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Trek Monitoring System: Enhancing Safety and Adventure in the Outdoors using Arduino UNO and NodeMCU

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Abstract

The Trek Monitoring System is a comprehensive hardware and software research initiative aimed at ensuring the safety and navigation of trekkers under the purview of Trekking Companies. This system addresses potential health and weather related challenges that may arise during treks, providing trekkers with a reliable guide to reach their destinations safely. The research encompasses a user friendly website offering essential information on various locations, detailed itineraries, and real time weather forecasts. Additionally, a specially designed hardware gadget, comprising a Temperature Sensor, Pulse Sensor, Arduino, LCD I2C Display, NodeMCU, and GPS Module, presents trekkers with instant temperature and pulse data while transmitting the same, along with precise GPS location, to the website. This facilitates continuous monitoring by Trekking Companies, enabling prompt assistance whenever necessary. The system further ensures regular assessment of trekker's health conditions, contributing to timely search and rescue operations when it is necessary. By providing an efficient and secure trekking environment encompassing weather forecasts, location tracking, and health monitoring, the Trek Monitoring System promotes a seamless and protected trekking experience.

Keywords: Trek Monitoring System, Safety, Navigation, Trekkers, Weather Forecasts, Health Monitoring, Location Tracking, Real time Data, Assistance, Trekking Adventure.

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1. Introduction

1.1 Background

Trekking has always been an adventurous and risky journey. Trekkers often encounter many problems such as suffocation, altitude sickness, misguided from the track, and unexpected weather changes which can ruin their trek. Trekking in Nepal is a relatively safe activity, but a decision to embark on a trek in Nepal should be individualized, with an understanding of the problems related to remoteness, altitude, and illness in the absence of medical facilities. Despite what many may perceive, in Nepal, trekking does not always entail travelling off by yourself into an unknown terrain. As they walk along the well marked trekking paths, travelers will often discover quite the opposite; hundreds of locals pass through each day as they haul food, water, and other odd necessities back to their tiny villages, along with dozens of fellow trekkers. The regularly spaced villages and teahouses allow trekkers good opportunities to rest and recover, either for a few minutes or the night. The strong culture and unreserved friendliness of the Nepalese people can also be witnessed as one traverse the hill tracks.

1.2 Motivation

The research focuses on trek monitoring, as newcomers to trekking can easily be misguided, especially in areas where there is no human assistance. One of the deadliest experiences, the Mardi Trek, served as motivation to select this research topic. The trekking team of Pashchimanchal Campus, Nepal was led to the upper base camp in a danger zone and lost their way while searching for the base camp sign. Sudden climatic changes, extreme cold, and fog with poor visibility left the trekking team demotivated, causing delays in their regular schedule. Luckily, the team returned safely. Learning from these experiences, a research design was devised to assist as a tourist guide, monitor, navigate, and provide necessary health precautions and information, making the journey less risky and more adventurous.

During the trekking journey, trekkers encounter several difficulties, such as sudden deterioration in health due to altitude, weather changes, and fatigue. Trekkers may also get misdirected from their trekking path, leading to various challenges. Sudden weather changes can create obstacles for trekkers during their journey. The research aims to address the highlighted challenges through the use of technologies, creating a safer and more enjoyable environment for trekkers.

1.3 Research Objectives

The main objectives of the research are listed below:

- To provide necessary information about the health condition of trekkers to the trekking company.
- To provide information about geographical locations and weather forecasts to the trekkers.
- To perform regular monitoring and navigation of trekkers so that necessary assistance can be provided in the time of need and any unexpected emergencies.

1.4 Research Scope and Applications

The system is designed to focus on the health conditions of trekkers with the accessibility of geographical locations and weather forecasting. We will develop the necessary skills to get our idea on the web and make it available to the trekking company considering effective and safe monitoring of trekkers. At the initial stage, we will develop the research for locallevel use and later on for nationwide use so that proper testing and integration of the research can be done. Affiliation programs can be implemented so that many customers can visit the site this serves as one of the best marketing strategies.

2. Problem Statement

Various research works have been carried till date for the safety of mountaineers like real time Climber Monitoring developing an E-Health Sensor Platform using Arduino and Raspberry Pi (Biometric Sensing). The systems were devised to help the mountaineers in tracking the Health and the GPS, etc. Through the related study it was found that there is no such specific research that are available in use in real time for monitoring or helping the trekkers. As trekking is a well adventurous and risky journey, one can face various issues like sudden climatic change, health hazards, separation from the team, and may need emergency support and rescue. There are lots of trekking companies in Nepal which ensure the safety of their customers and are providing very effective services too but the major problem with these companies is they are highly dependent on their guides and the company has no control and information about their trekkers. Imagine the scenario, some people get separated from their team and get lost on the way. In such conditions, it becomes very difficult to find those people. Similarly, many more problems may arise in such situations, so the research tries to solve those

problems with the use of technology. It will monitor the health condition, find, track, and navigate the location of the trekkers. It will predict the weather conditions of the area. It will send information to the main office of the trekking company. From the study of previous research reports, it was understood that the measured data was limited only between trekkers and the guide and there was no transfer of data to the website because of this, the trekking company could not access the trekker's location. Hence, the proposed research tries to overcome these issues by designing a prototype gadget and a website that regularly inspects and monitors the status of trekkers. The satellite image, GPS location, health related data, weather forecasting, trekking destinations, and a lot of information are included on the website. Thus, with keen interest, ample study, and tremendous efforts were contributed to building and growth of the research.

3. REQUIREMENTS

3.1 Hardware Requirement

The research comprises the following electronic components:

1. Arduino Uno
2. NodeMCU
3. GPS Module
4. Temperature Sensor
5. Pulse Sensor
6. LCD I2C Display
7. Jumper Wires
8. Bread Board

3.1.1 Arduino Uno

Arduino as shown in Figure 1 is an open source electronics prototyping platform based on flexible, easy-to-use hardware and software. Arduino can sense the environment by receiving input from a variety of sensors and can affect its surroundings. Arduino research can

be standalone, or they can communicate with software running on a computer. In this development, Arduino UNO is used as the main controller because it satisfies these conditions:

a) Microcontroller board based on 8-bit ATmega328P.

b) 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button.

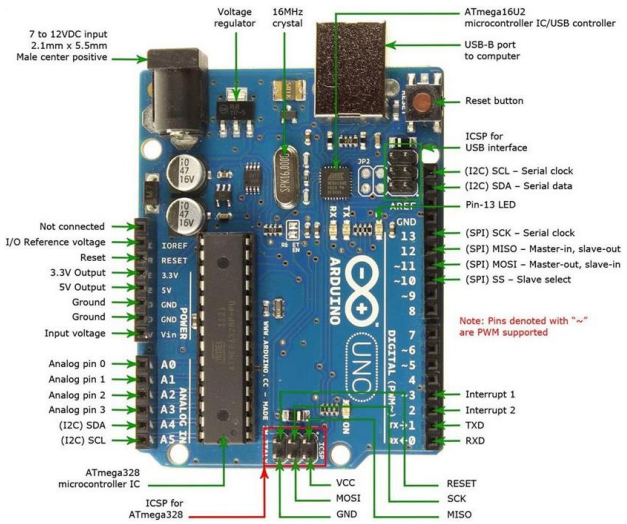

Figure 1. Arduino Uno Pin Diagram

3.1.2 NodeMCU

The NodeMCU as shown in Figure 2 is open-source software and hardware development environment built around an inexpensive System-on-a-Chip (SoC) called the ESP8266. The ESP8266, designed and manufactured by Espressif Systems, contains the crucial elements of a computer: CPU, RAM, networking (Wi-Fi), and even a modern operating system and SDK. That makes it an excellent choice for Internet of Things (IoT) research of all kinds.

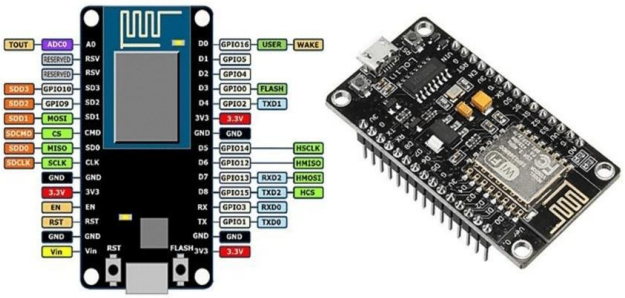

Figure 2. NodeMCU

3.1.3 GPS Module

The NEO-6MV2 as shown in Figure 3 is a GPS (Global Positioning System) module and is used for navigation. The module simply checks its location on Earth and provides output data which is the longitude and latitude of its position. It is from a family of standalone GPS receivers featuring the high performance U-blox 6 positioning engine. These flexible and cost effective receivers offer numerous connectivity options in a miniature (16 x 12.2 x 2.4 mm) package. The compact architecture, power, and memory options make NEO-6 modules ideal for battery operated mobile devices with very strict cost and space constraints. Its Innovative design gives NEO- 6MV2 excellent navigation performance even in the most challenging environments.

Figure 3. GPS Module

3.1.4 Temperature Sensor

LM35 as shown in Figure 4 is a temperature sensor that outputs an analog signal which is proportional to the instantaneous temperature. The output voltage can easily be interpreted to obtain a temperature reading in Celsius. The advantage of LM35 over the thermistor is, it does not require any external calibration. The coating also protects it from self-heating. Many low-end products take advantage of low cost, and greater accuracy and use LM35 in their products.

The formula to convert the voltage to centigrade temperature for LM35 is: Centigrade Temperature = Voltage Read by ADC / 10 mV (milliVolt)

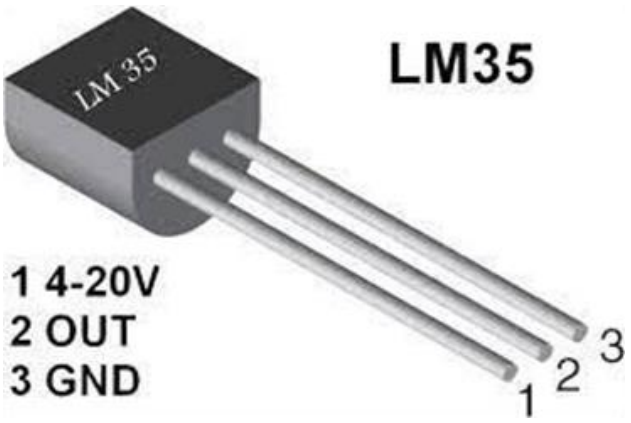

Figure 4. Temperature Sensor

3.1.5 Pulse Sensor

A plug-and-play sensor that is used to detect heart rate data is known as a pulse sensor as shown in Figure 5. This sensor is used by athletes, students, mobile and game developers, etc. This sensor clips on an earlobe or a fingertip by connecting right to an Arduino board through jumper cables. In real time, the pulse rate can be monitored through an open-source monitoring app.

Pin Configuration of pulse sensor:

Pin1 (Ground): This is a black color wire, used to connect to the GNDterminal of the system.

Pin2 (VCC): This is a red color wire, used to connect to a +3.3V/+5V voltage supply.

Pin3 (Signal): This is a purple color wire, used to connect the output signalwhich is pulsating.

Figure 5. Pulse Sensor

3.1.6 LCD I2C Display

This is a 16x2 LCD display screen with an I2C interface as shown in Figure 6. It is able to display 16x2 characters on 2 lines, and white characters on blue background. Usually, Arduino LCD display research will run out of pin resources easily, especially with Arduino Uno. And it is also very complicated with the wire soldering and connection. This I2C 16x2 Arduino LCD Screen is using an I2C communication interface. It means it only needs 4 pins for the LCD display: VCC, GND, SDA, and SCL. It will save at least 4 digital/analog pins on Arduino. All connectors are standard XH2.54 (Breadboard type). You can connect with the jumper wire directly. To avoid the conflict of the I2C address with other I2C devices, such as ultrasonic sensors, IMU, accelerometers, and gyroscopes, the I2C address of the module is configurable from 0x20-0x27 and its contrast can be adjusted manually.

Figure 6. LCD I2C Display

3.1.7 Jumper Wires

Jumper wires as shown in Figure 7 are simply wires that have connector pins at each end, allowing them to be used to connect two points with each other without soldering. Jumper wires are typically used with breadboards and other prototyping tools in order to make it easy to change a circuit as needed. Jumper wires typically come in three versions: male-to-male, male-to-female, and female-to-female. The difference between each is in the endpoint of the wire. Male ends have a pin protruding and can plug into things, while female ends do not and are used to plug things into. Male-to-male jumper wires are the most common and what you likely will use the most often. When connecting two ports on a breadboard, a male-to-male wire is what you'll need.

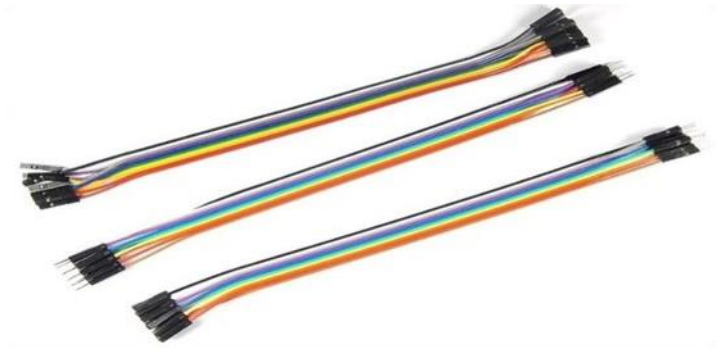

Figure 7. Jumper Wires

3.1.8 Breadboard

A breadboard as shown in Figure 8 is a solderless device for temporary prototypes with electronics and test circuit designs. Most electronic components in electronic circuits can be interconnected by inserting their leads or terminals into the holes and then making connections through wires where appropriate. The breadboard has strips of metal underneath the board and connects the holes on the top of the board. The metal strips are laid out as shown below. Note that the top and bottom rows of holes are connected horizontally and split in the middle while the remaining holes are connected vertically.

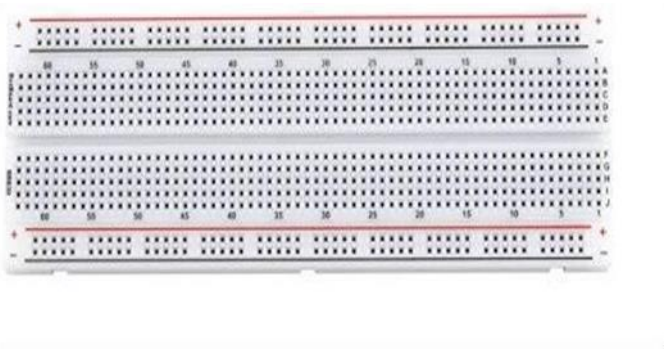

Figure 8. Bread Board

3.2 Software Requirement

The research comprises the following software tools:

1. HTML
2. CSS
3. Python
4. Django
5. MySQL
6. Arduino IDE

3.2.1 HTML

HTML stands for HyperText Markup Language. It is used to design web pages using a markup language. HTML is a combination of Hypertext and Markup language. Hypertext defines the link between the web pages. A markup language is used to define the text document within the tag which defines the structure of web pages. This language is used to annotate (make notes for the computer) text so that a machine can understand it and manipulate text accordingly. Most markup languages (e.g.HTML) are human readable. The language uses tags to define what manipulation has to be done on the text.

3.2.2 CSS

Cascading Style Sheets, fondly referred to as CSS, is a simple de sign language intended to simplify the process of making web pages presentable.CSS handles the look and feel part of a web page. Using CSS, you can control the color of the text, the style of fonts, the spacing

between paragraphs, how columns are sized and laid out, what background images or colors are used, layout designs, and variations in display for different devices and screen sizes as well as a variety of other effects. It gives an additional style to the HTML document. A cascading style sheet is a language that is designed to define the document formatting and look written in a markup language. Generally, CSS is applied to HTML documents to change various styles of user interfaces and web pages. It can be also applied to any document of XML, including XUL, SVG, and plain XML.

3.2.3 Python

Python is an interpreted, object oriented, high-level programming language with dynamic semantics. Its high-level built-in data structures combined with dynamic typing and dynamic binding make it very attractive for rapid application development, as well as for use as a scripting or glue language to connect existing components together. Python's simple, easy-to-learn syntax emphasizes readability and therefore reduces the cost of program maintenance. Python supports modules and packages, which encourages program modularity and code reuse. The Python interpreter and the extensive standard library are available in source or binary form without charge for all major platforms and can be freely distributed.

3.2.4 Django

Django is a high-level Python web framework that enables the rapid development of secure and maintainable websites. Built by experienced developers, Django takes care of much of the hassle of web development, so you can focus on writing your app without needing to reinvent the wheel. It is free and open source, has a thriving and active community, great documentation, and many options for free and paid for support. Django's primary goal is to ease the creation of complex, database driven websites. The framework emphasizes reusability and "pluggability" of components, less code, low coupling, rapid development, and the principle of don't repeat yourself. Python is used throughout, even for settings, files, and data models. Django also provides an optional administrative create, read, update, and delete interface that is generated dynamically through introspection and configured via admin models.

3.2.5 MySQL

MySQL is a relational database management system (RDBMS) developed by Oracle that is based on structured query language (SQL). MySQL is one of the most recognizable technologies in the modern big data ecosystem. A database is a structured collection of data. It may be anything from a simple shopping list to a picture gallery or a place to hold vast amounts

of information in a corporate network. In particular, a relational database is a digital store collecting data and organizing it according to the relational model. In this model, tables consist of rows and columns, and relationships between data elements all follow a strict logical structure. An RDBMS is simply a set of software tools used to actually implement, manage, and query such a database.

3.2.6 Arduino IDE

The Arduino Integrated Development Environment or Arduino Software (IDE) contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions, and a series of menus. It connects to the Arduino hardware to upload programs and communicate with them. Arduino IDE is an open-source software, designed by Arduino cc and mainly used for writing, compiling, and uploading code to almost all Arduino Modules It is available for all operating systems i.e., MAC, Windows, and Linux, and runs on Java Platform that comes with in-built functions and commands that play a vital role in debugging, editing and compiling the code. A range of Arduino modules are available including Arduino Uno, Arduino Mega, Arduino Leonardo, Arduino Micro, and many more. The main code, also known as a sketch, created on the IDE platform will ultimately generate a Hex File which is then transferred and uploaded to the controller on the board. The IDE environment mainly contains two basic parts: Editor and Compiler where the former is used for writing the required code and later is used for compiling and uploading the code into the given Arduino Module. This environment supports both C and C++ languages.

4. Methodology

4.1 Hardware Development

For the development of the hardware section, we have connected LM35 Temperature Sensor and Pulse Sensor to Arduino Uno and display the data sensed on LCD I2C Screen. The same data is transferred to the website using NodeMCU. Similarly, we have used a GPS module to track the location and send the location of trekkers to the website using NodeMCU.

4.2 Software Development

The Software Development was carried out in two phases namely Frontend and Backend. The HTML and CSS is used in Frontend i.e. designing User interface. Similarly,

Python as a programming language and Django framework is used for Backend server-side development. MySQL is used to actually implement, manage, and query such a database.

4.3 Block Diagram

Figure 9 shows the block diagram of the research where temperature and pulse sensors are connected to Arduino and the data sensed by sensors is displayed in an LCD screen interfaced with I2C. Arduino is connected to NodeMCU by serial communication. Similarly, GPS Module is connected to NodeMCU which traces the location. The data sensed by sensors and location traced by GPS module is sent to the IoT cloud and further retrieved to MySQL database. Finally, the data is fetched on the website where it is possible to inspect and monitorthe further enhancement and the efficiency required.

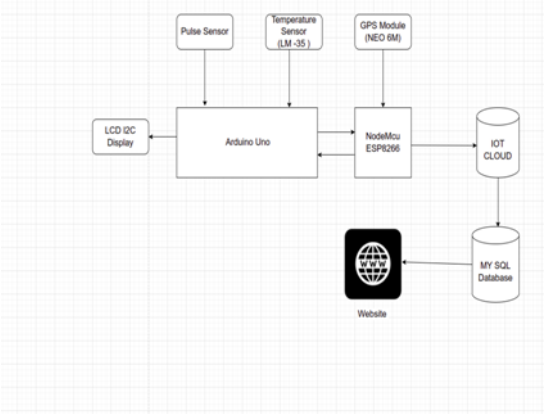

Figure 9. Block Diagram

4.4 Circuit Diagram

As shown in Figure 10, Arduino Uno and NodeMCU are used as microcontrollers.

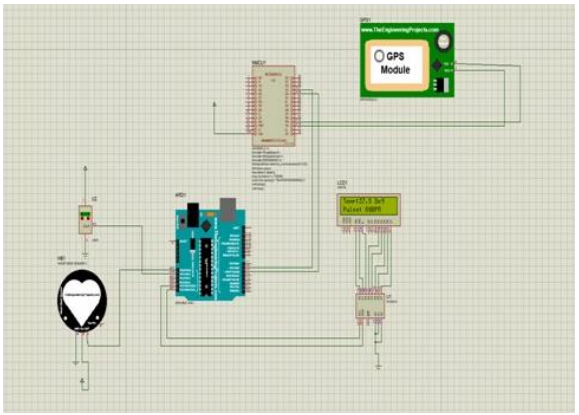

Figure 10. Circuit Diagram

Temperature Sensor (LM35) is connected to the Arduino using A1 analog pin while the Pulse Sensor is connected to Arduino using A0 analog pin. The change in temperature and Pulse is detected in Arduino and displayed on LCD screen which is interfaced with I2C. Serial data communication between Arduino and NodeMCU is done using the D5 and D6 pins of NodeMCU and the 5 and 6 digital pins of Arduino. GPS module is connected with NodeMCU using D1 and D2 pin which tracks the location data i.e. latitude and longitude of the trekkers and finally sent to the website.

5. Results and Discussions

5.1 Results

After the successful completion of the research, the designed prototype:

a) was capable of sensing data from LM35 Sensor and Pulse Sensor
b) was capable of displaying temperature and pulse rate on LCD I2C Display
c) was capable of tracking the location of trekkers
d) was capable of sending sensor data and GPS location to the website.

Some of the snapshots of the research's output are shown in the figure below:

Figure 11 shows the designed prototype which comprises Arduino Uno, NodeMCU, Bread board, GPS Module, LCD I2C Display, LM35 Temperature sensor, and Pulse sensor connected using Jumper wires, and the voltage required is supplied using a power bank. The temperature and pulse data are shown on an LCD screen and the same data is transferred to a website using NodeMCU.

Table.1 shows the current climatic situation of Mardi which includes weather description and temperature range i.e. minimum and maximum temperature and any variation in data is updated in the table.

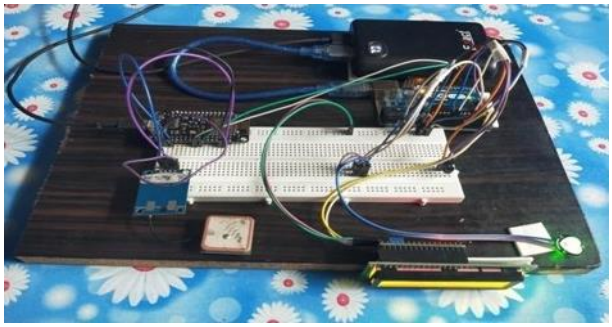

Figure 11. Designed Prototype

Table 1. Current Climatic Situation

Current Climatic Situation of Mardi Trek::

Weather	Description	Tempreture	Minimum Tempreture	Maximum Tempreture
Clear	clear sky	287.55	286.86	289.74
Clear	clear sky	292.52	290.16	293.67
Clear	clear sky	292.90	290.87	293.84
Clear	clear sky	293.01	290.75	294.33

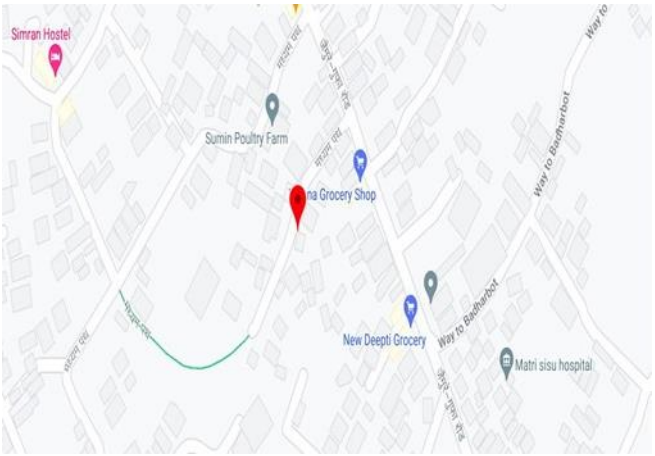

Figure 12. GPS Location

Figure 12 shows the location traced by GPS Module while experimenting the prototype which is indicated by a red indicator.

5.2 Discussion

The prototype of the research was made according to a circuit diagram. The output of the research was as per expectation. The data sensed by sensors were useful for monitoring health status considering Temperature and Pulse Rate. It was an immense pleasure working with the research team and this research enabled to gain great experience and generate ideas about research, documentation, and embedded systems.

Table 2. Data on Website

Time of Last measured	Pulse of trekkers	Temperature of trekkers
2022-05-07T17:29:24Z	62.00	36.00
2022-05-07T17:29:42Z	24.00	32.00
2022-05-07T17:30:17Z	25.00	31.00
2022-05-07T17:34:37Z	136.00	30.00
2022-05-07T17:35:25Z	70.00	43.00
2022-05-08T06:58:46Z	142.00	31.00
2022-05-08T06:59:03Z	117.00	28.00
2022-05-08T06:59:21Z	26.00	28.00
2022-05-08T06:59:38Z	25.00	30.00
2022-05-08T07:00:04Z	238.00	32.00
2022-05-08T07:23:35Z	53.00	41.00
2022-05-08T07:23:52Z	57.00	44.00
2022-05-08T07:24:10Z	63.00	39.00
2022-05-08T07:24:27Z	45.00	44.00
2022-05-08T07:24:44Z	133.00	38.00
2022-05-08T07:25:01Z	212.00	38.00
2022-05-08T07:25:18Z	197.00	44.00
2022-05-08T07:25:47Z	42.00	37.00
2022-05-08T07:29:17Z	238.00	34.00
2022-05-08T07:29:35Z	90.00	34.00
2022-05-08T07:29:52Z	237.00	36.00
2022-05-08T07:30:16Z	163.00	36.00
2022-05-08T07:30:33Z	76.00	35.00
2022-05-08T07:55:15Z	64.00	44.00
2022-05-08T07:55:32Z	33.00	36.00

Table 2. shows the Pulse and Temperature measured at different instances and the data is updated in the table whenever measured which can be viewed on our website.

6. Conclusion and Recommendation

6.1 Conclusion

The research has presented a means of monitoring the activities and condition of trekkers with the help of a designed prototype and website. Especially it demonstrates a working solution for ensuring the safety of trekkers and making the journey more adventurous &less risky. The attractive feature of the designed prototype is a simple mechanism to dis-

play sensed data on an LCD display interfaced with I2C, tracking GPS location with the use of a GPS Module, and sending data to the website.

6.2 Recommendation

Though the research works in a much more efficient way, there is still room for improvement for this system and it is hoped that further study can be carried out to further develop the system.

a) Use more accurate and precise sensors.
b) Representation of data in graphical forms.
c) Improvement of Lag in data transfer.
d) Use high quality jumper wires to make the connection stable and carry data with minimum resistance.

Reference

[1] Nevon Researchs. (2022). Electronics Software & Mechanical Researchs Ideas & Kits — Nevonresearchs.

[2] Garg, R., Bhola, J., & Soni, S. (2022). Healthcare monitoring of mountaineers by low power Wireless Sensor Networks.

[3] Cooking-hacks.com. (2022). Real-time Mountain Climber Monitoring using an E-Health Sensor Platform for Arduino and Raspberry Pi (Biometric Sensing).

[4] Satava, R., Angood, P., Harnett, B., Macedonia, C., & Merrell, R. (2022). The Physiologic Cipher at Altitude: Telemedicine and Real-Time Monitoring of Climbers on Mount Everest.

[5] Naik, H., Yadav, N., & Mishra, S. (2022). Emergency Location Sharing Using GPS Tracking.

[6] Upload.wikimedia.org. (2022). NodeMCU DEVKIT 1.0 [On-line]. Available: https://upload.wikimedia.org/wikipedia/commons/ thumb/7/7e/NodeMCU_DEVKIT_1.0. jpg/1200px-NodeMCU_DEVKIT_1.0.jpg? 20150411011546.

[7] Components101.com. (2022). Pulse Sensor Pinout. [Online]. Available: https://components101.com/sites/ default/files/component_pin/ Pulse-Sensor-Pinout.png.

[8] Bhola, J., Soni, S., & Cheema, G. (2020). Genetic algorithm based optimized leach protocol for energy efficient wireless sensor networks. Journal of Ambient Intelligence and Humanized Computing, 11, 1281-1288.

[9] Garg, R. K., & Soni, S. K. (2021). Empirical path loss models at 433 MHz in Himalayan snow for health monitoring. World Journal of Engineering.

[10] Yang, Y., & Cardei, M. (2010). Delay-constrained energy efficient routing in heterogeneous wireless sensor net- works. Sensor Networks, 7 (4), 236-247.

[11] Corke, P., Wark, T., Jurdak, R., Hu, W., Valencia, P., & Moore, D. (2010). Environmental wireless sensor networks. Proceedings of the IEEE, 98 (11), 1903-1917.

[12] Oliveira, L. M., & Rodrigues, J. J. (2011). Wireless sensor networks: A survey on environmental monitoring. Journal of Communications and Net- works, 6 (2), 143-151.

[13] Evers, L., Bijl, M., Marin-Perianu, M., Marin-Perianu, R., & Havinga, P. (2005). Wireless sensor networks and beyond: A case study on transport and logistics.

[14] Bennett, P., Soga, K., Wassell, I., Fidler, P., Abe, K., Kobayashi, Y., et al. (2010). Wireless sensor networks for Underground railway applications: case studies in Prague and London. Smart Structures and Systems, 6.

[15] Tsitsigkos, A., Entezami, F., Ram- rekha, T., Politis, C., & Panaousis, E. (2012). A case study of Internet of Things based on wireless sensor networks and smartphones. 28th Wireless World Research Forum Meeting.