Smart Accident Response System: Non-GPS Location and Nearby Hospital Detection with Medical Record Transmission

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***Abstract*—This paper introduces an innovative Smart Accident Response System designed to address limitations in conventional emergency medical services for vehicular accidents. Unlike previous systems relying on GPS modules and their antenna, this device employs non-GPS Google geolocation methods for instant accident location identification. Additionally, it integrates the Google geoplaces API to detect directions to the three nearest hospitals within a 5 km radius, thereby optimizing medical assistance response times. A notable feature of the system is its ability to promptly email the medical records of all individuals involved in the accident, along with directions to the accident site, to healthcare professionals and their family members within a 2-minute timeframe. By overcoming challenges related to location accuracy, especially in urban canyons or areas with poor satellite visibility, delayed medical information and unavailability of on-site medical records during rescue operations, and inefficient communication with family members and nearby doctors, our Smart Accident Response System aims to significantly enhance emergency medical responses, leading to improved patient outcomes in critical situations. The presented solution demonstrates a novel approach to leveraging geolocation and geoplaces API for intelligent accident response, making it a valuable contribution to the field of smart healthcare solutions.**

***Index Terms*—vehicle accident, geolocation, geoplaces, medical records, smtp, esp8266, Google Maps, spreadsheet.**

I. Introduction

Around 20-50 million people get non-fatal injuries in road accidents each year., which claim the lives of about 1.3 million people worldwide [1]. Based on estimated global road traffic fatalities 29% of all road traffic deaths are car occupants and 28% are motorized 2- or 3-wheelers [2]. In the year 2021, there were 4,12,432 recorded road accidents in India, resulting in 3,84,448 injuries and 1,53,972 fatalities. However, 18 to 45 is the age group most severely affected by car crashes, and this age group accounts for over 67% of all accidental deaths [3]. Efficient emergency response is crucial in reducing the impact of traffic accidents on human lives. The results of the survey show that a just one-minute decrease in accident response time results in a six percent gain in lives saved. This shows the importance of minimizing the duration between an accident and the arrival of emergency responders, particularly those equipped with prior information about the victim's medical history, allergies, and age. Such response strategies not only contribute to the prevention of traffic fatalities but also facilitate the provision of immediate and tailored medical services on-site.

A. Motivation, Objective and Key Contribution

The State and Union Police Departments have recorded a total of 4,61,312 traffic incidents. Territories (UTs) within the nation during the 2022 calendar year, claimed 1,68,491 lives and injuries in India [3]. The motivation behind this research is driven by the challenges faced by individuals or family members involved in vehicular accidents. Issues such as lack of location awareness delayed medical assistance, and communication hurdles underscore the critical need for an intelligent emergency response system.

Modern technologies and researchers utilize GPS, GSM, GNSS, or GPRS-based techniques to retrieve the current location and send messages [4]. As this module determines the present location, the antennas present in the modules are utilized to establish a connection with GPS satellites and gather coordinates through a low-profile, GPS circular polarization patch antenna [4], [5], [6]. This method is not practically possible as communication through satellite would not work effectively due to environmental factors like Weak signal strength in remote areas or bad weather hampers accuracy, Insufficient satellite visibility affects the precision of coordinates. Delays in obtaining accurate location data, and medical records of victims impact emergency response.

This research is committed to comprehensively addressing these challenges. The primary objective is to introduce a low-cost affordable small-sized device. using advanced and latest Google Cloud services to perform all the necessary task for free without the need for additional hardware like other IOT Devices required [19]. The goal is to provide a quick, seamless, and tailored response to vehicular accidents within a 2-minute timeframe, with aspirations of further reducing this to 30 seconds through continuous improvement and additional studies. This research not only presents a novel approach but seeks to demonstrate its practicality and effectiveness in addressing critical situations encountered during accidents.

II. Organization of Article

The organization of the article follows a standard structure for a research paper. Here is a breakdown of the organization:

I. INTRODUCTION: The introduction provides background information on the limitations of conventional emergency medical services for vehicular accidents. It introduces the Smart Accident Response System, emphasizing its reliance on non-GPS Google geolocation methods and integration with the Google geoplaces API.

III. LITERATURE REVIEW: This section reviews existing technologies and solutions for emergency response systems, highlighting limitations in traditional systems, GPS-based location systems, mobile health applications, and hospital navigation systems.

IV. ADDRESSING GAPS WITH THE PROPOSED DEVICE: The paper details the innovative features of the Smart Accident Response System, including automated identification and medical history retrieval, GPS-free location determination, real-time hospital information retrieval, and automated communication.

V. METHODOLOGY: The methodology section outlines the hardware components and connectivity, such as the integration of the ESP8266. It explains the geolocation method using nearby cell towers or access points, the structure and purpose of Excel sheets, and the HTTPS requests for information retrieval and storage. Additionally, it covers the email communication process using SMTP.

VI. RESULTS: IMPLEMENTATIONS AND DISCUSSION: This section presents the flow chart of the device working, testing, and simulation phases. It discusses real-world deployment considerations and the potential implications of the proposed device.

VII. FUTURE ROADMAPS: The future roadmaps section suggests opportunities for refinement and enhancement, including enhanced medical record security, machine learning integration, user interface development for emergency responders, and public awareness campaigns.

VIII. CONCLUSION: The conclusion summarizes the key findings and contributions of the research, emphasizing the transformative potential of the Smart Accident Response System in the field of emergency response systems.

III. Literature Review

The field of emergency response systems has witnessed significant advancements in recent years, with various solutions aiming to address the challenges associated with effective assistance during vehicle accidents. This section reviews existing technologies and solutions, emphasizing their limitations and highlighting the innovative features of our proposed device.

TABLE I
A COMPARATIVE SUMMARY OF THE DIFFERENT TECHNIQUES IN USE AS A SMART ACCIDENT RESPONSE SYSTEM

Reference	***Technology Used***	***Limitation***
M. Syedul et al. (2012)	GPS for location and GPRS, GSM to send text messages.	external Antenna for GPS and additional SIM card is required.
Baode Li et al. (2023)	Machine learning algorithms decision tree, classification and regression tree and random forest.	For more accurate prediction it requires more data models (trees), which results in a slower model.
S. Karthik. et al. (2023)	GPS for location and RF Transceiver for commu. with hospitals.	Need large antenna and more power for longer distance transmission.
H. Srivastava et al. (2022)	Used MPU9250,9-DoF,MEMS,IMU, Arduino nano,ESP8266 and GPS.	Very high cost as the whole process can be done using esp8266 only.
M. Almomani et al. (2011)	Used GPS, GPRS and GSM	external Antenna for GPS and an additional SIM card is required.

A. Traditional Emergency Response Systems

- Traditional systems relying on phone calls face limitations when individuals are incapacitated or unable to dial phone numbers to make calls.
- Possibly the people around the victim are not helping because of fear and just ignoring it, also known as the Bystander effect [7], [9].
- Some researchers propose traffic emergency response systems using data mining and the Internet of Things for quick and accurate control [8].

B. GPS-Based Location Systems

Several solutions leverage GPS technology to determine the location of an accident [4], [5]. However, these systems often require a clear line of sight to GPS satellites, rendering them less effective in areas with obstructed signals, such as urban canyons or dense foliage.

C. Mobile Health (mHealth) Applications

Mobile health applications offer features like storing medical information and sharing location data [10]. However, these solutions may rely heavily on user input, which can be challenging in emergencies, especially when individuals are unable to interact with their devices.

D. Hospital Navigation Systems

- Some systems lack real-time accident data, leading to delays in emergency response.
- Misdirection to hospitals ill-equipped for specific medical needs is a potential consequence.
- Ambulances may struggle to promptly locate accident sites.
- Lack of awareness about crucial victim details (e.g., age, blood type, allergies) hinders effective emergency response.

Survey findings emphasize the critical nature of communication in emergencies. Efficient communication of accident site details and victim requirements is crucial [11].

IV. Addressing Gaps with the Proposed Device

The device presented in this paper stands out as a low-weight, cost-effective, small-sized solution that bridges these identified gaps:

A. Automated Identification and Medical History Retrieval

By using the ESP8266 hardware and connecting to smartphone hotspots, the device can automatically identify individuals inside the vehicle and seamlessly retrieve their medical history stored on a dedicated website Figure 1. This eliminates the need for manual input during the critical moments following an accident. Before purchasing a vehicle all family members need to register themself with the device by sharing their mobile ssid, password and medical records unique ID. To obtain a unique ID one should register on a common website like an EHR (Electronic Health Record) [13], [10]. Later this device can be modified by adding a camera to recognize the family member which also increases the device's cost.

B. GPS-Free Location Determination

The device's innovative use of a geolocation API that taps into nearby cell towers or access points (AP) offers a GPS-free method for pinpointing the vehicle's location. This addresses the limitations of traditional GPS systems, ensuring accurate location data even in challenging environments. According to the provided study [12], geolocation is based on a positioning algorithm that estimates a mobile terminal's (MT) location coordinates by analyzing metrics reported by location-sensing devices.

C. Real-time Hospital Information Retrieval

Real-time retrieval of the names, directions, and contact details of the three closest hospitals is made possible by the integration of two Excel sheets: one for hospital details and the other for accident data storage. The device easily connects with Google Places API to fetch nearby hospitals from current coordinates, improving emergency services' responsiveness and giving hospitals access to crucial information.

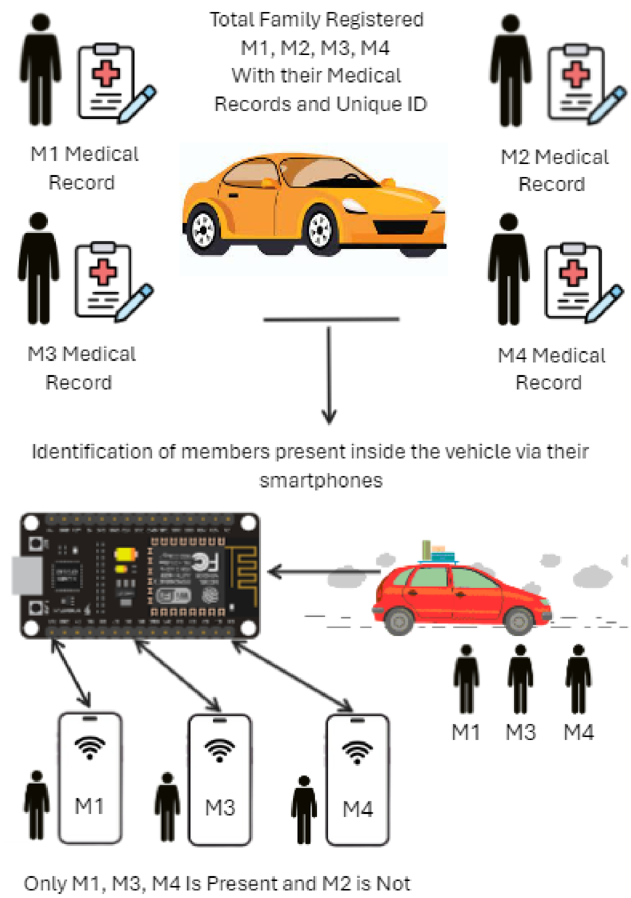


Fig. 1. Identification of members sitting inside the vehicle using esp8266

D. Automated Communication

The device's ability to initiate HTTP(secure) requests, coupled with the ESP8266's communication capabilities, ease the communication process. Automated email alerts via SMTP to both family members and medical facilities ensure that pertinent information, including the victim's medical history and precise location, reaches the relevant authority promptly.

The proposed device, built upon the ESP8266 hardware and employing an integrated approach to identification, location determination, and communication, represents a significant advancement in emergency response systems. This paper will further detail the design, implementation, and evaluation of the device, underscoring its potential to redefine the efficiency and effectiveness of accident assistance on an international scale.

V. Methodology

Figure 2 illustrates the device working overview at the accident site. This device can easily be embedded with the car as it is just 4x2 cm in size and weights nearly 20 grams also it is attached to a Lithium-ion chargeable battery, if the car battery stops during a high-impact accident then it can also

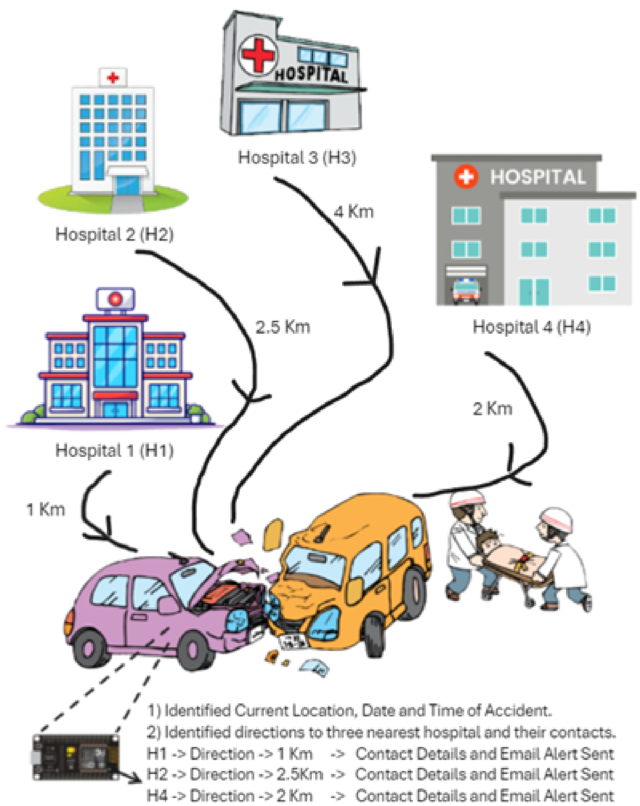


Fig. 2. Detection of Nearby Hospitals in range of 5 Km

operate by itself which makes this device robust and design cost as low as $2 with the processing time of 2 minutes.

A. Hardware Components and Connectivity

ESP8266 Integration: The heart of our device lies in the ESP8266, a versatile and cost-effective Wi-Fi module. This hardware component serves as the central hub for data processing and communication. It connects to smartphones by intelligently detecting and linking to their hotspots, allowing seamless interaction without the need for user intervention. Medical History Retrieval: The medical history of each family member is stored securely on a dedicated website. The ESP8266, upon detecting the individuals inside the vehicle by connecting to each person's mobile hotspot, establishes a connection to the website through the smartphone hotspots. Using unique identifiers assigned to each family member, the device fetches the corresponding medical records, ensuring a swift and automated retrieval process.

B. Geolocation Method Using Nearby Cell Towers or APs

Location Determination: To pinpoint the vehicle's location without relying on a conventional GPS module like neo-6m [13], our device employs a geolocation method based on nearby cell towers or access points (APs). By leveraging an API designed for this purpose, the device communicates with the surrounding cellular infrastructure and utilizes the Google geolocation API to fetch the current location. This innovative approach ensures reliable location data even in areas where GPS signals may be obstructed.

C. Excel Sheets Structure and Purpose

Hospital Details Sheet as a Database: One Spreadsheet is dedicated to storing comprehensive hospital details, including names, and contact information like emails, and phone numbers which can not be accessed publicly by anyone. This structured database serves as a quick reference for the device during an emergency, ensuring that the three nearest hospitals can be contacted in an emergency.

Accident Data Sheet: Another Excel sheet is designed to capture and store crucial accident information, such as date, time, location map, and directions to the three nearest hospitals. This sheet acts as a dynamic repository that facilitates real-time communication with emergency responders, medical facilities, family members, and victims.

A	B	C	D
Hospital Name	Email	Phone Numbernate Phone Nur	
Shri Mata Vaishno Devi N	20bec081@smvdu.ac.in	1111111111	1111111100
Medical Aid Centre	gcms.friend@gmail.com	2222222222	2222222200
Ayurvedic Dispensary	ɔ01.gcmsfriend@gmail.cc	3333333333	3333333300
PHC Tikri (Block HQ)	ɔ00.gcmsfriend@gmail.cc	44444444444	44444444400
RAVI MEDICOS NOMAIN	saathystartup@gmail.cor	5555555555	5555555500
Government Sub District	ıdwallah.jammu@gmail.c	6666666666	6666666600

Fig. 3. Hospital Details Sheet: storing hospital contact details

	A	B	C
1	Date (m/d/y)	Time	Accident Location
2	11/24/2023	4:12:51 PM	View on Map
3	11/24/2023	4:13:21 PM	View on Map
4	11/26/2023	12:38:57 AM	View on Map
5	11/27/2023	12:10:21 PM	View on Map
6			google.com/ı
7			

Fig. 4. Accident Data Sheet: storing live accident location with current date and time

D	E	F
Direction To Nearest Hospital 1	Direction To Nearest Hospital 2	Direction To Nearest Hospital 3
/aishno Devi Narayana Superspecia	: PHC Tikri (Block HQ)	: Medical Aid Centre
/aishno Devi Narayana Superspecia	: PHC Tikri (Block HQ)	: Medical Aid Centre
/aishno Devi Narayana Superspecia	: PHC Tikri (Block HQ)	: Medical Aid Centre
/aishno Devi Narayana Superspecia	Hospital Name: : Shri Mata Vaishno Devi Narayana Superspeciality Hospital Email: 20bec081@smvdu.ac.in Phone Number: 1111111111 Alternate Phone No.: 111111100	: PHC Tikri (Block HQ)

Fig. 5. Accident Data Sheet: Storing directions and contact details of three nearby hospitals

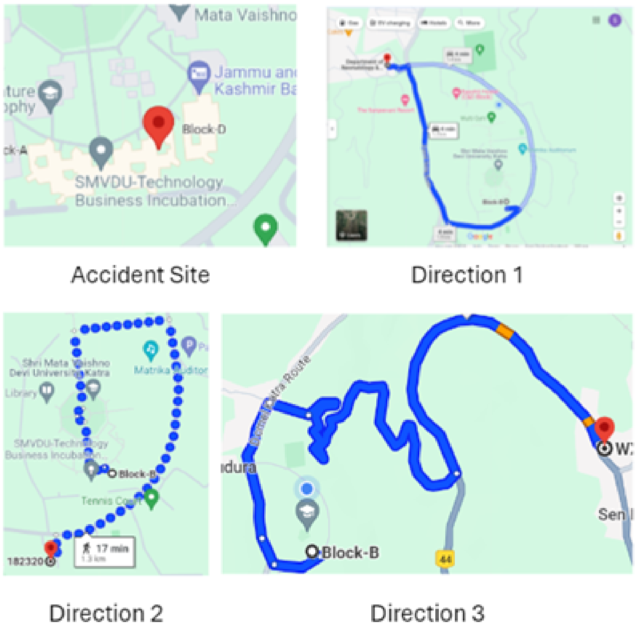


Fig. 6. Showing Accident location and directions to 3 nearest hospitals

D. HTTPS Requests for Information Retrieval and Storage

- Hospital Information Retrieval: When an accident occurs, the device initiates an HTTPS request to the Excel sheet storing accident data. This sheet then triggers an HTTPS request to the Google Places API, fetching the names, directions, and contact details of the three nearest hospitals based on the accident location. The obtained information is saved in the Excel sheet for reference.
- Accident Data Storage: Subsequently, the ESP8266 sends an HTTPS request to the same Excel sheet storing accident data, facilitating the storage of updated accident details, including date, time, and location. This information is critical for coordinating emergency responses and ensuring accurate and up-to-date records.

E. Email Communication Using SMTP

- Automated Email Alert Process: In the event of an accident, the ESP8266 initiates an email alert process to notify nearby hospitals, including family members and medical facilities. The device employs the Simple Mail Transfer Protocol (SMTP) to facilitate seamless and secure email communication [15].
- Email Content: The email content includes critical information such as the names and unique URLs of family members, the victim's medical history, the link to the Excel sheet containing accident details, and the precise location of the incident. This comprehensive email ensures that both family members and medical facilities receive pertinent information for an informed and expedited response.
- Secure Transmission: The ESP8266, equipped with the necessary security protocols, securely transmits these emails to predefined recipients, safeguarding sensitive medical information during the communication process.

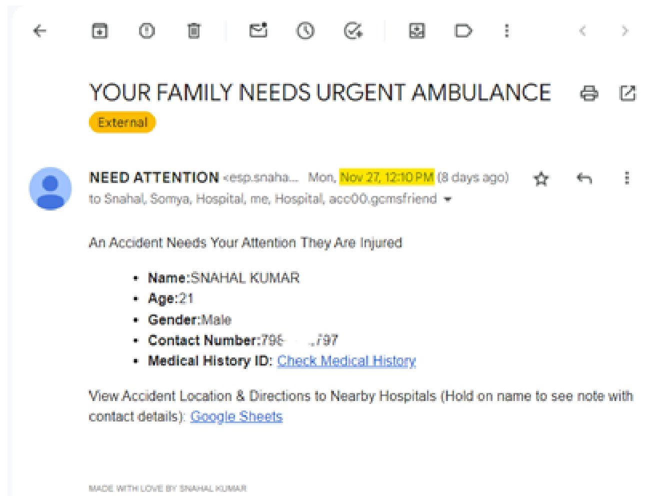


Fig. 7. Email Alert Received at 12:10 Pm

In Figure 4 you can see the accident time is 12:10:21 Pm and the email alert received time in Figure 7 is 12:10 Pm which signifies the response time of the device.

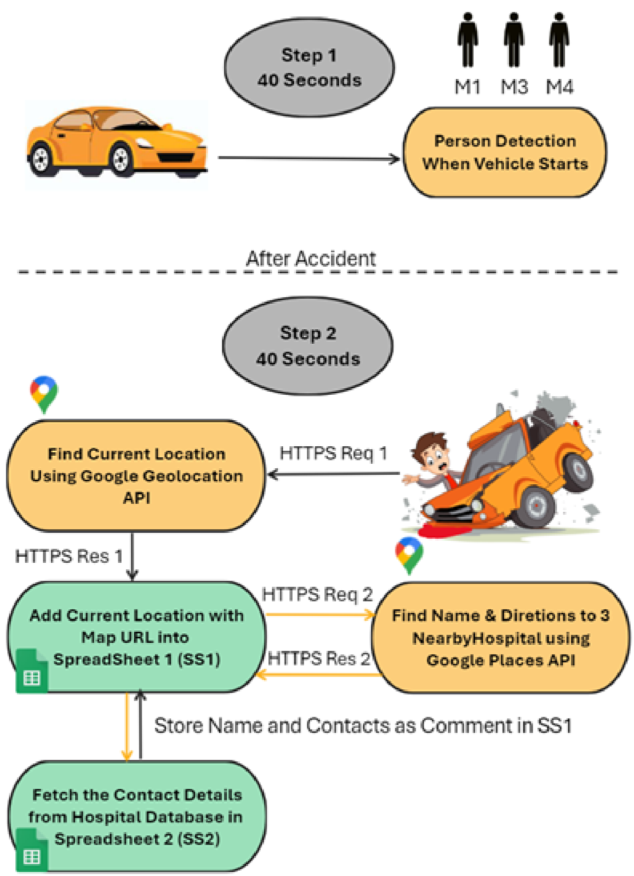


Fig. 8. Flow Chart of Device Working

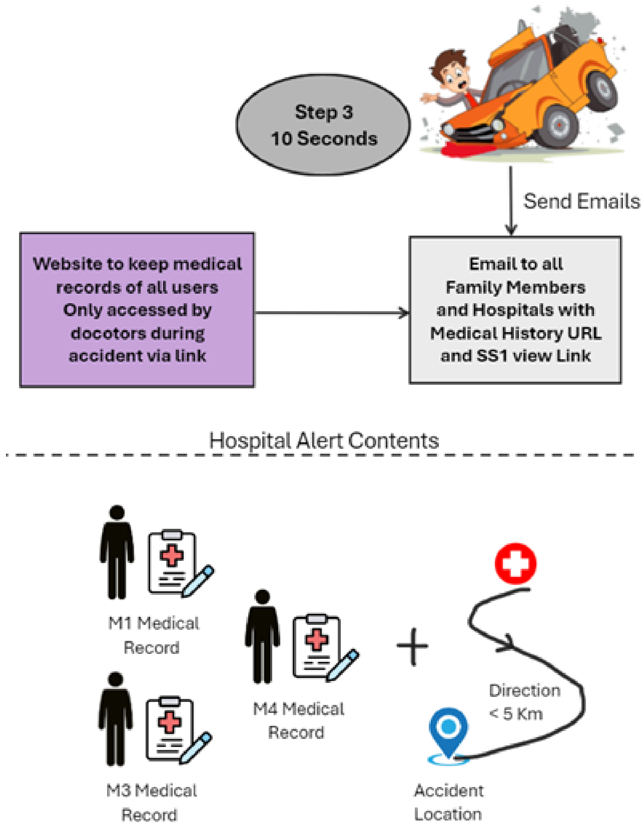
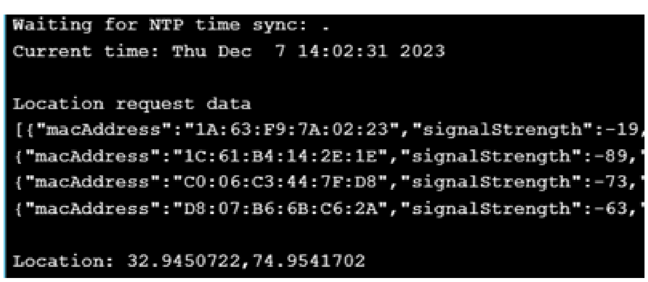


Fig. 9. Email Alert Content

VI. Results: Implementations and Discussion

Figure 10. Shows the result on the serial monitor of Arduino ide about the current location via geolocation service. The first part of the code execution is member detection. The second part is detecting the current location using geolocation API. The third part shows that the device is doing HTTPs requests to store the location in a spreadsheet and also find the nearby hospital, and the last part of the execution represents that the email has been sent to all the family members and hospitals. The testing and simulation phases generated a dataset compris-



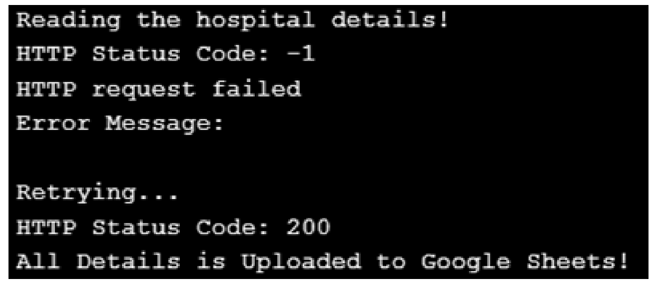
```
Waiting for NTP time sync: .
Current time: Thu Dec  7 14:02:31 2023

Location request data
[{"macAddress":"1A:63:F9:7A:02:23","signalStrength":-19,
{"macAddress":"1C:61:B4:14:2E:1E","signalStrength":-89,
{"macAddress":"C0:06:C3:44:7F:D8","signalStrength":-73,
{"macAddress":"D8:07:B6:6B:C6:2A","signalStrength":-63,

Location: 32.9450722,74.9541702
```

Fig. 10. Serial Monitor showing current location

ing various accident scenarios, each with unique parameters, such as location, time, and medical history. This dataset will be instrumental in further refining the device's algorithms, optimizing its performance, and validating its robustness in real-world conditions. In Figure 11 the device shows its error recovery process, if it fails to fetch or upload details to a spreadsheet then it will retry it which improves its error response. The device hardly takes 30 seconds after storing the data in a spreadsheet and sending an email to all the family members registered with the vehicle and 3 nearest hospitals, which reduces the response time.



```
Reading the hospital details!
HTTP Status Code: -1
HTTP request failed
Error Message:

Retrying...
HTTP Status Code: 200
All Details is Uploaded to Google Sheets!
```

Fig. 11. Retrying if no response

In summary, the results indicate that the proposed device effectively addresses the challenges outlined in the methodology. The seamless integration of hardware components, geolocation methods, Excel sheets, and SMTP-based email communication culminates in a comprehensive emergency response system. The subsequent sections of the research paper will delve into a detailed analysis of the results, discussing potential improvements, real-world deployment considerations, and the broader implications of this innovative device in the field of accident assistance.

Fig. 12. Device Image Size

VII. Future Roadmaps

While the device has showcased remarkable functionality, there are opportunities for refinement and enhancement:

- Enhanced Medical Record Security: Implementing additional encryption measures for medical records in mHealth [10] can further enhance the security of sensitive information during communication.
- Machine Learning Integration: Exploring machine learning algorithms for predictive accident analysis [16],[17] and optimized hospital recommendations could enhance the device's responsiveness and adaptability.
- User Interface for Emergency Responders [18]: Developing a user interface tailored for emergency responders to visualize accident data and medical information in real-time can streamline on-site decision-making.
- Public Awareness Campaigns: Conducting public awareness campaigns to promote the adoption of the device and educate communities about its benefits can contribute to widespread acceptance and utilization.

As the device progresses from the research and development phase to real-world deployment, the strategic collaborations will further amplify its role in saving lives and minimizing the impact of delayed assistance during vehicular accidents.

VIII. Conclusion

In conclusion, the development and testing of the proposed device for efficient assistance during vehicle accidents have yielded significant findings, pointing towards a transformative solution in the field of emergency response systems. The significance of this device lies in its ability to revolutionize the landscape of emergency response systems. By addressing the identified challenges, the device offers a comprehensive solution that combines hardware ingenuity, advanced Google API, real-time data retrieval, and secure communication. Its cost-effectiveness further enhances its accessibility and potential impact, particularly in scenarios where traditional systems may fall short.

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