# SMART REAL-TIME TRACKING SYSTEM FOR AEMILIANUM COLLEGE INC.

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**Abstract.** The device for tacking is an additional technology that the proponent can contribute to the institution. The use of Arduino and combining the hardware and software to come up with it became fruitful based on the evaluation conducted with the selected end users and identified IT experts.

The developed system with its features – the use of an alarm, sensors, short message services (SMS), and Google Maps became compliments each other. It gave compact structures which supported the goal of tracking lost valuable items. The developed system was found serviceable when it passed the testing and evaluation conducted and received a rating of 3.9325. On the part of IT experts and 3.78 on the part of the end users which means the system is "more than what is expected" by the evaluators. Thus, the system was given an overall rating of 3.85 which is considered to be "Very Applicable" as perceived by the evaluators who validated the developed system.

***Key Words:*** *Aemilianum College Inc.**, Arduino, Capstone Project**, Google Maps, Locator**, Monitoring System, Sensor, Tracking System*

# INTRODUCTION

COVID-19 made a sudden change in the lives and routines of many. It did not distinguish borders, race, or gender. It really changed lifestyles, work schemes, learning modalities, health practices, and many more. The world did not dream nor anticipate this kind of reality that one day everyone will be wearing a face mask and be restricted to go from one place to another. The World Health Organization stated that the COVID-19 pandemic has led to a dramatic loss of human life worldwide and presents an unprecedented challenge to public health, food systems, and the world of work (WHO, 2020).

With the implementation of the Enhanced Community Quarantine (ECQ) covering the entire island of Luzon in the Philippines, the majority of organizations in the country have also implemented policies to ensure employee welfare and business continuity to minimize impact during the ECQ period, according to a survey by Watson, a leading advisory, broking, and Solutions Company. These included work-from-home arrangements, mostly for their corporate office-based employees across industries, while those in operations adopted a skeletal workforce or split operations arrangement. For employees in many organizations, this is a time of great uncertainty. COVID-19 is changing the way people work, with travel bans, skeleton crews, remote work, and social distancing becoming the new norm. In many organizations, these new ways of working are raising questions and concerns (MacLennan, 2020).

Because of the change of movements in the workplace, things might get out of hand. The workplace is left with few workforces thus, valuable things are at risk. There might be instances that the worker assigned might be disorientated by the location of the equipment or tools used by a worker assigned on other days. Many problems will be brought to the work establishment if valuable things will be misplaced or to the extent might be lost or stolen. Establishments must be cautious and ready for any eventualities that will arise amidst this pandemic.

## Project Context

Albert Einstein said that "in the midst of crisis, lies great opportunity". The researcher was inspired by these words from a brilliant man of times. It is indeed heartwarming if people could present a solution to challenges brought by a situation that can be avoided.

The real-time tracking system is a smart buddy suitable for those establishments whose workforce is in limited need of security for their valuable things. In times like this, of course, there is a need for a well-organized management plan to provide assurance of

security.   Likewise, the proposed Smart Real-Time Tracking System could also augment the desired solutions.

The Smart Real-Time Tracking System could trace the locations of equipment, tool, or any valuable things at hand.   All hard-earned things deserve to be treasured and secured by using this system.   Hard-earned things can also be an appliance, cars, sentimental items which are not cheap to replace, or anything appreciated being kept with value and importance. It is kept in a safe room or storage to assure its security.  The more it is valuable, the more it is attracted to thieves, thus the more the safest room is needed for it and a system like the Smart Real-Time Tracking System is essential.

## Purpose and Description
Once the real-time tracking system is programmed and successfully attached to equipment or any valuable thing which needs security that will be the start of the operation of the device.  The moment the device detects motion, automatically, the system will send a message that will be received by the property custodian or in-charge.  Likewise, the system where it was attached will also make sounds that will provoke the thief to withhold his plan. Another feature of the system, is the location tracer of the valuable thing via Google maps and it has a capacity to send message of location once texted using a mobile phone.

The system is battery operated, a hardware and software combination using A9G Module and Arduino IDE.  It can smartly be used for real-time tracking using Google maps, command SMS notifications, and alarms.

## Specific Objectives
Specifically, the study aimed to:
1. Design and develop a smart real-time tracking system using:
    1.1. A9G Module
    1.2. Arduino Integrated Development Environment (IDE)
2. Design and develop a system that shares for all users with the following features:
    2.1. Real-time tracking system using Google Maps
    2.2. sensor
    2.3. Informing the system user of location through:
        2.3.1. Short Message Service (SMS)
    2.4. Buzzer Alarm System
3. Evaluate the developed system using the industry software quality model – the  ISO 25010 evaluation tool in terms of:
    3.1. functional suitability;
    3.2. performance efficiency ;
    3.3. compatibility;
    3.4. usability;
    3.5. reliability;

       3.6.   security;
       3.7.   maintainability; and
       3.8.   portability

**Inception**

      In this phase, the proponent immediately consulted the target end-user.  She wrote a letter addressed to the ACI School Director, with attention to the Property Custodian.   She chose to personally talk to the in charge of tools and equipment safety in the College.  It is prudent enough to consult him about the processes being observed in the College.

      There were protocols being observed in the workplace when it comes to the safety of the equipment and materials.  It was noted by the researcher for the sake of the efficiency of the developed system.  All aspects of the system must fit its purpose and that is to secure the safety of some identified equipment in the workplace.

      The proponent also listed all the materials needed in the development.  She checked the prices online.   Some of the specifications she wanted to achieve did not materialize because of the current situation in the country regarding COVID – 19 pandemic.  Especially the size of the A9G Module that she wanted to procure.  There were no small sizes available in the market.  And therefore, the proponent opted for the second choice she prepared to have.

**Elaboration**

      The proponent checked all the hardware and software requirements.   All the necessary things needed in the development were checked.  Likewise, the design of the device was also carefully designed.
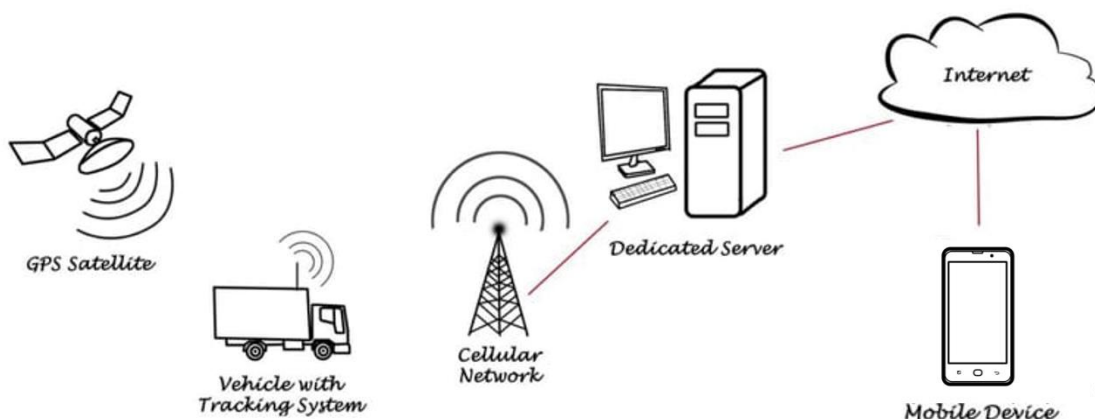


**Figure 4.1 - System Architecture of the Developed System**

Figure 4.1 showed the System Architecture of the Developed System, illustrating the processing of data from the tracking system to the GPS Satellite to the cellular network, to the server which is accessed using the internet to the laptop or mobile device.

## Construction

In designing and developing the project entails focus since it was the first time for the researcher to have this kind of project – combining hardware and software components in programming.   But it was a challenge accepted in order to push self to level up and earned additional jewels to her degree.
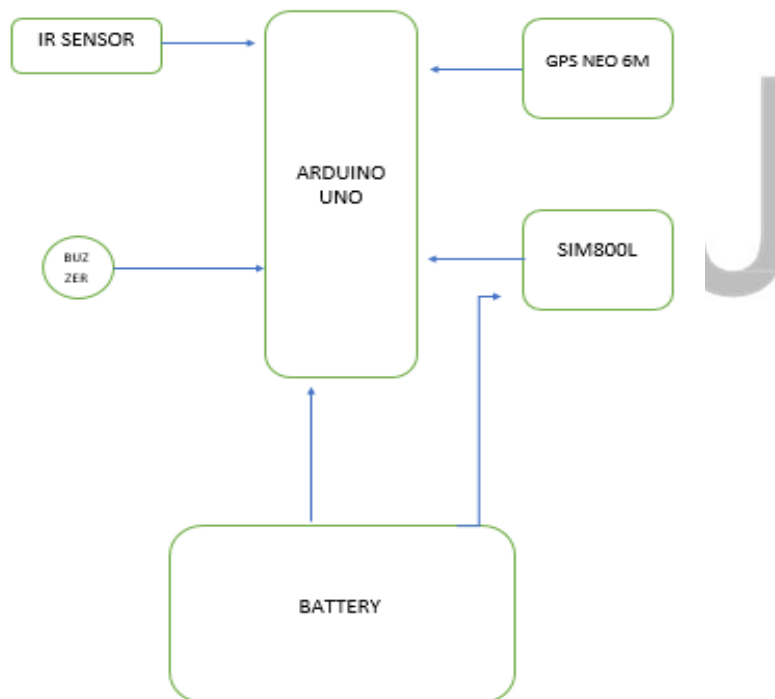


**Figure 4.2. - Components Diagram of the Developed System**

Figure 4.2 showed the components diagram of the developed system.  It displayed the hardware used:  Infrared (IR) sensor, Global Positioning (GPS) NEO 6M, Buzzer, Arduino Uno, Sim800L and the battery.
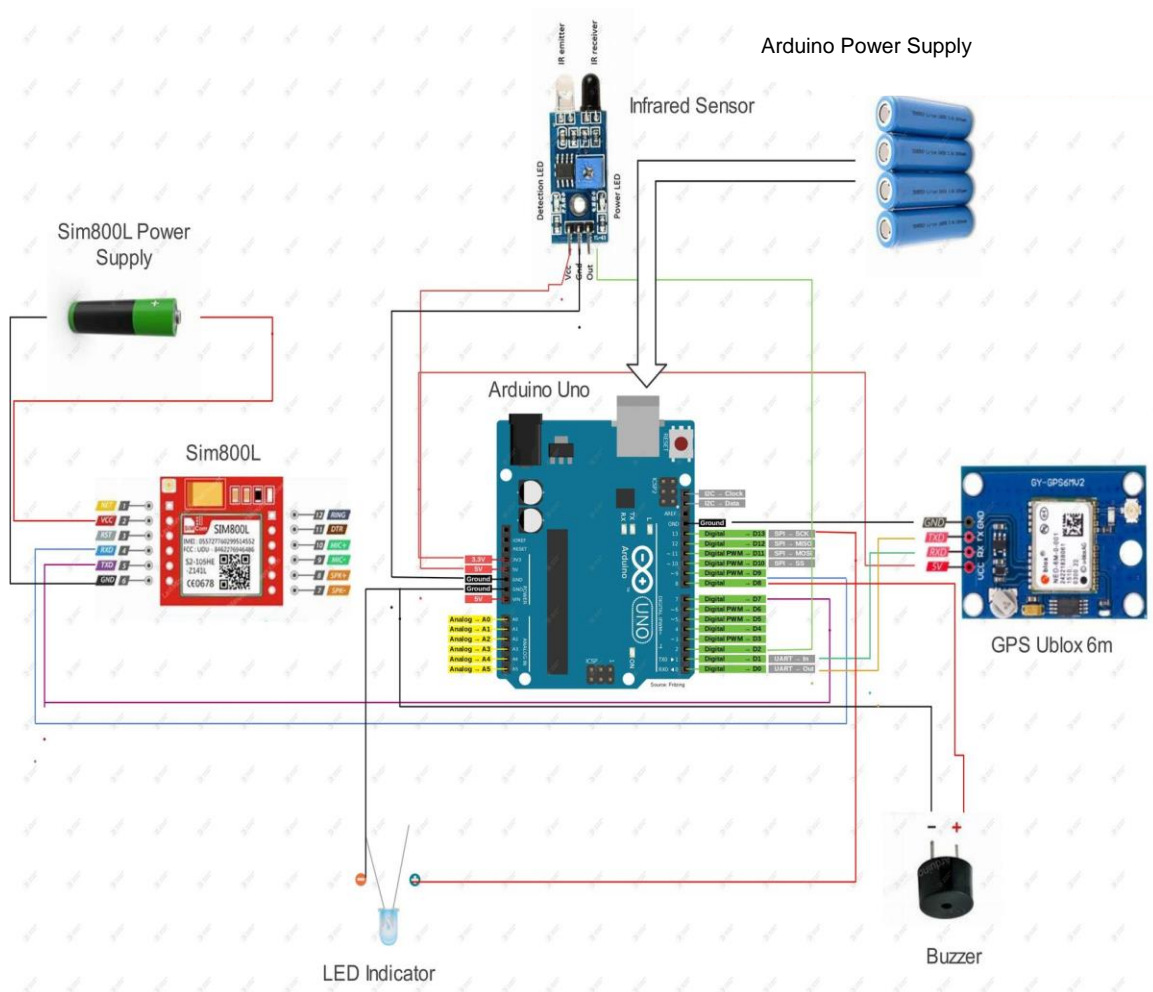
**Figure 4.3. - Pictorial Diagram of the Developed System**

Figure 4.3 displayed the Circuit Diagram of the developed system wherein the proponent carefully assembled for couple of weeks. Fixing the circuit was quite delicate

considering the size.  But the researcher was really determined in fixing the circuit to see the final-end of the planned device.
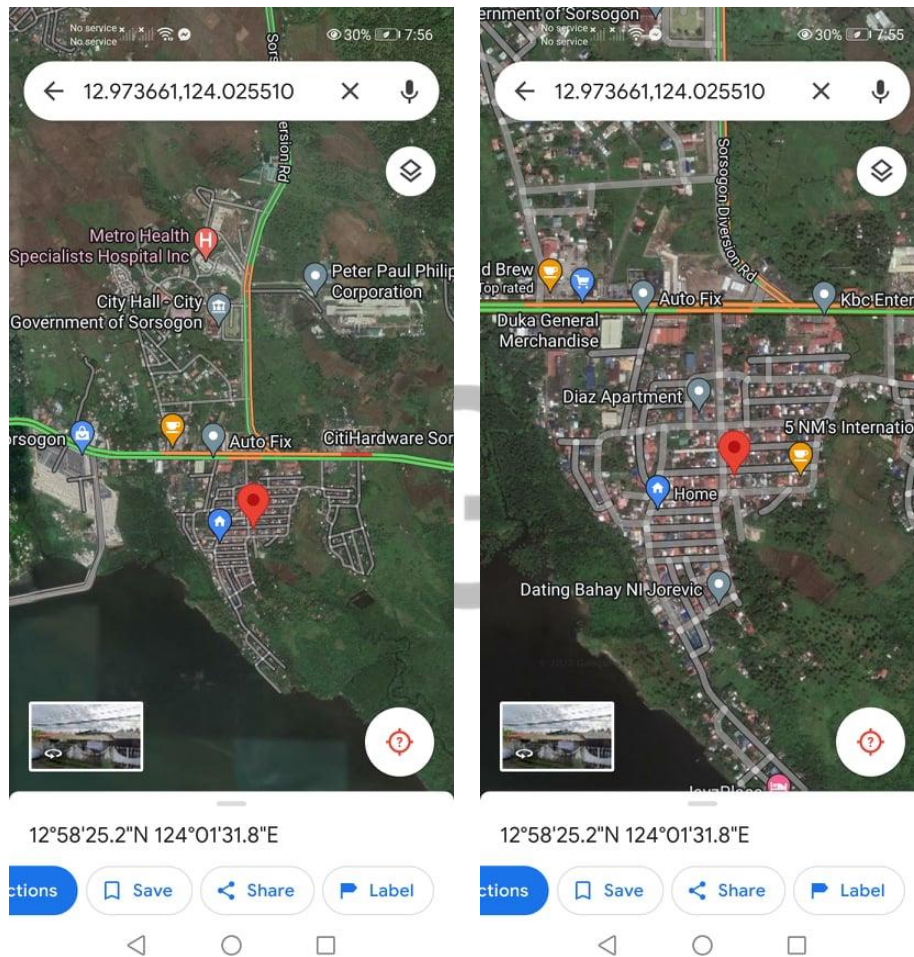


**Figure 4.4.  - The Tracking Device using the Google Maps**

Figure 4.4 showed how the tracking device used Google maps which offered satellite imagery, aerial photography, street maps, 360° interactive panoramic views of streets wherein it could help in finding exact locations
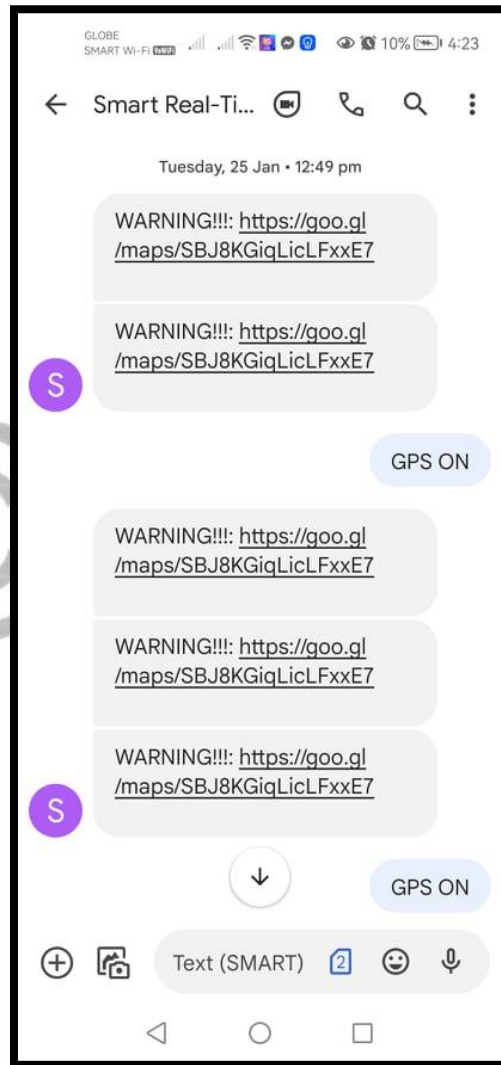
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**Figure 4.5. The Developed System using the SMS Notification**

Figure 4.5 displayed the SMS Notification feature of the developed system.  It was the message processed by the device to notify the concerned person of the exact location of the unit being tracked.



**Figure 4.6. - The Smart Real Time Tracking System**

Figure 4.6 displayed the exact appearance of the Smart Rear Time Tracking System.

The Smart Real-Time Tracking System was evaluated by two sets of evaluators:   ten (10) identified end users,   and ten (10) IT experts using industry software quality model – the ISO 25010 evaluation tool.

The formula used to determine the weighted mean was:

$$\text{Weighted mean} = \frac{F_1(1)+F_2(2)+F_3(3)+F_4(4)+F5(5)}{F_1+F_2+F_3+F_4+F_5}$$

Where: The numerical rate:  (1) not applicable, (2) slightly applicable, (3) applicable, (4) very applicable, (5) highly applicable = Overall Satisfaction.

**Table 4.11. - Overall Evaluation of the Smart Real-Time Tracking System**

|  | Quality Characteristics | IT Experts | End Users | Average | Interpretation |
|---|---|---|---|---|---|
| 1.0 | Functional suitability | 3.97 | 3.8 | 3.08 | More than what is expected |
| 2.0 | Performance Efficiency | 4.0 | 4.1 | 4.05 | Far more than what is expected |
| 3.0 | Compatibility | 4.05 | 3.0 | 3.50 | More than what is expected |
| 4.0 | Usability | 3.78 | 4.8 | 4.29 | Far more than what is expected |
| 5.0 | Reliability | 3.78 | 3.7 | 3.7 | More than what is expected |
| 6.0 | Security | 3.98 | 3.0 | 3.49 | More than what is expected |
| 7.0 | Maintainability | 3.96 | 3.7 | 3.83 | More than what is expected |
| 8.0 | Portability | 3.94 | 4.1 | 4.02 | Far more than what is expected |
|  | **Mean** | **3.93** | **3.78** | **3.85** | **More than what is expected** |
|  | **Overall Mean** |  | **3.85** |  | **Very Applicable** |

Table 4.11 reflects the overall evaluation results of the developed system.  With an overall mean of 3.85, the system is deemed "more than what is expected", for a newbie researcher who developed a tracking device like the Smart Real Time Tracking System intended for her Alma Mater – the Aemilianum College Inc.  The system minimally satisfied all quality model characteristics in terms of functional suitability, performance efficiency, compatibility, usability, reliability, security, maintainability, and portability, thus can be utilized by the end-users.

**Transition**

Using the Rational Unified Process (RUP), the final phase in the development of the system was the Transition.  It was in the heart of the researcher to hand over the final project to its recipient – the Aemilianum College Inc.  It would be of great help to the institution to have the device.  It was indeed an added new technology that would showcase the skills, talents, and creativity of the students in the College.

**Summary of Findings**

During the development and after testing and evaluation of the developed system the following findings have been established:

1. The device for tacking is an additional technology that the proponent can contribute to the institution. The use of Arduino and by combining the hardware and software to come up with it became fruitful based on the evaluation conducted with the selected end users and identified IT experts. By evaluating its functionality and performance efficiency, the developed system turned out to be "more than what is expected" having a rate of 3.885 as the overall mean

2. The developed system with its features – the use of an alarm, sensors, short message services (SMS), and Google Maps became compliments each other. It gives compact structures which support the goal of tracking lost valuable items. The developed system found it serviceable when it passed the testing and evaluation conducted and received a rating of 3.9325 in the part of IT experts and 3.78 in the part of the end users which means the system is "more than what is expected" by the evaluators.

3. The eight (8) quality characteristics, such as functional suitability, performance efficiency, compatibility, usability, reliability, security, maintainability, and portability of the developed system were tested and evaluated. From this perspective, the evaluators, unanimously agreed that the developed system turned out to be "more than what is expected" having a rate of 3.85 as the overall mean.

**Conclusions**

Based on the findings of this study the following conclusions are formulated:

1. The combined hardware and software components which resulted in the development of the tracking device and with the evaluation made by the Evaluators using the ISO 25010 industry standard model, with the overall ratings of 3.85 unanimously agreed that the developed system turned out to be "more than what is expected", thus can be used for its purpose with the assurance that it will be the functional and reliable new device for the end-users.

2. Upon testing the device with all its features – the sensor, the buzzer, the tracking system using Google Maps, and the SMS notifications were all in operation as expected. The four (4) features were all complimentary with each other. Thus, the developed system is a new technology in service of tracking valuable items for the intended end-users.

3.  The Evaluators found the developed system to be useful in tracking lost items. Evaluating the functional suitability, performance efficiency, compatibility, usability, reliability, security, maintainability, and portability of the developed system, in the perspective of the respondents, unanimously agreed that the developed system turned out to be "more than what is expected" having a rate of 3.85 as the overall mean.  Thus, the system is considered to be "Very Applicable" as perceived by the evaluators who validated the developed system.

## Recommendations

The conclusion drawn from the findings were the following:

1.  The developed system is secured, reliable, and has the ability to be accessed anywhere at any time using internet connections, thus may be installed and used by the department.
2.  Passing the ISO 25010 quality model, with an overall mean of 3.85 from the identified respondents, the developed system can be assured of its functional suitability, performance efficiency, compatibility, usability, reliability, security, maintainability, and portability, thus it may be used to where it is intended for.
3.  The developed system may be deployed and used for its purpose.
4.  Additional functionalities may be studied and integrated into the system for better services.