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GSM-enabled Real-Time Tracking and Vital Signs Monitoring Military Smartwatch

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Abstract. In military operations, soldier safety is a top priority. As a result, the researchers developed a smartwatch, receiver unit, and android software as a system for the military's real-time tracking and vital signs monitoring. The wristwatch has a display screen showing the time, date, temperature, messages, and a magic tape for attaching to the wearer. Additionally, it has two Arduino microcontrollers, a temperature sensor, a pulse sensor, a GPS module, and a GSM module. Data from the smartwatch is transmitted to the cloud database using the receiver device. Additionally, it includes an Arduino microcontroller, a GSM module, and a node microcontroller unit. However, the Android app installed on the Android tablet collects information from a cloud database. It adds the device's location to Google Maps, and additional details are displayed when the marker is clicked. It can also display messages sent via a smartwatch and send messages itself.

Keywords: Military Smartwatch, Real-Time Tracking, Vital Signs Monitoring with GSM, Equipment, Smartwatch, Tracking with GPS.

1. Introduction

In an era characterized by rapid technological advancements and increasing demands for military readiness and effectiveness, the convergence of cutting-edge technology with military equipment has become paramount. The GSM-enabled Real-Time Tracking and Vital Signs Monitoring Military Smartwatch is one such innovation that stands at the forefront of this transformation. This groundbreaking research is dedicated to exploring the capabilities and implications of this remarkable device, which has the potential to revolutionize how military personnel operate in the field.

The modern battlefield is a dynamic and complex environment where information, communication, and real-time data can differentiate between success and failure. In this context, integrating GSM (Global System for Mobile Communications) technology into a military-grade smartwatch offers a transformative solution that brings real-time tracking, communication, and health monitoring to the fingertips of our brave servicemen and women.

This research delves into the multifaceted aspects of the GSM-enabled military smartwatch, dissecting its key features, functionalities, and potential applications. The primary focus is on the seamless real-time tracking capabilities that enable commanders to monitor the precise location of troops in the field. Simultaneously, this smartwatch empowers soldiers to constantly communicate with their units and superiors, enhancing situational awareness and coordination.

Moreover, the smartwatch incorporates vital signs monitoring, an invaluable feature that ensures the well-being of military personnel and enables quick response in case of injuries or health emergencies. This innovation is set to redefine the standard of care and support for military forces in combat and training scenarios.

The implications of this research extend beyond the military domain, as the principles and technologies developed may find applications in search and rescue operations, disaster relief efforts, and even civilian healthcare. By examining this innovative fusion of technology and military equipment, we hope to pave the

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way for enhanced mission success and the protection of those who serve our nations with unwavering dedication and valor.

It is crucial to be ready for battle in order to ensure a nation's security. Soldiers who push themselves to the absolute limit are essential to this. The military is divided into three branches: the army, navy, and air force. Each deployed military member's location and current condition must be reported to the headquarters. It can aid in strategy formulation and army direction. One of the significant challenges in military operations is communication between the base station and the deployed soldiers. [1], [2] There are no consolation prizes for the runner-up in war. It means that a faction must be at the top. Being a soldier who fights for the country is hard. They live for the nation and die for it. Thus, military equipment plays a crucial role in every war. The military does not fall back on technology. Engineers and scientists are continuously developing gear for the military. Technology in the military has evidently evolved over the past centuries, from using sticks and stones to modern warfare equipment.

Technology plays a big part in how wars are being fought today. The more money you have, the more technology can be invested in the military, which could lead to an advantage on the battlefield. Technology in warfare became the catalyst of modernity. It is not only the gears and equipment that have become more dangerous but also the vehicles have been upgraded to bring terror across the world. These upgrades became the necessary precondition for war. It sends a message that technology is a must for warfare. [3], [4]

It is known to everybody that communication is the best way to understand each other. Communication plays a vital role in the military, especially when operations are to be fought. When there is good communication, both parties can understand each other. There are now a number of ways to communicate with others. The most significant factor in communicating is how fast the message can be delivered and how it will be delivered. Hence, a number of technologies that focus on communication have been developed and are being developed.

Global positioning systems (GPS) are significant in military operations because of the advantages they offer for search and rescue, target tracking, missile and projectile guidance, and navigation. [5]. Further, the Global System for Mobile Communications or GSM in the military is helpful in sending messages by encrypting the messages needed. Android (Operating System) is one of the well-known and used OS on mobile devices. Using Android Studio, mobile applications can be developed and implemented in the military field. Thus, this study focuses on creating a system that uses these technologies in order to detect location and vital signs and send messages.

2. Background of The Study

War has formed part of history. How people engage in war forms part of their warfare, and this is where technology comes in. Innovation is their warfare that goes hand in hand with what technology will introduce. [6]. Basically, modern military technology is still the same, but its capacity has changed to a different level. It becomes more powerful and dangerous to mankind. The evolution of warfare technology is evident during World War II. We have the atomic bomb, jet aircraft, guided missiles, and proximity fuse as examples. [3]

During war and military operations, soldiers get injured, lose communication, and worse, get lost on the battlefield. According to Doug Loverro, the deputy assistant secretary of defense for space policy, “If we lost GPS worldwide, most of our warfighters—in fact, all of our warfighters—would lose the ability to navigate and tell and drop the precision munitions and do everything we do with GPS.” [7] Global Positioning System plays a vital role in military warfare. It is a satellite-based network for military navigation and location. The US military uses GPS not only in its battlefield communication but also as a guide for bombs. Losing their GPS worldwide would give their opponents a significant advantage in winning the war. [8]

In the Philippines, the government should consider improving military technology. There is a significant lack of modern equipment needed to combat problems such as terrorism like the MILF, MNLF, Abu Sayyaf, ISIS, and the Maute Group. The situation in Marawi is a basic example of why there is a need to improve the military’s battle gear. [9] It is distressing to witness or know that a number of lives are being ended without a good fight. It is not all about guns and ammunition now. Modern technology would remove an advantage in securing the lives of soldiers and civilians.

The army thus continues to enhance wearable battlefield computers. [10] Communication is sending and receiving information from the pointer. [11] Communication is essential during the battle. It would be very difficult for soldiers if they were unable to communicate with the control room administrator. Accuracy is still a must to achieve the end result. Careful planning and coordination with each other form part of their strategy.

Existing equipment can be used for search and rescue in some dangerous war rescue conditions and includes such items like boats and scuba diving equipment. However, these items of equipment are almost always unavailable to front-line emergency service rescue teams on arrival at a lifesaving search and rescue operation. Hence, monitoring of vital signs is beneficial in military combat casualty care. It is crucial to be able to monitor vital signs at all levels, especially during the course of war or while there is an ongoing operation. Ease of use, including display readability and compatibility with aircraft environments (airworthiness), are other essential factors. The military seeks to use the same equipment between services whenever possible. It is also necessary that these monitoring devices are lightweight and robust in order to maintain quality and endurance in all states of conditions that may affect the devices. Reliability in measuring the properties of vital signs is essential because monitors are only as good as their measurement technologies. There has always been an advancement in technology in vital sign measurement, especially in giving results in reading. Generally, using these critical signs, monitors can keep watch over soldiers and other military personnel who are active in service. [12]

In recent years, the integration of GSM-enabled real-time tracking and vital signs monitoring into military smartwatches has emerged as a promising advancement in wearable technology for military applications. In the study of [13] explored the feasibility of such systems, demonstrating the effectiveness of GSM-enabled tracking in providing continuous location updates for military personnel, even in challenging environments. Meanwhile, [14] focused on the development of wearable ECG monitoring systems, emphasizing the crucial role of continuous vital signs monitoring for early detection of health issues in military settings. The study [15] provided insights into the challenges and opportunities of communication technologies for military wearables, stressing the importance of two-way communication capabilities in GSM-enabled smartwatches for effective soldier-command center interaction [15]. Additionally, [16] highlighted the significance of ergonomic design and user interface intuitiveness in ensuring the acceptance and effectiveness of wearable devices, although their study was not specific to military applications. Finally, [17] reviewed the impact of wearable technology on military operations, emphasizing the need for interoperability with existing military systems for enhanced operational effectiveness. Collectively, these studies underscore the potential and importance of research on GSM-enabled Real-Time Tracking and Vital Signs Monitoring Military Smartwatch technology in improving soldier safety and performance in diverse operational environments.

3. Objectives

The general objective of this study is to develop a Military Smartwatch with a GPS tracker and an android application using vital signs that will optimize the Military's needs for the technology revolution.

- To accurately identify the location of a soldier via GPS.
- To send and receive messages between a soldier and the base unit using GSM.
- To monitor the pulse rate and body temperature of soldiers.
- To create an application that will display the location of soldiers on the field.

4. Methodology

The researchers' primary objective is to monitor the soldiers during the war, identify their locations, communicate with the base unit, and provide health monitoring to soldiers, such as body temperature and pulse rate. The study utilized standard techniques in the engineering design process, such as researching, specifying requirements, evaluating and planning solutions, creating a model, and testing solutions. In order to implement the project, the researchers used a microcontroller unit to process data and send information to other components. [18], a temperature sensor for determining the body temperature of the soldier, a pulse rate sensor for determining if the device is connected or disconnected, a GPS module for tracking the location of a soldier, a GSM module for sending data over to the base unit, and an OLED display for soldier's user interface.

To implement the hardware components, the researchers used Arduino software to write programs using C++ programming language, which is an Integrated Development Environment (IDE).

The Android Application provided a friendly interface for the base unit. This data is composed of location, body temperature, heart rate, and messages retrieved from the database using the Wi-Fi module.

Figure 1 illustrates the level 1 diagram of the developed military smartwatch with a GPS tracker and Android application using vital signs. It shows how the soldier unit is connected to the base unit. The battery, GPS module, sensors, and emergency button are connected to the soldier unit's microcontroller. When there is information that needs to be sent to the base unit, the GSM will do its purpose, which is to send messages. The message is then sent to the base unit's microcontroller to store data from the database and then deliver it to the Android device. Meanwhile, the Level 1 diagram provides a system architecture with all modules and their interconnections.

Figure 2 shows the flowchart operation of the system and how it will monitor the soldier. The system starts by measuring the soldier's location, which will be transmitted to the mobile application through GSM and Wi-Fi modules. The vital signs of soldiers, such as body temperature and pulse rate, will also be monitored. The red indication will be displayed if the soldier's bpm is zero. The orange indicator will be displayed if the emergency button is pressed. The backup button can identify what kind of backup the soldier needs. The mobile application can also determine if the life of a soldier is in danger by measuring or computing his/her vital signs.

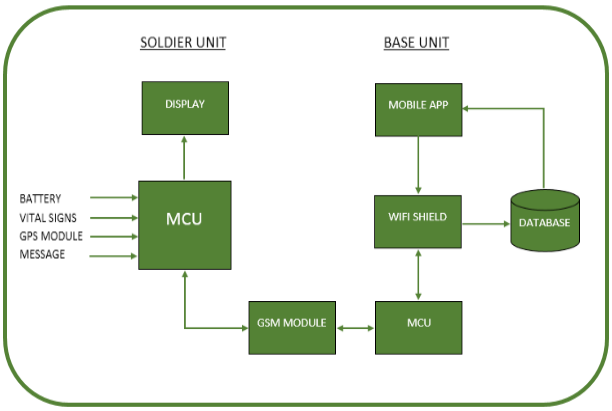

Fig 1: Level 1 diagram of the Development of a Military Smart Watch with GPS Tracker and Android Application Using Vital Sign

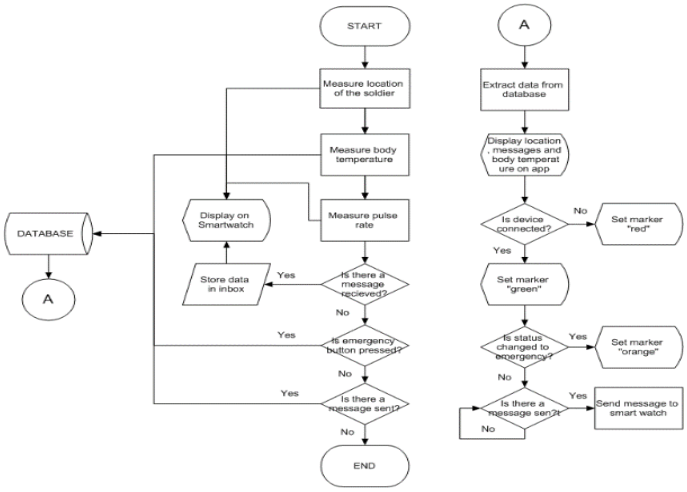

Fig 2: System Flowchart

4.1. Arduino Microcontroller Module

Figure 3 serves as the control for other components connected to the microcontroller. Arduino is an open-source physical computing platform based on easy-to-use software and hardware. Arduino boards are capable

of receiving data using sensors, switches, and other input devices and turning it into an output–LED display, activating a motor, and returning a set of data. [19]

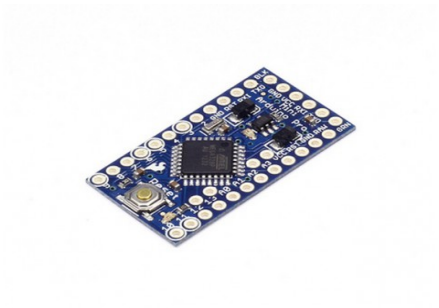

Fig 3: The Arduino Pro Mini, seen from the Arduino store website. Photographed by Arduino [20]

4.2. GPS Module

Figure 4 measures the value of the longitude and the latitude based on the position of the Smartwatch. It has an output, which is the position or the location of the Smartwatch. After measuring the location of the device, the data gathered will be transferred to the microcontroller. A signal is continuously broadcasted by the GPS satellites that include a pseudorandom code, a sequence of one that the receiver can translate, a message that has the time transmission time scale**,** and the location of the GPS satellite. [21], [22], [23]

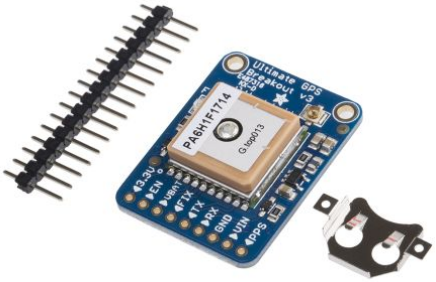

Fig 4: The Adafruit Ultimate GPS Breakout, seen from the Adafruit website. Photographed by Adafruit [24]

4.3. Pulse Sensor Module

Figure 5 is a well-designed plug-and-play sensor that can take pulse rate via blood flow seen through the skin. [25] The sensor measures the number of beats per unit of time. The module outputs the heartbeat of the soldier. The module also transfers the value to the microcontroller.

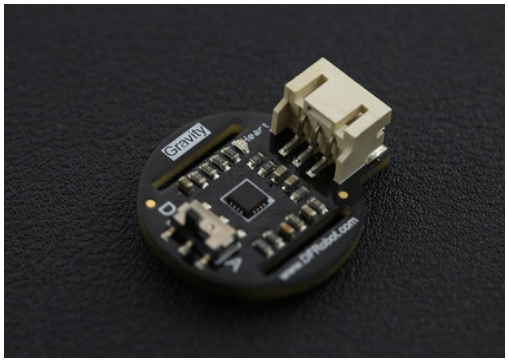

Fig 5: The Gravity: Heart Rate Monitor Sensor, seen from the DFRobot website. Photographed by DFRobot drive the future [26]

4.4. Body Temperature Module

Figure 6 measures the temperature of the wearer of the device. [27] The microcontroller then processes the data received from the module.

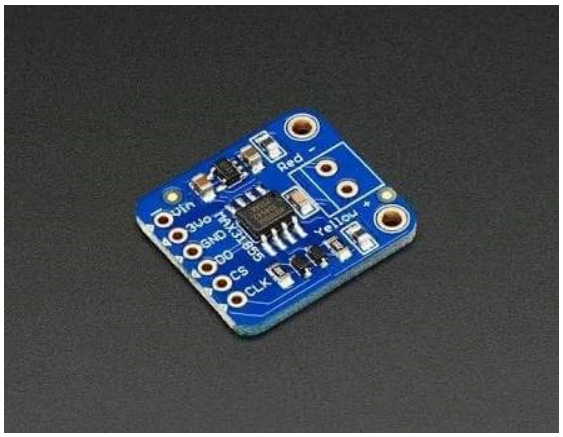

Fig 6: The Thermocouple Amplifier MAX31855 Breakout Board, seen from Adafruit website. Photographed by Adafruit [28]

4.5. Mobile Application Module

Figure 7 is used for communication and monitoring the base unit of the soldier. The application has input in the system, which includes the soldier's location, health status, and message notification if there is one. The module will display the location of each soldier along with their health status and message notification. Lastly, the application will display all the information needed to monitor each soldier during the war.

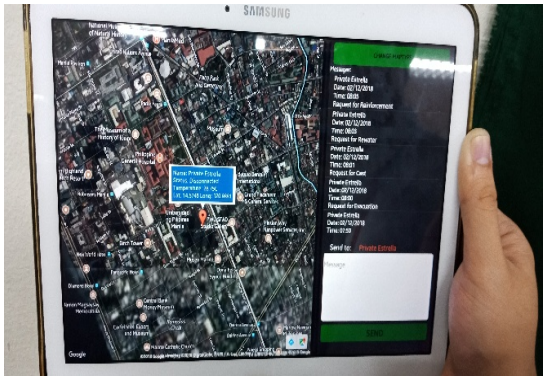

Fig 7: Mobile Application Module

4.6. Base Unit Receiver Module

Figure 8 is used to receive all data sent by the military smartwatch. It is composed of a GSM module, microcontroller, Wi-Fi module, battery with power boost and a switch. The GSM module receives all the data and sends it to the microcontroller, which will process the data. The Wi-Fi module is responsible for sending the data to the database that the Android application will access.

Fig 8: Base Unit Receiver Module

4.7. Military Smart Watch Module

Figure 9 is used to communicate soldiers to the base unit. It is composed of a microcontroller, GPS module, GSM module, body temperature sensor, pulse sensor, battery with power boost, and OLED display. The microcontroller will process all the data coming from the GPS module, GSM module, and sensors. The location, body temperature, and time will be displayed on the OLED display. It has an inbox menu that stores and

displays five messages coming from the base unit. A send menu is also shown on the screen for sending preset messages to the base unit.

Fig 9: Military Smart Watch Module

4.8. Analysis

With the use of GSM technology, the research GSM-enabled military smartwatch provides continuous location updates in real-time. This feature improves situational awareness for both command centers and the wearer. While other technologies, such as GPS-based trackers, provide comparable real-time tracking capabilities, they may experience signal loss indoors or in crowded urban areas.[29]

Vital sign monitoring, such as blood pressure, body temperature, and heart rate, is integrated into the research wristwatch. By giving vital health information to medical professionals and the wearer, this function improves military safety. For soldiers in the field, it can be inconvenient if existing military wearables only provide a limited amount of vital sign monitoring or necessitate additional equipment for thorough tracking.[30]

In order to improve overall interoperability and efficacy, the research wristwatch is made to easily interface with current military systems, including communication, medical, and command and control systems. While some military wearables on the market now might have comparable integration capabilities, there might be compatibility problems or restricted interoperability with legacy systems, necessitating further adaptation.[31]

5. Results and Discussion

Military smartwatches with GSM capability for real-time tracking and vital sign monitoring are significant technological achievements with wide-ranging applications. These smartwatches improve situational awareness and facilitate better-informed decision-making by giving commanders a real-time picture of the whereabouts and health conditions of their troops through the integration of GSM technology. Heart rate, body temperature, stress levels, and other vital indicators are continuously monitored. This allows for the early detection of health problems or injuries, enables timely medical intervention, and ultimately improves military safety and well-being on the battlefield. Furthermore, by analyzing the data gathered by these smartwatches, resource allocation and emergency response may be optimized, hence increasing mission efficacy.

However, challenges such as integration with existing military infrastructure, data security concerns, and the need for comprehensive training and adoption strategies must be addressed to fully realize the potential benefits of this technology while mitigating potential risks. Overall, the GSM-enabled real-time tracking and vital signs monitoring military smartwatch represents a significant step forward in enhancing military capabilities and protecting the lives of soldiers in the field.

6. Summary of Findings

Technology has been pushed through creating more inventions. As technology evolves, military equipment continues to adapt to these changes. New technology devices are designed for military purposes, and with that, the researchers came up with the idea of developing an army smartwatch that would help the base unit monitor the soldiers, make communication convenient, and at the same time be convenient for the soldier as they carry the device. The project aims to create a smartwatch that is capable of sending and receiving messages and, at the same time, monitors its location and body temperature. Also, the project aims to develop an android

application that would be used to track the exact location of the soldiers and display their conversations during the war. For communication, the GSM module was used to send data between a soldier and the base unit. A GPS module was used to generate the longitude and the latitude to determine the location of each soldier. For processing all the data coming from the watch, Arduino Pro Mini and Nano are used. C++ and Java are the main languages used for all the software. After a series of tests, it showed that the project met all the desired objectives and passed all the engineering requirements. Existing command and control systems can be connected with military smartwatches that have GSM-enabled tracking and vital sign monitoring. Commanders can make better decisions because of this integration, which gives them real-time situational information on the whereabouts and health of their troops. [13] In addition to talking with other military communication devices like radios and satellite communication terminals, smartwatches may also interact with one another because of their GSM capacity. The smooth communication between soldiers and their commanders is ensured via interoperability, which applies to any communication medium. [32] Medical staff can get real-time information on soldiers' health state by integrating military smartwatches with vital sign monitoring capabilities with battlefield medical systems. In the event of injuries or other medical emergencies on the battlefield, this integration allows for speedier and more efficient medical responses.[33]

7. Conclusions

The researchers conclude the following in the study:

- In order to accurately identify the location of a soldier, a GPS module was used to determine the latitude and the longitude of the device. Every change in the area will notify the location in the database.
- In order to create a path of communication between the soldier and the base unit, a GSM module was used because the signal of a GSM is better than the signal of an internet. The GSM is used to transmit the data coming from the watch to the base unit and vice versa.
- Pulse and temperature sensors were used to monitor the soldier’s pulse and body temperature. The sensors were placed effectively to gather the most accurate data that the watch can get when the device is worn. The pulse sensor finds the flow of blood through the skin and detects the blood pulse through it. The external temperature may affect the sensor's readings.
- To create a mobile application for Android, an application called Android Studio was used to program the mobile application. The mobile application extracts the data from the database processes the data received and displays the data in the screen.
- By continuously monitoring vital signs such as heart rate, body temperature, and even stress levels, these smartwatches can provide real-time alerts to commanders if any soldier's health deteriorates. This allows for prompt medical attention, reducing the risk of casualties due to health-related issues on the battlefield.
- Commanders may always be more aware of where their troops are at all times because of real-time tracking capabilities. This can be essential for planning operations, guaranteeing soldiers' safety, and efficiently adapting to shifting situations on the battlefield.
- In emergencies, such as a soldier being wounded or separated from their unit, the real-time tracking feature can enable rapid response and rescue operations, potentially saving lives.

8. Recommendations

The researchers recommend the following list in order to improve the project’s aesthetics, protection, and data transmission efficiency.

- To make the smartwatch a waterproof device. This is to make the device adaptive to rainy weather.
- To improve the transmission of data. This will allow the data to be received immediately by the mobile application.
- To use a battery with higher capacity. This is to make sure that the smartwatch will last longer on the battlefield.
- Apply other technology to charge the battery. This is for emergency cases if the battle has been extended to the limit of the battery/

- To allow the two units to communicate through call. This is to reduce the bulky equipment of the soldiers
- To apply security in the system. This is to ensure nobody can access the conversations and soldiers' data.

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