]

Chapter 4

4.1 How the Device Works:

Altogether, the microcontroller does a nice job accumulating the instructions and getting all the individual components to work together. The programmed operation sequence is shown hereby:

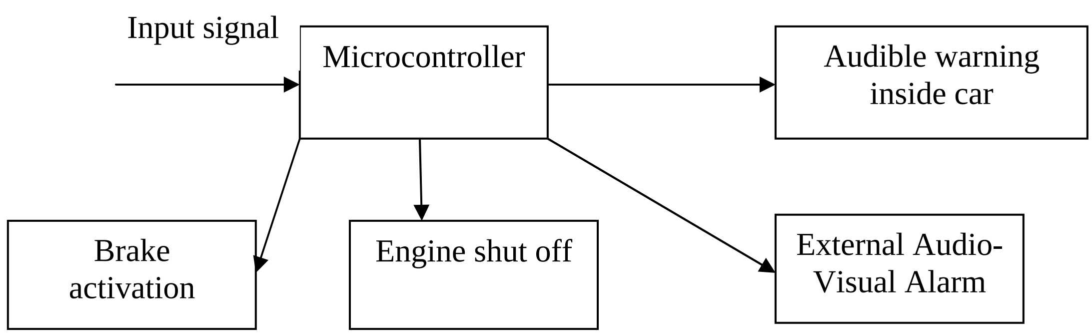

Fig 17: Simplified diagram representing operations

These orders are executed in steps that can also be demonstrated in a timeline for clear understanding.

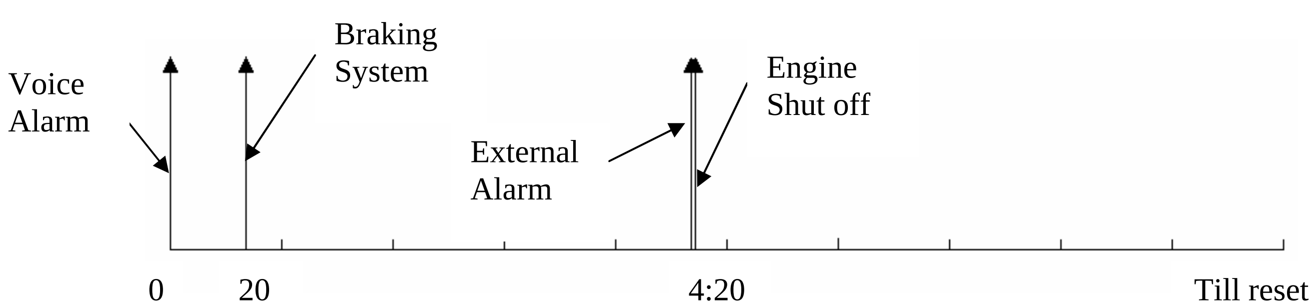

Fig 18: Timeline

As an explanation to the timeline figure given above, it can be said that from the moment the cell phone receives a call, it triggers a pulse to the microcontroller which the microcontroller takes as the "operation order". As soon as the microcontroller receives the pulse it activates the Voice Alarm which we have not succeeded in completing yet.

Chapter 5

5.1 Practical Implementation:

The entire prototype was installed in the car successfully with the main components working satisfactorily. With a few exceptions, the device gave expected results. Starting from the microcontroller delivering appropriate signals to the components, the braking system and the external alarms are working as desired.

The braking module was installed, but a little lower towards the pedal. The main circuit had its VCC taken from an adapter extracted from a broken down printer. This adaptor has two outputs: 5V and 24V. Accordingly, the GND to the power was fed back to the adapter.

The stepper motor rates 5V and 1.25A but it is known that these motors can be overdriven with voltages multiple times higher than they rate. Therefore we hooked up the motor with a 12V and 1A adapter. This showed no signs of damage or heating up of the adapter and leading to lower current supply.

The stepper motor phases were not connected directly to the microcontroller. The signals needed amplification and thus they were put through Darlington pair transistors via diodes.

The relays took their driving pulses from the microcontroller and the inputs were connected to the car battery +ve terminal. The other ends of the relays were connected to individual Normally Open terminals. These connected back to the equipments desired to run. Their GNDs went to the battery –ve.

Although initially the relays were meant to interrupt the GNDs of the headlamps and the horn, we had to make changes because once the battery GND was connected to the car, the horn kept blowing automatically as it already received GND from the car body. So instead we decided the relays to interrupt the live connections of the headlamps and the horn.

Chapter 6

6.1 Limitations:

We failed to implement three major aspects of our device. They are:

1. Activation of the device through the embedded cell phone

   The cell phone was meant to be the prime source for activating the microcontroller. However, due to the low Voltage signal generated by it through pulses and unknown dysfunctions of the microcontroller through mismatching signal levels, the remote signal was not brought to be the source of activation. Still, we had tried to adjust and compensate the 3.5V output of the cell phone by amplifying the voltage but ultimately the microcontroller dysfunctions predominated. Effort has been employed at trying to overcome such hurdles through the installation of logic gates in order to manipulate the input signal. This attempt also failed as the first input to the microcontroller could be set to be GND only, not HIGH as expected. The microcontroller assumes a HIGH input automatically without any external pulse. So an independent signal could not trigger the microcontroller, resulting in the microcontroller functioning on its own.

2. Audible warning through voice processor VP1000A

   The lack of availability of this chip and alternatives was the prime cause for us not being able to touch on this area of our project. We even checked online and at all the local electrical component outlets in vain. Importing the chip was not an impossibility but the cost involved was enormous as these chips are only shipped in bulk quantities.

3. Operation of the Engine Relay

Practically implementing this aspect of the device was not possible as it would require a permanent alteration of the engine circuitry and the car available was not open to such changes.

Chapter 7

7.1 Conclusion:

The primary objective was to design a car security system that would be easily available and affordable, without any compromise on efficiency and reliability. This objective has been achieved to a significant degree as the total cost of the components and services are well within an affordable range. During the period of this thesis, the main aim was the completion of the circuitry installed within the car to manipulate the required functions. This aim was realized to a great degree with only a few sections incomplete, the reasons for which have already been explained.

7.2 Future Work:

The first clear priority is to overcome the limitations that were faced during the thesis. The next step is to integrate this device with the telephone network and reach a reasonable agreement in terms of cost. With further research the design will be altered to make the circuit interactions within the car entirely wireless to prevent any external threat to the system, keeping the cost as low as possible of course. After these things have been established steps will be taken to eventually give this device a commercial shape for it to achieve its ultimate purpose: an economical and reliable solution against car theft.

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[2] http://www.howstuffworks.com/ignition-system.htm

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[4] www.datasheetcatalog.com

[5] http://interactive.usc.edu/members/phoberman/relayCircuit.gif

APPENDICEX

```
//INPUT is PORTB's PIN0 and PIN1
//PIN0 is the input
//PIN1 is the reset

//OUTPUTS are PORTC and PORTD
//PORTC is the stepper motor output(PIN0,PIN1,PIN2,PIN3)
//PORTD is the voice,light and horn output (PIN0=voice,PIN1 and PIN2 are
//Light and horn


//SYSTEM SPECIFICATION
//WHEN PIN0 of PORTB recieves input, it will sent a pulse with a duration
//of 20s to PORTD's PIN0
//Then the stepper motor will continue to run for 3 min(PORTC)
//finally light and horn will blink with a interval of .5s till reset is
//active


#define F_CPU 8000000UL  // 1 MHz




#include <util/delay.h>
#include <avr/io.h>

//Delay macro function
void delay_ms(unsigned int ms){

   while(ms){
```

```
            _delay_ms(1.000);
            ms--;
            }
}



//main programme
int main()
{

        DDRB=0b11111111; //OUTPUT PORT

    unsigned int i=0;
        DDRC=0x00;//INPUT PORT


        DDRD=0b11111111;        //OUTPUT PORT



                if(!(PINC & (1<<PC0)))//WAITING FOR PC0 TO BE HIGH
                {
                        PORTD=0x01;//VOICE WARNING TRIGGERED
                        delay_ms(20000); //delay 20 seconds
                        PORTD=0x00;//VOICE WARNING TRIGGER STOP

                        for(i=0;i<500;i=i+1)
                        {

                                PORTB=0b00000001;
                                delay_ms(150);
```

```
				PORTB=0b00000010;
				delay_ms(150);
				PORTB=0b00000100;
				delay_ms(150);
				PORTB=0b00001000;
				delay_ms(150);//stepper works for 300s=5min

			}

			PORTB=0b00000000;
		}

	while(1)

		{
		if(!(PINC & (1<<PC0))){
			PORTD=0b00001110;
			delay_ms(500);
			PORTD=0b00001000;
			delay_ms(500);
			}
		}
	return 0;
}
```