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REAL- TIME SENSOR FUSION MONITORING SYSTEM

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ABSTRACT:

The Smart Jacket project introduces an innovative wearable technology, combining advanced monitoring and communication features to enhance safety, health, and connectivity. This multifunctional garment is equipped with live GPS tracking, vital sign monitoring, environmental sensors, a wireless communication system, and an integrated camera. With the capacity to send data over the internet, it finds applications across outdoor adventure, healthcare, emergency services, and more. This project synopsis outlines the methodology, advantages, and potentialapplications of the Smart Jacket, highlighting its significant contributions to various fields. In response to the demands of modern military and hazardous work environments, this project introduces a revolutionary Smart Jacket. Integrating GPS, GSM, IoT, and health monitoring sensors, the jacket provides real-time data on the wearer's physiological parameters, location, and environment. The system, compact and user-friendly, features an ESP32 Cam, DHT22 Sensor, MAX30102 Pulse Oximeter, GPS module, GSM module, and a lithium-ion battery.Key features include live GPS tracking, wireless communication through GSM, and continuous monitoring of vital signs. The integrated wide-angle camera enhances situational awareness. Data istransmitted in real-time to a central control system for informed decision-making andprompt emergency response.

Keywords: Real-Time sensor fusion monitoring system, sensor integrated monitoring system, safety monitoring system

INTRODUCTION

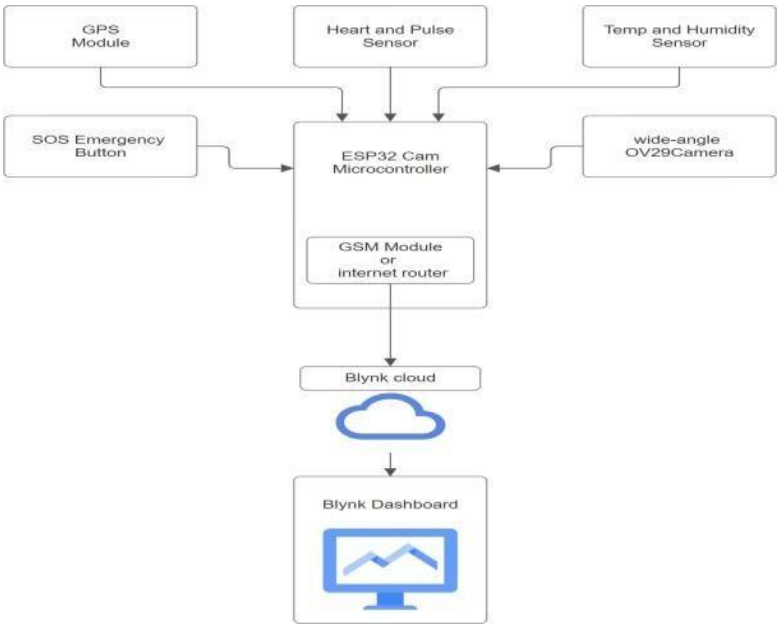
In the rapidly evolving landscape of wearable technology, the Smart Jacket stands as a remarkable fusion of style, safety, and connectivity. This project emerges from the vision of creating a versatile garment that transcends traditional apparel, offering advanced features designed to address the diverse needs of its users.

The Smart Jacket is designed to meet the growing demand for personal safety, health monitoring, and seamless communication in an increasingly connected world. By integrating a suite of cutting-edge technologies, this wearable device has the potential to revolutionize various industries and enhance the lives of users across the board.

In this introduction, we delve into the core elements of the Smart Jacket, beginning with a broad overview of the project's objectives and its significance. Additionally, the advantages of the Smart Jacket and its potential applications across different sectors will be examined, demonstrating the versatility and impact of this groundbreaking technology.

PROPOSED SYSTEM ARCHITECTURE

The system operates through a network of interconnected components. Sensors embedded in the jacket collect data on air quality, health parameters, audio, and visuals. A microcontroller processes and formats this data, which is then transmitted wirelessly to a cloud database via a communication module. The data is securely stored in the cloud and visualized in real-time using Grafana dashboards, enabling continuous monitoring. When sensor readings exceed set thresholds, the system triggers Telegram notifications, including snap pictures, to alert the user. Users can also interact with the jacket through a Telegram bot for data retrieval and commands. An SOS button allows for emergency alerts, and a record button enables audio or video recording to be stored on an SDcard.



.Fig 1: Block Diagram of proposed system

METHODOLOGY

1. Design Phase: Begin with a thorough design phase where the Smart Jacket's overall design and sensor/module integration are carefully planned.
2. Component Selection: Select the sensors, communication modules, and electronic components based on their reliability and compatibility with the design.
3. Integration of Sensors and Modules: Integrate the selected components into thejacket, ensuring they do not compromise comfort.
4. Software Development: Develop the necessary software to handle data collection,processing, and user interfaces, including a user-friendly mobile app.
5. Testing and Calibration: Conduct rigorous testing and calibration to fine-tune sensorsand algorithms for accuracy and reliability.

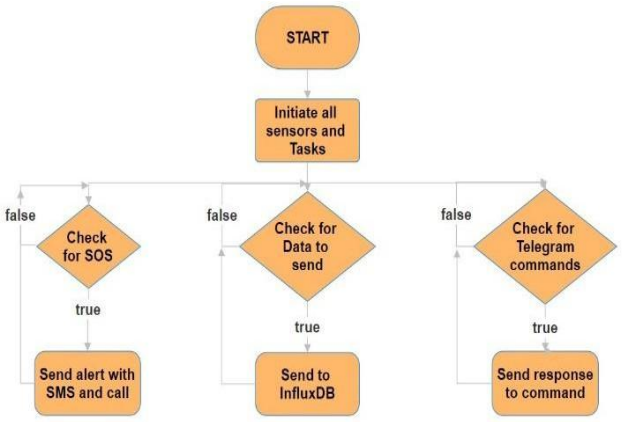


Fig 3: Flowchart of Proposed system

LITERATURE SURVEY

1. **Soldier Health and Position Tracking System (SHPTS)**

- **Authors:** Ashi Aggarwal; Vidit Kumar; Vasu Singhal; Ranjeeta Yadav
- **Research Focus:** Utilizing GPS, Node MCU, and sensors for soldier health and position tracking in battlefield scenarios.
- **Published On:** 2023 International Conference on Sustainable Emerging Innovations in Engineering and Technology (ICSEIET), 14-15 September 2023.

- **Description:** SHPTS focuses on enhancing soldier safety by providing real-time GPS tracking, health monitoring, and transmitting vital information wirelessly to a control room.

2. IoT-based Soldier Health and Position Tracking System

- **Authors:** J Lakshmi Prasanna; M. Ravi Kumar; Chella Santhosh
- **Research Focus:** IoT and GPS-based tracking and monitoring of soldiers' health and positions for enhanced defence capabilities
- **Published On:** 2022 6th International Conference on Computing Methodologies andCommunication (ICCMC), 29-31 March 2022.
- **Description:** The paper emphasizes the importance of
- soldier health and proposes anIoT-based system for real- time tracking and health monitoring.

3. Soldier Health Monitoring and Position Tracking (E-Vest)

- **Authors:** Vaishnavi Shivaji Pund; Sharayu Kashinath Dongre; Piyush Somnath Amate
- **Research Focus:** Introduces the E-Vest for Soldier Health and Position Tracking, awearable vest with sensors tracking GPS locations, vital signs, and physical activity.
- **Published On:** 2023 4th International Conference on Electronics and Sustainable Communication Systems (ICESC), 06-08 July 2023.
- **Description:** The E-Vest aims to improve military operations by providing real-time data to a central command post, enabling quick response to anomalous situations.

4. Wearable Smart Jacket for Coal Miners Using IoT

- **Authors:** Christo Ananth; B.Sri Revathi; I. Poonguzhali; A. Anitha; T. Ananth Kumar
- **Research Focus:** Designing a smart wearable for coal miners, detecting toxic gases,tracking miner location, and monitoring health parameters using IoT.
- **Published On:** 2022 2nd International Conference on Technological Advancementsin Computational Sciences (ICTACS), 10-12 October 2022.
- **Description:** The wearable smart jacket ensures the safety of coal miners by monitoring environmental conditions and enabling rapid response in case of emergencies.

5. Prototyping IOT Based Smart Wearable Jacket Design for Securing the Life of Coal Miners

- **Authors:** Ghulam E Mustafa Abro; Shoaib Ahmed Shaikh; Safeeullah Soomro
- **Research Focus:** Proposes a smart wearable jacket for coal miners, detecting hazardousgases, monitoring pulse rate, and providing real-time location information through IoT.
- **Published On:** 2018 International Conference on Computing, Electronics & Communications Engineering(iCCECE), 16-17 August 2018.
- **Description:** The wearable embedded system aims to secure the lives of coal miners by continuously monitoring health parameters and sending real-time updates to the basecamp

COMPONENTS

HARDWARE COMPONENTS

ESP32-WROOM-32:

It is a powerful, generic Wi-Fi+BT+BLE MCU module that targets a wide variety of applications, ranging from low-power sensor networks to the most demanding tasks,such as voice encoding, music streaming and MP3 decoding.

At the core of this module is the ESP32-D0WDQ6 chip*. The chip embedded is designed tobe scalable and adaptive. There are two CPU cores that can be individually controlled, and theCPU clock frequency is adjustable from 80 MHz to 240 MHz. The user may also poweroff the CPU and make use of the low-power co-processor to constantly monitor the peripherals forchanges or crossing of thresholds.

ESP32 integrates a rich set of peripherals, ranging from capacitive touch sensors, Hall sensors, SD card interface, Ethernet, high-speedSPI, UART, I2S and I2C.

The integration of Bluetooth, Bluetooth LE and Wi-Fi ensures that a wide range of applications can be targeted, and that the module is future proof: using Wi-Fi allows a large physical range and direct connection to the internet through a Wi-Fi router, while using Bluetooth allows the user to conveniently connect to the phone or broadcast low energy beacons for its detection. The sleep current of the ESP32 chip is less than 5 µA, making it suitable for battery powered and wearable electronics applications. ESP32 supports a data rateof up to 150 Mbps, and 20.5 dBm output power at the antenna to ensure the widest physical range. As such the chip does offer industry-leading specifications and the best performance for electronic integration, range, power consumption, and connectivity.

ESP32-CAM Hardware Overview:

Technical Specifications:

Processors:

Xtensa dual-core 32-bit LX6 microprocessor running at 240MHz, delivering up to 600DMIPS.

Ultra low power (ULP) co-processor enhancing powerefficiency.

Ai Thinker A9G GPRS Series Module

Ai Thinker A9G GPRS Series Module is a complete quad-band GSM/GPRS module that supports GPRS and GPS/AGPS technologies and is integrated into acompact SMD package.
A9G can be widely used in various IoT applications, suitable for home automation, industrial wireless control, wearable electronics, wireless location-aware devices, wireless positioning system signals, and other IoT applications. It is an ideal solution for IoT applications.
A9G adopts an SMD package, which can realize the rapidproduction of products through standard SMT equipment.
It is especially suitable for modern, large-scale, low-cost production methods, and is convenient for various IoT hardware terminal applications. Compared with the previous generation A6/A7, the integration of A9/A9G is higher, and the cost reduction of the core chip also makes the whole solution more cost-effective.

5. Sensors:

DHT11 is a low-cost digital sensor for sensing temperature and humidity. This sensor can be easily interfaced with any micro-controller such as Arduino, Raspberry Pi etc… to measure humidity and temperature instantaneously.
The MAX30102 pulse oximeter and heart rate sensor is an I2C-based low-power plug- and-play biometric sensor. It can be used by students, hobbyists, engineers, manufacturers, and game & mobiledevelopers who want to incorporate live heart-rate data into their projects.
Tilt sensors are devices that produce an electrical signalthat varies with an angular movement. These sensors are

used to measure slope and tilt within a limited range of motion. Sometimes, the tilt sensors are referred to as inclinometers because the sensors just generate a signal butinclinometers generate both readout and a signal.
The KY-024 Linear magnetic Hall sensor reacts in the presence of a magnetic field. It has a potentiometer to adjust the sensitivity of the sensor and it provides both analog and digital outputs.

The TTP223 is a touch pad detector IC replicating a single tactile button. This touch detection IC is designed for replacing traditional direct button key with diverse pad size.
A gas sensor is a device which detects the presence or concentration of gases in the atmosphere. Based on the concentration of the gas the sensor produces a corresponding potential difference by changing the resistance of the material inside the sensor, which canbe measured as output voltage. Based on this voltage value thetype and concentration of thegas can be estimated.
SOFTWARE REQUIREMENTS1.InfluxDB
InfluxDB is an open-source time series database (TSDB) developed by the company InfluxData. It is used for storage and retrieval of time series data in fields such as operations monitoring, application metrics, Internet of Things sensor data, and real-time analytics. It also has support for processing data from Graphite.[1]
InfluxDB provides an SQL-like language with built-in time-centric functions for querying a data structure composed of measurements, series, and points. Each pointconsists of several key-value pairs called the fieldset and atimestamp.
When grouped together by a set of key- value pairs called the tagset, these define a series. Finally, series are grouped together by a string identifier to form a measurement.

Values can be 64-bit integers, 64-bit floating points, strings, and booleans. Points areindexed by their time and tagset. Retention policies are defined on a measurement and control how data is downsampled and deleted. ContinuousQueries run periodically, storing results in a target measurement.

GRAFANA

Grafana is a multi-platform open source analytics and interactive visualization web application. It provides charts, graphs, and alerts for the web when connected to supporteddata sources.

There is also a licensed Grafana Enterprise version with additional capabilities available as aself-hosted installation or an account on the Grafana Labs cloud service.[2] It is expandable through a plug-in system. End users can create complex monitoring dashboards[3] using interactive query builders. Grafana is divided into a front end and back end, writtenin TypeScript and Go, respectively.[4]
As a visualization tool, Grafana is a popular component in monitoring stacks,[5] often usedin combination with time series databases suchas InfluxDB, Prometheus[6][7] ,Graphite;[8] monitoring platforms such as Sensu,[9] Icinga, Checkmk,[10] Zabbix, Netdata,[7] and PRTG; SIEMs suchas Elasticsearch[6] and Splunk; and other data sources. The Grafana user interface was originally based on version 3 of Kibana.[11

Telegram

Telegram also has social networking features, allowing users to post stories, create large public groups with up to 200,000 members, or share one- way updates to unlimited audiences in so-called channels.[7] The service also provides an open API for the creation ofcustom bots which can perform various tasks, integrate other services into Telegramchats, or work as mini apps.[8]

CIRCUIT DIAGRAM

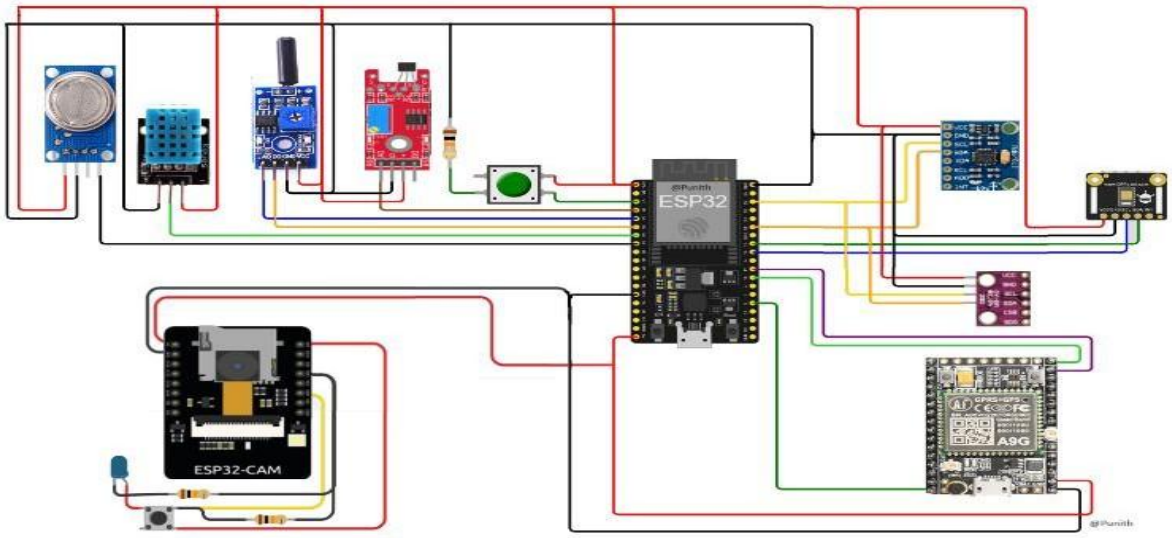


Fig 3. Circuit diagram of real time sensor fusion monitoring system

EXPECTED OUTCOMES

The expected outcomes for this project encompass a cohesive integration of various sensors—such as MAX30102, DHT11, MPU-6050—within the Smart Jacket, enabling comprehensive health and environmental monitoring capabilities. The project aims for consistent and reliable transmission of sensor data to a cloud-based InfluxDB database at regular intervals, ensuring a continuous stream of accessible and up-to-date information. Implementing an intuitive Grafana dashboard will offer real-time visualization and historicalanalysis of sensor data trends. Threshold-based notifications via Telegram will promptly alert users when sensor parameters surpass predefined limits, accompanied by snapshot images for immediate attention.

The successful interaction with the Smart Jacket system through a Telegram bot will enable remote access to real-time data and the issuance of commands. Additionally, the project targets functional emergency response mechanisms tied to the SOS button for initiating emergency alerts and video recordings, while the record button allows for user-initiated video capture stored in the SD card. Integration of all components within the wearable Smart Jacket design, meticulous testing, and validation to ensure reliability and accuracy, comprehensive documentation, user feedback collection, and continuous improvement rounds off the expected outcomes. Ultimately, these objectives aim to create a dependable, user-friendly, and effective Smart Jacket system for health monitoring and emergency response.

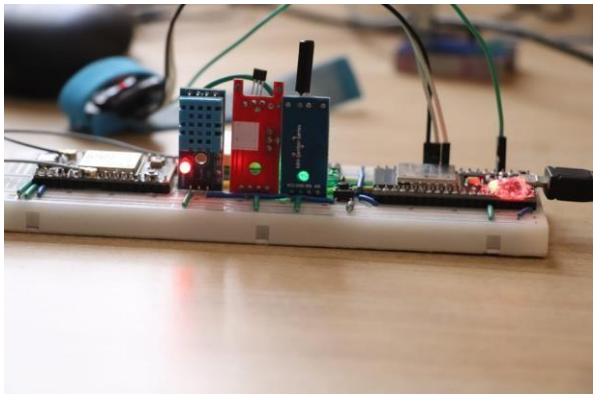


Fig 4: Result

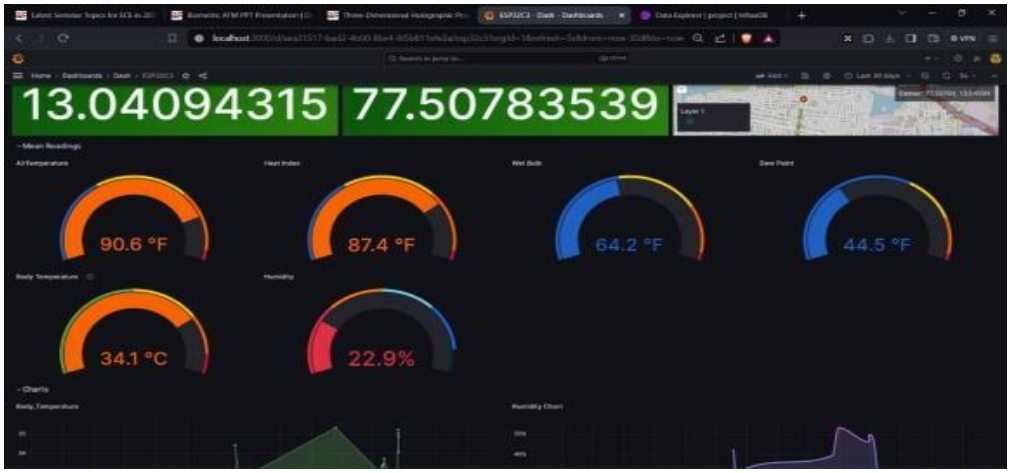


Fig 5. Display of result in monitor

CONCLUSION

Upon successful completion, the project is expected to deliver a high-quality, innovative garment that offers a unique combination of safety, health monitoring, and connectivity features for its users.

- Real-time vital sign monitoring and accurate GPS tracking.
- Seamless wireless communication using GSM technology.
- Compact, user-friendly design for optimal mobility.
- Wide-angle camera for enhanced situational awareness.
- Implementing an intuitive Grafana dashboard will offer real-time visualization and historical analysis of sensor data trends.
- Threshold-based notifications via Telegram will promptly alert users when sensor parameters surpass predefined limits, accompanied by snapshot images for immediate attention.

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