Construction and Evaluation of Arduino-based with Real-time Notification Anti-Carnapping (ARNAC) Device

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Abstract: - This study aimed to construct and evaluate of an Arduino-based Anti-Carnapping Device with Instant Messaging Technology. It is an improvised mechanism aimed to help the community to protect their vehicles from thievery. The concept of the Hannafin and Peck model was employed in this study. The following is a summary of the research results: 1. the construction stage of the Arduino-based with Real-time Notification Anti-Carnapping (ARNAC) device goes through gathering and analyzation of data, designing the device, which entails the software, hardware and cost and benefit analysis, and then followed by the actual construction of the device; 2. the researchers evaluate the technological characteristics of the ARNAC device based on ISO 9126 standards such as functionality, reliability, efficiency and security; and 3. the level of effectiveness of the implementation in terms of its operation and accuracy of the ARNAC device was evaluated and described. The researchers amassed car owners, industry practitioners and Philippine National Police personnel from the research locale of the study. The respondents' approval qualifies the developed ARNAC device as an innovated reliable anti-theft equipment.

Key Words — ***Anti-Carnapping Device, Arduino, Real-time Notification, Vehicle.***

I. INTRODUCTION

The Philippines have progressed in terms of communication, transportation, entertainment, and other things that have enhanced the lives of the Filipino people. Most people nowadays rely on technology because of the benefits it provides that make our life simpler. Because of technological advancements, security in today's society has also progressed. Different kinds of security systems have been created to prevent thievery. Most of the commercial and residential establishment utilized Closed-circuit Television (CCTV), burglar alarm and button alarm. On the other hand, vehicles have their own version of security devices such as, dash cam, steering wheel lock, car lock alert system, car key protector, mini-GPS tracker, security tire clamp, car alarm security, and wireless anti-theft alarm.[1] Among the types of security features mentioned, GPS tracker is one of the most sophisticated and secured.

Republic Act No. 10883, or otherwise known as the New Anti-Carnapping Act of 2016 (RA 10883) is a law which punishes car napping in the Philippines. RA 10883 states that punishment will be imposed to those who commit crime of car napping which refers to the taking, with intent to gain, of a motor vehicle belonging to another without the latter's consent, or by means of violence against or intimidation of persons, or by using force upon things.[2]

Based on the analysis of the researchers, the anti-carnapping devices sold in the market only emit an alarming sound or can be tracked using GPS but these are expensive. The researchers also noted that there is no anti-carnapping device that sends a text to car owners in case their car is being used by an unauthorized person or has been stolen. Therefore, the researchers thought of developing an anti-carnapping device that has the ability to emit an alarming sound and send a text to the vehicle owner. This device is cheaper compared to the ones available in the market. The researcher also aims to look into its potential commercialization.

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II. REVIEW LITERATURE

Innovation is the process of enhancing an existing concept or product with fresh knowledge and ideas while also significantly altering society.

2.1 Anti-Theft Device

Antitheft device (ATD) is defined as a device in a car that reduces the chance that the vehicle will be stolen or vandalized or increases the chance of recovering a stolen car. Such devices include Global Positioning Systems (GPS), local alarms, and starter disablers.[3] As stated in the study of Deypalubos et.al. which entitled "Biometric as Anti-Car napping Device" that their device is a car security device which allows engine starting to be controlled by fingerprint identification which has an automatic video call and GPS tracking feature which allows the user to identify carnapper's location in case the vehicle will be stolen.[4] Moreover, car napping cases would surely decrease within a year.[4]

According to K. Lappanitchayakul, there are many anti-theft devices available on the market. In his study entitled "Anti-theft device for car: Alert system using radio wave", he mentioned that the mechanisms use in ATD include gear locking devices, steering wheel locking devices, clutch/brake locking systems, TDS system, voice transmissions, wireless door-lock remote control system, the GPS car tracking devices.[5] Based on the study "Anti-theft vehicle tracking and regaining system with automatic police notifying using Haversine formula", it states that the system will track the vehicle and offer to incarcerate the vehicle in a minimum period of time when it is lost. Further, the device can track the vehicle and provide a locking system because of the GPS and GSM technology used to it.[6] As stated in the study of Hossain et.al. which entitled "Design of a lost cost Anti-theft Sensor for Motorcycle Security Device" that their device security measures will be based on detection of the rotation of its handlebar. Their designed sensor detects the thievery situation only when the handlebar rotates from left to right at a certain angle or vice-versa which really needs to be done to run a bike.[7]

Based on the study entitled "Anti-theft Vehicle Monitoring and Tracking Android Application using Firebase as Web Service" by Mutiawani et.al., stated that one way to keep the vehicles safe from thievery is by utilizing an Android application that is capable of monitoring and tracking a vehicle. Further, their device has a special built-in feature like the ability to locate the position of the user's vehicle with the usage of GPS and Google maps.[8] If the vehicle moves from its original position, the application will notify the user and track its new position. Moreover, the application was developed using the Agile software methodology.

2.2 Arduino-based Project

Arduino is an open-source electronics platform based on easy-to-use hardware and software. Arduino boards are able to read inputs – light on a sensor, a finger on a button, or a Twitter message – and turn it into an output – activating a motor, turning on an LED, publishing something online. [9] Arduino technology is very useful in making do-it-yourself projects because of its simplicity. The microcontroller or the Arduino board is basically available in the market and it comes with Arduino IDE that is utilized to program the microcontroller via a personal computer. This technology has been utilized on well-known successful projects since it was introduced to the public in 2005. As stated in the study of Arbain et.al., which entitled "LAS: Web-based Laboratory Attendance System by integrating RFID-ARDUINO Technology", Arduino Uno microcontroller board has been used as the hardware platform while the web design has been developed in Adobe Dreamweaver and Fireworks and integrated and organized it in XAMPP application server. The researchers utilized Visual Basic scripting to integrate the hardware to a SQL database.[10]

Another project related to Arduino has caught the attention of the researchers. This time it focuses on farming. Based on the study of Putjaika et.al., which entitled "A Control System in an Intelligent Farming by using Arduino Technology", stated that agriculture is an important foundation of Thai economy.[11] Putjaika et.al. wants to improve the production process in planting, that's why they developed an intelligent farming system that will help them achieve their goal. The focus of this system is to control the watering and roofing systems of an outdoor farm based on the sensor system that includes temperature, humidity, and moisture and light intensity sensors.

On the other hand, the study entitled "A model for Remote Controlled Mobile Robotic over Wi-Fi Network using Arduino Technology" by Aneiba and Hormos shows a new way of creating project using Arduino technology. The focus of their study is the development of a robotic module. Communication between the robotic module and the operator is done through the Wi-Fi network for operation and control purposes. The communication occurs over a secured custom-made

Encryption/Decryption Algorithm to avoid others from controlling the module.[12] According to Areed, Arduino technology helps her solve the problem that may arise just in case keys are not available if you want to access a certain facility. Her paper entitled "A keyless Entry System based on Arduino Board with Wi-Fi Technology" has been developed through a microcontroller and php language. The idea of this system is to access a locked door without having a key.[13] It is proven that the developed system will be helpful for those who are concerned in this kind of problem. According to Nasution et.al. that the development of remote-control technology has grown rapidly along with the development of communication technology nowadays.[14] In their paper entitled "Electrical Appliances Control Prototype by using GSM Module and Arduino" they said that they utilized GSM SIM 900 and Arduino for controlling relay modules.

2.3 Real-time Notification

Real-time notification is can be done using Global System for Mobile communication (GSM), as Ndungu defined it as a digital mobile network that is widely used by mobile phone users in Europe and other parts of the world.[15] GSM uses a variation of time division multiple access (TDMA) and is the most widely used of the three digital wireless telephony technologies: TDMA, GSM and code-division multiple access (CDMA). As stated on the paper of Okokpujie et.al., which entitled "A Face Recognition Attendance System with GSM Notification" current biometric procedures for attendance are too disturbing.[16] Okokpujie et.al. developed a system that will take class attendance using the face as the biometric; it is a stress-free and non-disturbing method. To put simply, the developed system of Okokpujie et.al will take attendance, facial features extracted from acquired face images and stored picture templates were compared using Fisher Linear Discrimination algorithm for any match and the gathered vital information of attendance reports were sent through an available network to designated cellular phones.

Another study entitled "GSM-based Notification Speed Detection for Monitoring Purposes" by Sabudin et.al. presents the design of a GSM-based black box system for speed detection.[17] Sabudin et.al. developed a system that differs from the current existing black box system which notifies the driver through alarm systems and information is recorded in the black box. Further, the system designed to integrate a new black-box system integrated with the GSM notification system to send alert information to traffic authorized personnel through SMS. Meanwhile, the paper of Sakib and Abdullah which entitled "GPS-GSM based Inland Vessel Tracking System for Automatic Emergency Detection and Position Notification" presents a developed and upgraded version of Vehicle Tracking System (VTS) for inland vessels.[18] In addition to the characteristics available in traditional VTS for automobiles, the developed and upgraded version has the capability of remote monitoring of the vessel's motion and orientation. Another system has been developed which focuses on reading power meters automatically via GSM. The "Automatic Power Meter Reading System using GSM Network" is developed by Tan et.al, which consists of GSM digital power meters installed in every consumer unit and an electricity e-billing system at the energy provider side.[19] They said that on the power provider side, an e-billing system was utilized to manage all received meter reading messages, compute the billing cost, update the database, and publish billing notification to its respective consumer via SMS, email, web portal and printed postage mailing. The develop system demonstrated the effectiveness and efficiency of automatic meter reading, billing and notification through the usage of GSM network.

According to Morsalin study which entitled "Freighter fuel level detection and overload alarming system with safety notification via GSM", the developed system has been designed to monitor fuel level and total amount of load on the freighter and generate scan report for the captain of the freighter.[20] Further, developed a system designed for three different freighter load levels, no load, optimal load and overload. They said that at initial level, it will remain in no load status, when load increases and still remain in optimal level, the system will notify crews to initiate voyage. If the load increases to overload level, the system sends alarm and alert messages to the main control for necessary initiative. The communication between the vessel and main control tower is done by GSM modules to ensure long distance reliable communication.

2.4 Relevance of Literature Reviewed in the Current Study

The literature reviewed in this section supplied the researchers with an understanding of the need for the development of an Arduino-based with Real-time Notification Anti-carnapping device which can serve as an additional security measure for the car owners. The body of literature cited by the researchers allowed them to filter through the ideas reviewed such that they were able to concretize their concepts in the design of the developed device that is the focus of their study.

III. METHODOLOGY

The developmental research design was used in this study. Developmental research, according to Richey and Nelson, that it is the systematic study of designing, developing and evaluating instructional programs, processes, and products that must meet the criteria of internal consistency and effectiveness.[21]

Fifty (50) respondents evaluated the ARNAC device. The distribution was as follows: ten (10) PNP personnel, ten (10) industry practitioners and thirty (30) car owners in the municipalities of Santa Rosa and Zaragoza and city of Cabanatuan, Nueva Ecija, Philippines.
Critics of the research assessed the instrument's content validity. The validity and reliability of the survey items were confirmed through a number of gatherings and conversations. To assess the content of the main instrument, respondents were given questionnaires to fill out.

In determining the internal consistency of the item, Cronbach's Alpha was used in computing the reliability coefficient. Both first and second administration of the test yielded a result of 0.76 and rated as moderately high, thus demonstrates the reliability of the test.

IV. RESULTS AND DISCUSSION

This study utilized the Hannafin and Peck model notion to construct the Arduino-based with Real-time Notification Anti-carnapping Device.

4.1 Construction of the Arduino-based with Real-time Notification Anti-carnapping (ARNAC) Device based on Hannafin and Peck model.

The construction of the ARNAC device followed the four (4) stages of the Hannafin and Peck model such as needs assessment, design, development and implementation and evaluation and revision. The first stage of construction, the needs assessment stage described the gathering and analyzation of data. On the other hand, the second stage, the design stage covers the software, hardware and the cost and benefit analysis of the developed device, while the third stage, the development and implementation are the actual construction of the ARNAC device followed by series of implementation to its intended end-users. Finally, the last stage, the evaluation and revision stage described the evaluation of the respondents and minor revisions was made based on the suggestions of the respondents.

4.1.1 Needs Assessment

The researchers' goes through two phases under this stage. The first phase was the gathering of information and the conceptualization on the features and qualities of the ARNAC device based on the literature reviewed by the researchers. This would serve as the foundation for the design and construction of its prototype. The second phase was the analyzation of the information gathered. After analyzing the data on the conceptualization of the ARNAC device design, decision has been finalized. The researchers prepared the circuit diagram of the device, as well as the different materials needed during its construction. They identified the readily available tools, materials and equipment that will aid them in during its construction.

4.1.2 Design

The overall design of the anti-theft mechanism considered its physical structure or the hardware, the application used in programming the system or the software, and the project cost. Further, the researchers come up with the schematic diagram of the ARNAC device as shown in figure 1. This diagram served as the assembly of the developed device.

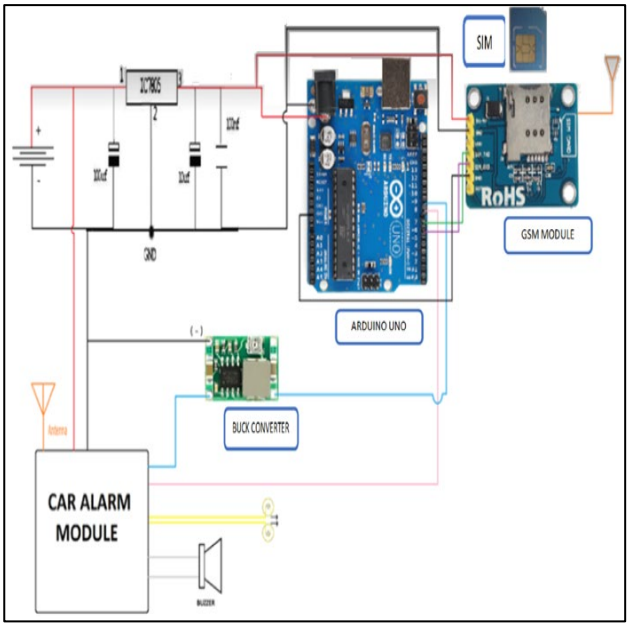

Fig.1. Schematic diagram of the ARNAC device

4.1.2.1 Hardware

The hardware of the anti-theft mechanism is composed of electronic components, Arduino board, motorcycle alarm, sim card, and 18-gauge automotive wires. Figure 2 shows the hardware utilized in the project.

Fig.2. Hardware utilized in the construction

4.1.2.2 Software

The researchers utilized the Arduino Integrated Development Environment (IDE) as its programming software. The Arduino Software (IDE) contains a text editor for writing code, a message area, a text console, and a toolbar with buttons for common functions and a series of menus.[22] Furthermore, it is cross-platform application that is written in functions from C and C++. The researchers used Arduino IDE to build and upload applications to the Arduino compatible boards using third-party cores. Figure 3 shows one of the researchers while programming the ARNAC device.

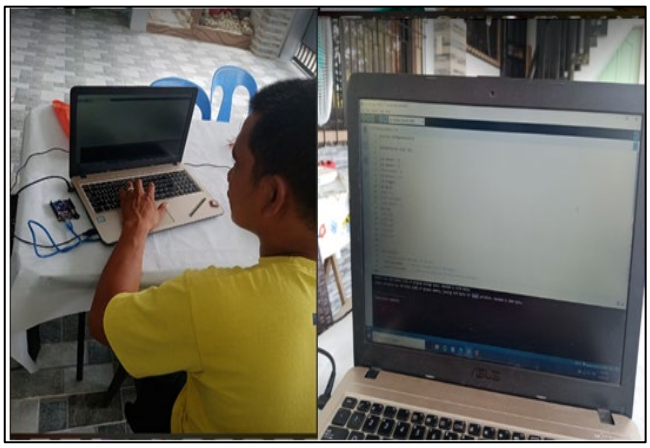

Fig.3. Programming the ARNAC device system using Arduino IDE

4.1.2.3 Cost and Benefit Analysis

The researchers considered all aspects to make the ARNAC device cost cheaper than the existing anti-carnapping devices. A material that is already available helps the researchers to save some money. Table 1 shows the total cost of the project.

Table.1. Total Costing of the ARNAC device

Quantity	Unit	Materials	Price
1	pc	Smart SIM Card 5G	₱40.00
1	pc	Sim 8001 gsm module	₱340.00
1	set	Arduino uno	₱199.00
1	set	Yamaha Motorcycle Anti- Theft Alarm Remote Control Engine Starter	₱350.00
1	pc	DC-DC 3.3V 5V 9V 12V 3A Adjustable Buck Down Voltage Regulator Power Module	₱7.00
1	pc	Transistor 7805	₱40.00
1	pc	Capacitor 100 mf	₱3.00
1	pc	Capacitor 10 mf	₱2.00
2	m	Wires	₱20.00
		Total	**₱1,001.00**

As shown in the table, the total expense of the ARNAC device when constructed was ₱ 1,001.00 only. Based on the total cost of the developed device, it shows that the device is much cheaper to those anti-carnapping devices available in the market. This indicates that the ARNAC device is a reliable and efficient way of protecting the vehicle's owner.

4.1.3 Development and Implementation

The development and implementation stage described the actual construction of the ARNAC device and followed by series of implementation to its intended end-users. During the assembly, one of the researchers carefully constructed the ARNAC device so that there will be no materials to be damaged. He cautiously soldered the electronic components of

the Arduino board as shown in figure 4. On the other hand, figure 5 shows the fully developed device.

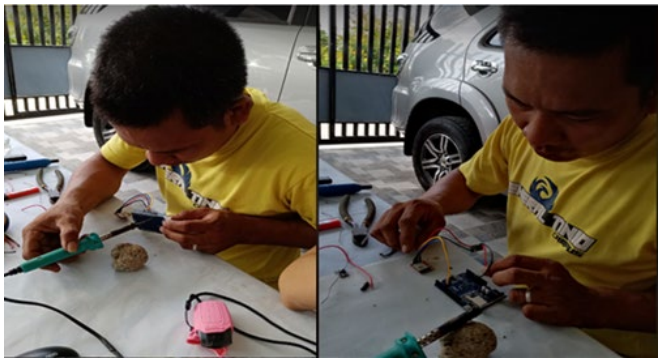

Fig.4. Assembling the electronic component of the ARNAC device

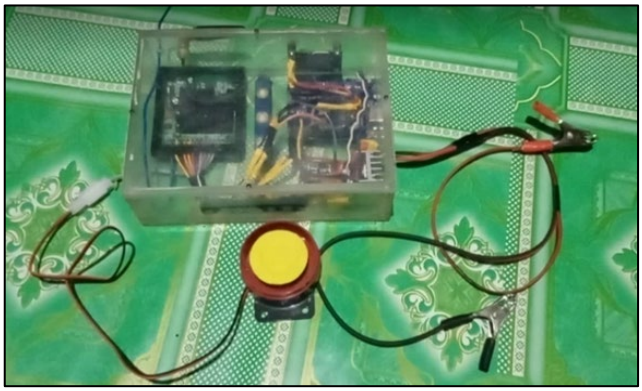

Fig.5. Developed ARNAC device

Figure shows the developed ARNAC device with casing to avoid dirt and moisture. It also shows that it is connected with an alarm to make a loud noise in case the vehicle is being stolen. Meanwhile, figure 6 and 7 shows the implementation of the ARNAC device into its intended environment.

Fig.6. ARNAC device being tested in utility vehicle

Fig.7. ARNAC device being tested in motorcycle

4.1.4 Evaluation and Revision

The evaluation and revision stage described the evaluation of the respondents and minor revisions was made based on the suggestions of the respondents. There are the two (2) ways the respondents evaluated the ARNAC device technological characteristics; the actual research instrument and the instrument made from Google form. Some of the respondents preferred the latter. Some of the revisions were made based on the suggestions of the respondents.

4.2 Evaluation of the Arduino-based with Real-time Notification Anti-carnapping (ARNAC) Device by the respondents based on ISO 9126 standards.

The ARNAC Device was assessed by three sets of respondents, such as car owners, industry practitioners and PNP personnel from Cabanatuan City, Santa Rosa and Zaragoza, Nueva Ecija, Philippines. They were asked to assess the technological characteristics of the developed device such as functionality, reliability, efficiency and security of the ISO 9126 standards. Table 2 shows the summary of evaluation done by the respondents.

Table.2. Summary of Evaluation on ARNAC device Technological Characteristics

Technological Characteristics	**Weighted Mean**	**Verbal Description**
Functionality	3.67	Very Functional
Reliability	3.61	Very Reliable
Efficiency	3.65	Very Efficient
Security	3.70	Very Secure

4.3 Level of effectiveness of the of the implementation of the Arduino-based with Real-time Notification Anti-carnapping (ARNAC) Device in terms of its Operation and Accuracy.

The three (3) sets of respondents were asked to describe the level of effectiveness of the implementation of the ARNAC device and consequently approved this particular niche as highly effective in terms of its operation and accuracy.

V. CONCLUSION

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

- The Arduino-based with Real-time Notification Anti-carnapping device has been constructed successfully using its intended hardware and software.
- The developed ARNAC device is much cheaper than those anti-theft devices available in the market.
- The developed ARNAC device was assessed by the car owner, industry practitioner and PNP personnel respondents.

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