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A Sensor-Integrated I.O.T based Glove for Empowering Self- Monitoring of Health Vitals by Bedridden Individual

Dr. Sandeep S R[1], Anupriya S[2], Preethi B[3], Spandana K[4]

[1]*Associate Professor, Department of Electrical & Electronics Engineering, S J B Institute of Technology*

[234] *U.G. Student, Department of Electrical & Electronics Engineering, S J B Institute of Technology*

***Abstract*—Effective diabetes management requires consistent monitoring of blood glucose levels and other vital signs, a process that can be particularly challenging for bedridden individuals. These patients often depend on caregivers for frequent health checks, limiting their autonomy and potentially impacting their overall well-being. This project introduces a novel solution: a Sensor-Integrated Internet of Things (IoT) based glove, specifically designed to empower bedridden diabetic patients with the ability to independently monitor their health vitals. Leveraging advanced non-invasive sensor technologies, this innovative glove enables continuous and accurate monitoring of blood glucose levels and other critical health metrics. By facilitating greater control over their health data, this device aims to enhance the quality of life for bedridden diabetic patients. Promoting self-monitoring independence, this project has the potential to significantly improve health outcomes and overall well-being for this vulnerable population.**

***Index Terms*— Cloud Storage, Non-Invasive Monitoring, Vital Sign Tracking, Sensor-Integrated Glove.**

I. INTRODUCTION

Effective diabetes management requires continuous monitoring of various health vitals to ensure timely interventions and maintain optimal health. For bedridden individuals, frequent monitoring can be particularly challenging, often necessitating the assistance of caregivers. This reliance on external help can significantly limit their autonomy and impact their overall well-being.

Traditional methods of monitoring vital signs, such as blood glucose levels, involve invasive procedures that are not only uncomfortable but also impractical for bedridden patients. Additionally, vital parameters like SpO2 (oxygen saturation), body temperature, and pulse rate are crucial for comprehensive health management but are often overlooked due to the inconvenience of frequent manual checks.

To address these challenges, this project proposes the development of a Sensor-Integrated Glove designed to empower bedridden diabetic patients with the ability to independently monitor their vital signs. This glove incorporates advanced non-invasive sensor technologies to measure SpO2, body temperature, and pulse rate. The integration of these sensors into a wearable glove provides a comfortable and user-friendly solution for continuous health monitoring.

The glove features an OLED display for real-time feedback, allowing patients to monitor their health metrics easily. By enabling patients to track their own SpO2, temperature, and pulse rate, this device aims to enhance their quality of life and reduce dependency on caregivers for routine checks.

TK EN Hhis project focuses on promoting self-monitoring independence for bedridden diabetic patients. By providing a reliable, non-invasive, and easy-to-use monitoring solution, the Sensor-Integrated Glove has the potential to significantly improve health outcomes and overall well-being for this vulnerable population.

II. PROPOSED METHODOLOGY

The proposed Sensor-Integrated Glove employs advanced sensor technologies, a microcontroller unit, and cloud-based data storage to achieve its objectives of continuous and autonomous health monitoring for bedridden diabetic patients. The methodology is outlined as follows

a) Sensor Integration

1. *MAX30102 Sensor:*
   - Function: Measures heart rate and blood oxygen saturation (SpO2).

- Placement: Integrated into the glove's fingertip.
- Operation: Utilizes pulse oximetry principles to provide accurate readings. Potential for non-invasive blood glucose estimation.

2. *MAX30102 Sensor:*

- Function: Measures heart rate and blood oxygen saturation (SpO2).
- Placement: Integrated into the glove's fingertip.
- Operation: Utilizes pulse oximetry principles to provide accurate readings. Potential for non-invasive blood glucose estimation.

3. *DS18B20 Temperature Sensor:*

- Function: Measures the wearer's body temperature.
- Placement: Embedded in the glove fabric.
- Operation: Uses the 1-Wire communication protocol, providing high precision and a wide operating temperature range, ideal for continuous monitoring.

4. *HW072 Light Dependent Resistor (LDR) Sensor:*

- Function: Detects ambient light levels.
- Placement: Integrated within the glove.
- Potential Applications: Monitoring sleep patterns or detecting when the glove is removed.

b) Data Acquisition and Processing

1. *ESP32 Microcontroller:*

- Role: Central processing unit of the glove.
- Functions:
  - Collects data from the MAX30102, DS18B20, and LDR sensors.
  - Processes the collected data.
  - Prepares data for transmission and manages power consumption.

c) Wireless Communication and Data Storage

1. *I2C Communication Protocol:*

- Role: Facilitates communication between the ESP32 microcontroller and the integrated sensors.
- Operation: Ensures efficient and reliable data transfer within the glove.

2. *ThingSpeak Cloud Platform:*

- Role: Provides a platform for remote access, storage, and visualization of the processed data.
- Operation:
  - Processed data is wirelessly transmitted to ThingSpeak.
  - Enables remote monitoring by caregivers and healthcare providers.
  - Supports data analysis and visualization tools for enhanced health management.

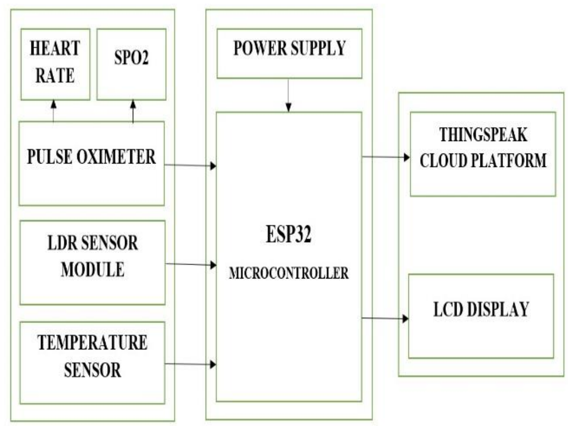

Fig 1 Block Diagram

III. CLARKE'S ERROR GRID METHOD FOR CALIBRATION OF BLOOD GLUCOSE

Accurately converting sensor voltage readings into meaningful blood glucose levels is crucial for wearable health monitors. The Clarke Error Grid method provides a valuable tool for calibrating these sensors, ensuring reliable data for users. This method employs a grid-based analysis that compares reference blood glucose measurements obtained from traditional finger prick tests with the corresponding voltage outputs from the sensor. By plotting these data points, the Clarke Error Grid reveals potential discrepancies between sensor readings and actual blood glucose levels.

The primary benefit of this method lies in its ability to identify systematic errors and biases within the sensor data. This allows researchers and developers to fine-tune the sensor's calibration algorithm, ultimately leading to more accurate blood glucose estimations. As a cornerstone for calibrating blood glucose sensors in wearable technology, the Clarke Error Grid method enables precise adjustments based on real-world data, paving the way for reliable and trustworthy health monitoring solutions.

IV. HARDWARE IMPLEMENTATION

The sensors for heart rate, blood oxygen, and temperature are strategically positioned within the glove to ensure optimal data collection. The selected processing unit is housed in a separate compartment to ensure performance without compromising comfort. A communication protocol facilitates seamless data exchange between the processing unit and all integrated sensors. Breathable materials are used in the glove's construction to prioritize user comfort during extended wear. The design securely houses all necessary components while maintaining a comfortable fit for various hand sizes. The hardware prioritizes accurate data collection while remaining user-friendly for easy adoption. Sensor placement and data transmission methods are designed to minimize power consumption and extend battery life. Additionally, the hardware implementation is adaptable, allowing for potential future integration of additional sensors.

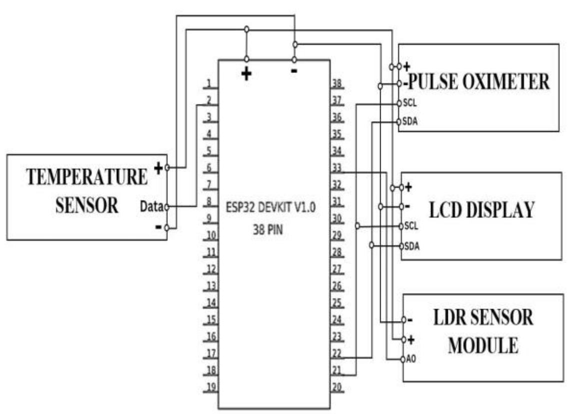

Fig 2 Hardware Connections

V. *RESULTS*

The Sensor-Integrated IoT glove project yielded a promising prototype for promoting self-monitoring of health vitals among bedridden individuals, with a particular focus on diabetic patients. The glove successfully integrated sensors for real-time monitoring of heart rate, SpO2, and body temperature. Additionally, the project explored the potential of using pulse oximetry principles for non-invasive blood sugar estimation, indicating future research opportunities in this area. Health data was effectively transmitted to a cloud platform (ThingSpeak) for remote access, storage, and analysis. This design empowers bedridden diabetic patients to independently monitor their health, reducing their reliance on caregivers and enhancing their autonomy.

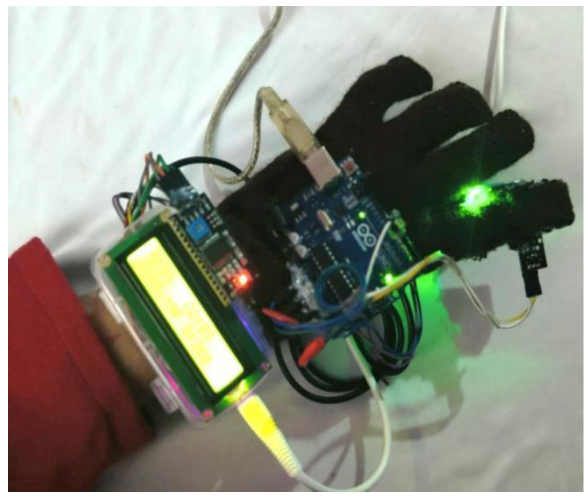

Fig 3. Working Model of Sensor integrated IOT based Glove

VI. ANALYSIS

The Sensor-Integrated IoT glove demonstrates promising performance in promoting self-monitoring of vital signs for bedridden individuals. The project successfully created a glove that provides real-time data on heart rate, SpO2, and body temperature, empowering patients to actively manage their health and helping caregivers identify potential health concerns early for informed treatment decisions. Although the exploration of non-invasive blood sugar estimation did not yet meet clinical accuracy, it represents significant progress towards more convenient diabetes management. The user-centric, comfortable, and easy-to-use design addresses barriers to adoption, encouraging patients to incorporate the glove into their daily routines for long-term health benefits.

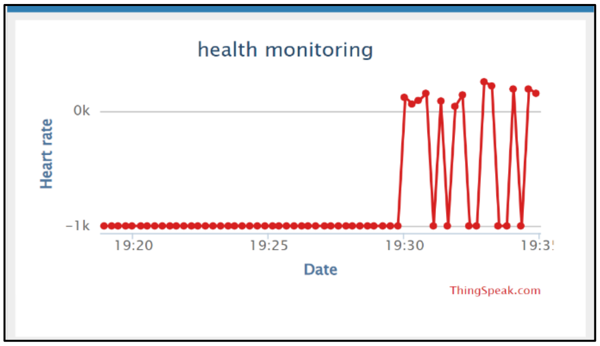

FIG 4. CONTINUOUS MONITORING OF HEART-RATE

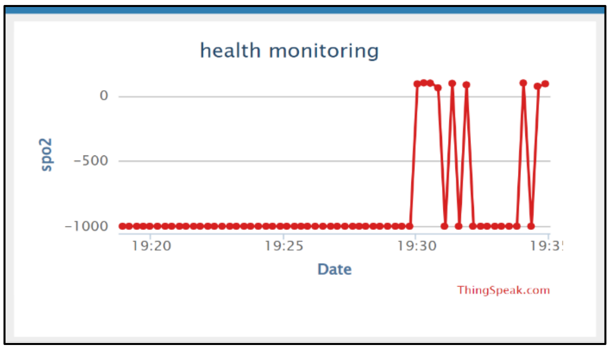

FIG 5. CONTINUOUS MONITORING OF OYGEN SATURATION (SPO2)

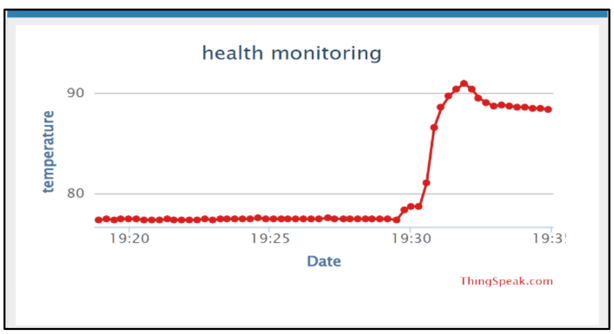

FIG 6. CONTINUOUS MONITORING OF TEMPERATURE

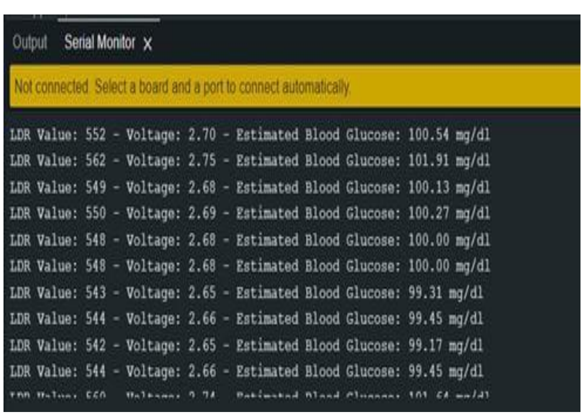

Fig 7. Calibration of Blood-Sugar Level

VII. CONCLUSION

The Sensor-Integrated IoT glove project demonstrably offers a compelling solution to the challenges of self-monitoring for bedridden individuals, particularly those with diabetes. The glove successfully integrates sensors for real-time monitoring of heart rate, blood oxygen, and body temperature in bedridden individuals. While the exploration of non-invasive blood sugar estimation highlights its potential, further advancements in sensor technology are needed for reliable integration. The user-centric design, featuring breathable materials and a secure fit, prioritizes comfort and wearability. Wireless data transmission to a cloud platform enables remote access and storage of health data. This project establishes a strong foundation for self-monitoring improvements in bedridden diabetic patients.

VIII. FUTURE SCOPE

The potential of the sensor-integrated IoT glove extends far beyond its current capabilities. Future advancements could eliminate the need for finger pricking, providing a convenient and painless method for non-invasive blood sugar monitoring. The glove can be adapted to monitor additional health parameters such as blood pressure, respiration rate, and activity levels. Implementing advanced data analysis techniques could turn raw data into actionable insights, generating health alerts and personalized recommendations. Integration with a user-friendly mobile app would allow patients to easily access, track, and share health data with caregivers or healthcare professionals. Additionally, the glove's functionalities can be adapted for various chronic health conditions, expanding its benefits to a wider range of patients.

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