Immobilizer Compact System (ICS) Using Microcontroller-Based GPS-GSM Module

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Abstract: - This study developed an Immobilizer Compact System (ICS) using the Microcontroller-based GPS-GSM Module to contribute to the community, particularly those who own a vehicle, in protection of their possessions. The concept of the Input-Process-Output (IPO) model was applied in this study. The research findings are summarized as follows: 1. the Immobilizer Compact System (ICS) using a Microcontroller-based GPS-GSM Module goes through collecting data, followed by the actual construction of the device based on the required materials, hardware, and software; 2. the researchers evaluate the technical features of the Immobilizer Compact System (ICS) based on some ISO 25010 standards in terms of its functionality, reliability, efficiency, and security; 3. the developed Immobilizer Compact System (ICS) was assess the level of effectiveness when implemented in its environment is determined by its operation and accuracy. The researchers gathered vehicle owners, industry experts, and PNP personnel. The overwhelming response of the respondents' study makes the developed device functional, reliable, efficient, and secure.

Key Words: —*Immobilizer Compact System (ICS), Microcontroller-based GPS-GSM Module, Security Device, Technology*.

I. INTRODUCTION

The advancement of technology has exceeded everyone's expectations. Perhaps it is true to believe that the heights of science have been reached in the present epoch.[1] Significant developments in wireless sensor networks, telecommunications, and informatics have enabled the realization of ubiquitous intelligence, which predicts the future Internet of Things technologies. Swift innovation around the globe has been driven by a universal aim—industrial technological development. Developing countries like the Philippines' have improved the quality of life of every citizen, particularly in terms of transportation and communication advancements. The majority of people in the present era celebrate the technological revolution due to the benefits it offers and the efficiency it provides in both industrial and educational domains.

Manuscript revised September 18, 2022; accepted September 19, 2022. Date of publication September 20, 2022.

This paper available online at www.ijprse.com

ISSN (Online): 2582-7898; SJIF: 5.59

Today's technical advancements have led to a steady increase in security. Several security methods have been created to reduce theft. Most commercial establishments have CCTV (closed-circuit television), which is very effective at deterring and solving crimes. Commercial establishments also use burglar alarms, which deter burglary theft by sounding a loud alarm; button alarms that instantly notify the closest police station that a crime has been attempted or is occurring; and many more.

The government has addressed security concerns to protect every citizen from vehicular crimes. The New Anti-Carnapping Act of 2016 under Republic Act No. 10883 is a law that punishes carnapping in the Philippines.[2] Hence, RA 10883 punishes the crime of carnapping which refers to the taking, with intent to gain, of a motor vehicle belonging to another without the latter's consent, or through violence against or intimidation of persons, or by using force upon things.[2] In line with this, individual rights as citizens are protected by laws, which guard against violations on the part of other people, groups, or even the government. Our laws also guarantee our general safety.

Safety measures have been strengthened and improved the quality of security in both public and private sectors. Based on the Senate's report from the Highway Patrol Group (HPG) of the Philippine National Police (PNP), motorcycle theft is one of

the most common obstacles in the country.[3] The Philippine National Police (PNP) has noticed a cyclical rise in the number of car and motorcycle theft occurrences around the country. Although the security of cars and motorcycles can be increased by requiring identification before starting them, there are still occasions when they are stolen. For instance, lifting a motorcycle off the ground and putting it in a vehicle is the most popular routine of motorcycle theft.[3] Accordingly, the theft of vehicles from public parking lots has become a security concern.[4] The PNP-HPG assures the people that they will continuously keep track of every carnapping occurrence countrywide.[5]

Furthermore, Sundari, Laxminarayana, and Laxmi highlighted that while everyone must utilize vehicles, safeguarding against theft is also essential.[6] Possibly, having an authentication security scheme might help to reduce vehicle theft. At present, there are many forms of authentication, including fingerprint, retinal, iris, and facial recognition, which are utilized to enhance security features on various devices. Perhaps, face recognition is one of the most sophisticated and secure security measures among those methods that have been developed for the moment.

An embedded system integrated with the Global Positioning System (GPS) and the Global System for Mobile Communication (GSM) is used to develop an effective automobile security system for anti-theft (GSM). According to Ndungu, the Global System for Mobile Communication (GSM) is a digital mobile network that is widely used by mobile phone users in Europe and other parts of the world.[7] With the help of technology utilizing FPGA-controlled GPS and GSM, the car's location may be determined. The Global Positioning System (GPS) is a system of satellites in orbit that communicates with receivers on Earth in order to provide exact information about their position in space. Indeed, during the Cold War's height, it was initially applied to military activities. The development of vehicle tracking systems began in the maritime sector.[8] Verma and Bhatia agreed that GPS is one of the technologies used in many different applications nowadays. [6] It is one of the programs that allows you to monitor and track your vehicle on a regular basis. According to Lappanitchayakul, the fascinating thing about GPS tracking devices is that they work on the idea of connecting to the cell phone network to transmit to the owner's phone, upon request, the GPS location of the vehicle in the event that it is stolen.[9] Castro also emphasizes the value of using GPS localizers in vehicle as a sensory tool for tracking the movements and activities of individuals.[10] This tracking device may show you the location and route taken by the car, and you can view that information from any other distant location. It also includes a web application that displays the precise location of the target. We can track targets with this technology in any kind of weather. GSM and GPS are both used in this system. The vehicle's position (latitude and longitude) is sent from a distant location using a GSM modem.[11] This system, which is intended for users in the land construction and transport industries, offers real-time information in an accessible format, such as the location, speed, and anticipated arrival time of the user's moving vehicles. The two points' communication procedures may benefit from using this approach as well. GPS vehicle tracking guarantees their security while traveling. This tracking system is installed in the client's vehicles as a theft prevention and recovery tool. In tandem with the stolen car's engine speed decreasing and being forced to idle, the vehicle owner or police follow the signal sent out by the tracking system to find the stolen vehicle. Without the password, the engine cannot be restarted after being turned off. This system, which was implemented for four-wheelers, is typically utilized by navy operators for routing, send-off, on-board information, and security. Thus, consumer vehicles now come with tracking systems as a theft deterrent and recovery tool. The technology may track the location of the vehicle and at the same time notify the owner through SMS if the theft occurs.

In response to this issue, researchers are working to create an Immobilizer Compact System (ICS) using the Global Positioning System (GPS)—Global System for Mobile Communication (GSM) Module to help vehicle owners protect their vehicles when they're not using them or in the event that they are stolen. Additionally, the research intends to investigate its potential commercialization.

II. RESEARCH METHODOLOGY

A developmental research approach was used in this study. Developmental research scenarios include the evaluation of the final product as well as the analysis and description of the product-development process.[12] The Immobilizer Compact System (ICS) using the Microcontroller-based GPS-GSM Module is the development product in this study.

Fifty (50) respondents evaluated the Immobilizer Compact System (ICS). The distribution was as follows: ten (10) PNP personnel, ten (10) industry experts, and thirty (30) vehicle owners in the municipalities of Santa Rosa, Talavera, and the City of Cabanatuan, Nueva Ecija, Philippines.

The questionnaire was used to evaluate the Immobilizer Compact System (ICS) as to its functional suitability, reliability, performance efficiency, and security. A number of interviews and discussions were conducted to ensure that the items in the questionnaires were valid and reliable. The experts demonstrated the validity and suitability of the instrument for use in the study. The reliability coefficient was calculated using Cronbach's alpha to assess the item's internal consistency. The test's dependability is demonstrated by the fact that both the first and second time it was administered, the score was 0.76, which is considered moderately high.

III. Results And Discussion

This study utilized a Microcontroller-based GPS-GSM module to build an Immobilizer Compact System (ICS), adhering to the Input-Process-Output (IPO) Model concept.

1.1 Gathering of data

Data collection for the study is done in two stages by the researchers. The initial phase was the development stage, which started when the researchers investigated and planned the various characteristics and features of the Immobilizer Compact System (ICS) that would form the basis for the creation of its prototype. The design of the device was built on the results of this study. This was connected to the steps of planning and designing the research. The actual construction of the prototype is done during the study's assembly phase, and the Immobilizer Compact System (ICS) is tested in its intended environment. Second, the evaluation phase started when the researcher's requested comments from the study's respondents, which included vehicle owners, industry experts, and PNP personnel. The information gathered during this phase was statistically handled and examined. Following a summary and evaluation of the data, recommendations and recommendations for further research were made.

1.2 Analysis of data

Data analysis, according to Calzon, is the procedure of collecting, modeling, and evaluating data with the goal of generating insights that support decision-making.[13] In this study, prescriptive analysis was used. A plan of action is typically developed for the firm to solve the issue or decision using the knowledge gained from the previous three forms of data analysis (descriptive, diagnostic, and predictive). A conclusion has been made after carefully examining the information regarding the design of the Immobilizer Compact System (ICS).

The researchers' layout includes the device's circuit layout and the various components that will be required for its construction. Then they noted the equipment, supplies, and tools that were close at hand that would help them create the Immobilizer Compact System (ICS) using the GPS-GSM module.

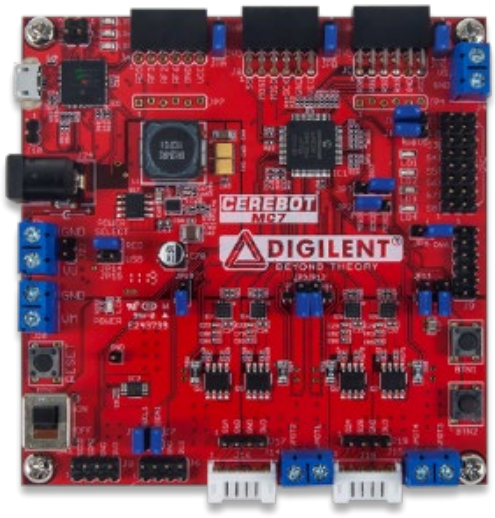
1.3 Design

The Immobilizer Compact System (ICS) overall design takes into account its physical components, or hardware, the software required to program the system, or software, and the project cost.

1.3.1 Hardware

Electrical components, a **Cerebot MC7** board, a vehicle anti-theft alarm, a sim card, and 18 gauge automotive cables make up the hardware of the immobilizer compact system (ICS). Some of the materials utilized during the assembly are shown in Table 1.

Table.1. Hardware Specifications/Descriptions.



The *Cerebot MC7* specifications are the following:

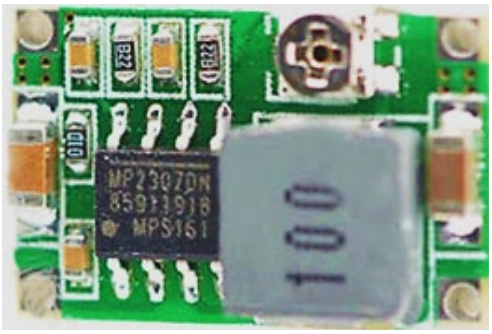
- Integrated programming/debugging circuit
- 16 10-bit analog inputs
- One CAN network interface
- 256Kbit I2C EEPROM
- 8 16-bit timer/counters
- 8 input capture units
- 4 SPI Channels
- 5 I2C connectors

The *Sim 800L GSM module* specifications are the following:

- Supply voltage: 3.8V - 4.2V
- Recommended supply voltage: 4V
- Power consumption:
  - sleep mode < 2.0mA
  - idle mode < 7.0mA
  - GSM transmission (avg): 350 mA
  - GSM transmission (peek): 2000mA
- Module size: 25 x 23 mm
- Interface: UART (max. 2.8V) and AT commands
- SIM card socket: microSIM (bottom side)
- Supported frequencies: Quad Band (850 / 950 / 1800 /1900 MHz)
- Antenna connector: IPX
- Status signaling: LED
- Working temperature range: -40 do + 85 ° C

The *GPS Module NEO-6M 3V-5V Universal Power Supply with Antenna* specifications are the following:

- This module has an external antenna and built-in EEPROM.
- Interface: RS232 TTL
- Power supply: 3V to 5V
- Default baudrate: 9600 bps
- Works with standard NMEA sentences



The *DC-DC 3.3V 5V 9V 12V 3A Adjustable Buck Down Voltage Regulator Power Module* specification are the following:

- Adjustable output voltage
- Input: DC 4.75V-23V
- Output: DC 1.0V-17V
- Intelligent Buck Regulator Chip

The *Smart SIM Card 5G* specification are the following:

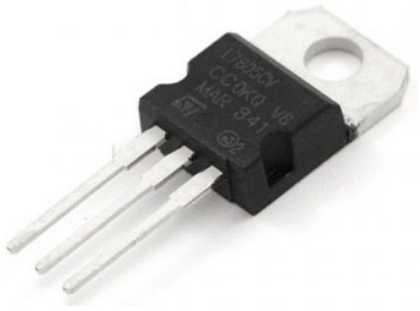
- SIM Format: Regular, Micro, Nano
- SIM Network: 5G, 4G/LTE, 3G, 2G

The *18 Gauge Automotive Wire* specification are the following:

- PVC Insulation resists abrasion, grease, oil, and acids.
- For general purpose wiring of automobiles, boats, RV's, and other general purpose low voltage electrical circuits.
- Temperature rated to 176°F (80°C).
- RoHS compliant and meets SAE J1128.
- Copper core is made from 16 strands of 30 gauge pure copper.
- Nominal outside diameter is 0.095".

The *Vehicle Anti-Theft Alarm Remote Control Engine Starter* specification are the following:

- Color: black
- Material: Anti-lock Braking System
- Size: 20.5*11.5*4cm
- Working voltage: DC 12V
- Speaker volume: 125dB



The *Transistor 7805* specification are the following:

- Pin 1 is the INPUT Pin. A positive unregulated voltage is given as input to this pin.
- Pin 2 is the GROUND Pin. It is common to both Input and Output.
- Pin 3 is the OUTPUT Pin. The output regulated 5V is taken at this pin of the IC.

The descriptions of *100uf and 10uf Capacitors* are great transient/surge suppressors. Attach one between the power and ground of your project to ensure smooth power delivery. High quality radial electrolytic capacitors.

1.3.2 Software

For their programming environment, the researchers used the MPLAB Integrated Development Environment (IDE). The MPLAB (IDE) Software comes with a text editor for writing code, a message box, a text console, a toolbar with buttons for basic tasks, and a number of menus.[14] Additionally, the application is cross-platform and was created using C and C++ functions. Utilizing third-party cores, the researchers created programs in the MPLAB (IDE) and uploaded them to the Cerebot MC7 developmental board.

1.3.3 Cost benefit analysis

Researchers took into account all possible factors to make the Immobilizer Compact System (ICS) less expensive than the current security measures. The use of pre-existing materials allows researchers to make some financial savings. The project's entire cost is displayed in Table 2.

Table.2. Bill of Materials of the Immobilizer Compact System (ICS)

Quantity	**Unit**	**Materials**	**Price**
1	piece	Smart SIM Card 5G	₱40.00

1	piece	Sim 800L gsm module	₱340.00
1	set	Cerebot MC7	₱1200.00
1	set	Motorcycle Anti- Theft Alarm Remote Control Engine Starter	₱600.00
1	piece	DC-DC 3.3V 5V 9V 12V 3A Adjustable Buck Down Voltage Regulator Power Module	₱400.00
1	piece	Transistor 7805	₱40.00
1	piece	Capacitor 100 µf	₱30.00
1	piece	Capacitor 10 µf	₱20.00
2	meter	Wires	₱20.00
		Total	**₱2,690.00**

1.4 Execution

Everything began with planning and progressed through designing and assembly. The study's implementation is the final stage of the immobilizer compact system's (ICS) development. It is now that the researchers have incorporated the created technology into its intended setting. For the immobilizer compact system (ICS) to operate without dropping, breaking, or being damaged, it must be positioned correctly inside the engine compartment. Figure 1 illustrates how the designed immobilizer compact system (ICS) was installed and tested by the researchers.

Fig.1. The actual installation of the developed Immobilizer Compact System (ICS) using the GPS-GSM module

1.5 Improvisation

When the researchers carefully planned the intended design of the immobilizer compact system, the study's improvisation started. The researchers designed the device's schematic diagram. The immobilizer compact system (ICS) will be put together using the blueprint as a guide. Additionally, the buck converter receives current from the vehicle's 12-volt battery and transforms it to a 5-volt supply for the Cerebot MC7. The connection of a vehicle alarm taps to the battery and the supply of 5 volts from Cerebot MC7 to line 1 (SIM 800L). The immobilizer compact system was expertly built by the researchers during assembly to ensure that no materials would be harmed.

Figure 2 depicts the fully developed process. The newly created immobilizer compact system (ICS) has a housing to protect the device from foreign substances. In the event that the vehicle is stolen, the immobilizer compact system (ICS) using the GPS-GSM module will activate in the following manner. Firstly, the Immobilizer Compact System (ICS) includes an alarm system that will sound a loud noise; secondly, it will immediately notify the owner through GSM and, at the same time, the vehicle's location could be tracked using a GPS tracker in the scenario that the said vehicle was taken by an unauthorized person.

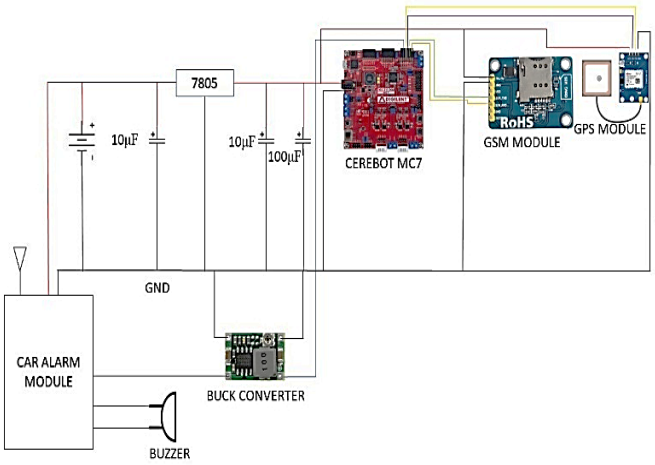


Fig.2. The newly developed Immobilizer Compact System (ICS) using the GPS-GSM module

IV. CONCLUSION

Based on the findings of the study, the following conclusions are drawn:

- The Immobilizer Compact System (ICS) using the GPS-GSM module has been successfully developed, utilizing the hardware and software intended.
- Compared to existing Immobilizer devices (ICS) on the market, the newly created immobilizer compact system (ICS) is significantly less expensive.
- In terms of technical features, the developed Immobilizer Compact System (ICS) receives convincing and affirmative responses from vehicle owners, industry experts, and PNP personnel respondents.
- The established Immobilizer Compact System's (ICS) level of effectiveness and the evaluation of the same group of respondents were the main areas of focus, and the findings were overwhelmingly positive.

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