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SMART HEALTHCARE SYSTEM USING FUZZY NEURAL NETWORKS

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ABSTRACT

This paper introduces a smart healthcare system utilizing IoT technology and Fuzzy Neural Networks (FNN) to monitor patients and assess their conditions. The system incorporates an ESP8266 microcontroller, MLX90614, and MAX30100 sensors for real-time data acquisition of vital health parameters like heart rate, SPO2 levels, and body temperature. The key feature is the integration of Fuzzy Neural Networks for intelligent decision-making in evaluating patients' conditions as normal or abnormal, accommodating the uncertainty inherent in healthcare data for precise assessments. Collected data is transmitted to a centralized system, accessible via a mobile application for healthcare professionals and patients to monitor real-time health metrics conveniently. Additionally, a web interface visualizes Fuzzy Logic system outputs, providing transparency into the decision-making process and enabling healthcare providers to understand how patient conditions are evaluated based on sensor data. By combining IoT and FNN, this Smart Healthcare System enables continuous monitoring and improves the accuracy of condition assessments, offering potential benefits such as timely interventions and reduced workload for healthcare professionals through intelligent decision support.

Keywords: Decision Support System, Fuzzy Neural Networks, Iot, Mobile Application, Real-Time Data Acquisition.

I. INTRODUCTION

The modern world, with its aging population, rising levels of pollution, and persistent pandemics, presents several health challenges for people, making healthcare essential. So, to reduce health-related complications, robust and flexible healthcare systems are always needed. Modern healthcare facilities are a major difficulty, particularly in poor nations with insufficient high-quality hospitals and medical professionals in remote places. Innovation is crucial to address the problems faced by healthcare systems nowadays.

In the ever-evolving landscape of healthcare, the Smart Healthcare System stands out as an example of innovation, effortlessly combining modern technologies to transform patient care. At its core, this system harnesses the strength of both the Internet of Things (IoT) and Fuzzy Neural Networks to monitor and evaluate patients' health in real-time. The proposed system utilizes an ESP8266 microcontroller, seamlessly interfaced with MLX90614 and MAX30100 sensors, enabling real-time acquisition of critical health parameters. These parameters include heart rate, SPO2 levels, and body temperature, forming a comprehensive dataset crucial for evaluating a patient's overall well-being. The distinguishing feature of our system lies in the incorporation of Fuzzy Neural Networks, intelligently processing healthcare data to make nuanced decisions regarding the patient's condition. In summary, the Smart Healthcare System is a testament to the transformative potential of integrating IoT, Fuzzy Neural Networks, and advanced sensor technologies. By providing real-time insights into patients' health conditions, this system not only empowers individuals to actively monitor their well-being but also equips healthcare professionals with a powerful tool for making informed and timely decisions. The synergy of these components marks a significant advancement towards a more personalized, efficient, and responsive healthcare paradigm.

II. METHODOLOGY

Building a smart healthcare system involves a multi-step process that integrates hardware components, sensor data collection, cloud services, mobile application development, and the implementation of fuzzy logic for decision-making.

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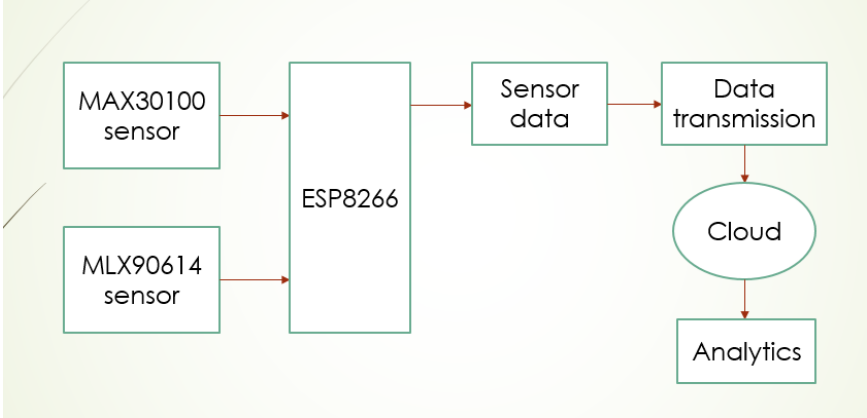

Figure 1: Block Diagram of the proposed system.

Collecting Sensor Data

To begin with, the data collection phase requires setting up the hardware components. This involves connecting the MLX90614 and MAX30100 sensors to an ESP8266 microcontroller. The sensors, responsible for measuring body temperature, SpO2, and heart rate, should be interfaced with the microcontroller using appropriate communication protocols such as I2C. The firmware for the ESP8266 needs to be developed to read data from these sensors, employing sensor libraries and datasheets to interpret raw data accurately. Additionally, a data processing algorithm should be implemented to filter and calibrate the sensor readings, ensuring the accuracy of the collected data.

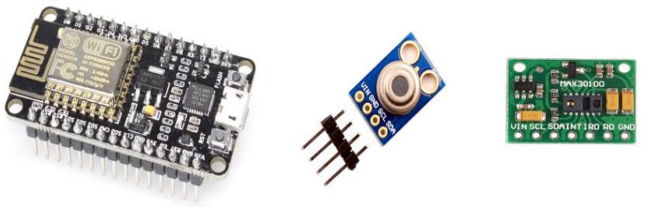

Figure 2: Components of Smart Healthcare System.

The MAX30100 is a sensor module designed for heart rate and blood oxygen (SpO2) monitoring. It is commonly used in wearable devices such as fitness trackers and smartwatches. It can be used to measure the heart rate of an individual by detecting the pulsatile signal from blood flow. In addition to heart rate monitoring, the MAX30100 can also estimate the blood oxygen saturation level (SpO2) by measuring the absorption of light at different wavelengths.

The MLX90614 is an infrared (IR) non-contact temperature sensor. It is commonly used for measuring the temperature of an object without direct contact. It measures the temperature of an object by detecting the infrared radiation emitted by the object.

These two sensors are connected to ESP8266. Here, ESP8266 is used instead of Arduino UNO because ESP8266 contains inbuilt Wi-Fi and doesn't need any external modules like Bluetooth module for transmitting data to cloud.

Transmitting Data to Firebase Cloud

The data collected through sensors is then transmitted to the cloud. Here, we are using Firebase Realtime Database to store data collected through sensors in the cloud. First, we need to set up the Firebase environment by creating a new project. Then, click on Authentication and get started. In the project settings, we can get the API key which should be included in the code for transmitting data to the cloud. Now, create a real-time database and after successful creation of a real-time database, copy the URL that should be included in the code. Finally, by making necessary changes in the code, the data collected through sensors is stored in the cloud.

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Mobile Application Development

Simultaneously, the development of a mobile application is crucial for users to access and visualize the collected sensor data. The mobile app project, created for either iOS or Android, should integrate the Firebase SDK. This integration facilitates fetching sensor data from the Firebase Cloud and presenting it in a user-friendly interface. Real-time updates can be achieved by implementing Firebase listeners for live data.

Fuzzy Logic Implementation

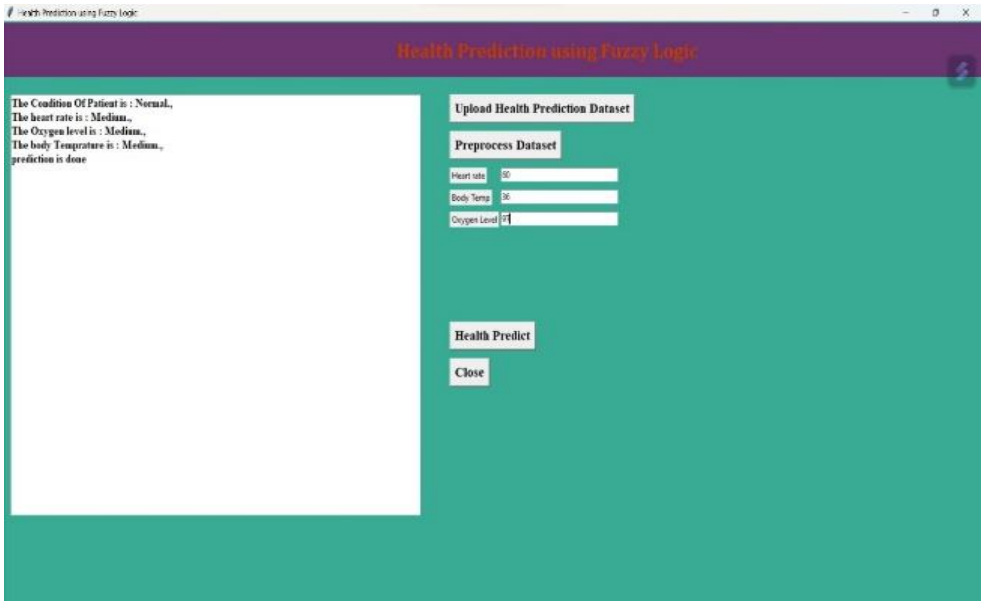
The final component involves the implementation of fuzzy logic for decision-making and the development of a web interface. To implement a fuzzy neural network, first, we need to import the libraries and modules, including Tkinter for GUI, NumPy, pandas, scikit-learn, Matplotlib, and scikit-fuzzy. Then, data training and testing have to be done, and fuzzy logic algorithms must be implemented to analyze the healthcare data. This involves defining rules and membership functions for normal and abnormal conditions. The web interface then displays the decision (normal or abnormal) based on the fuzzy logic analysis.

III. MODELING AND ANALYSIS

The Smart Healthcare System introduced in this paper leverages IoT technology and Fuzzy Neural Networks (FNN) to monitor patients and evaluate their conditions. This system is built upon an architecture that integrates an ESP8266 microcontroller, MLX90614, and MAX30100 sensors for real-time data acquisition of vital health parameters including heart rate, SPO2 levels, and body temperature. A key feature of this system lies in the incorporation of Fuzzy Neural Networks, enabling intelligent decision-making to assess patients' conditions amidst the inherent uncertainty in healthcare data. Data collected from the sensors is transmitted to a centralized system, accessible through a mobile application for both healthcare professionals and patients to conveniently monitor real-time health metrics. Additionally, a web interface offers visualization of the outputs of the Fuzzy Logic system, providing transparency into the decision-making process and facilitating healthcare providers' understanding of patient condition evaluations based on sensor data. Through the combination of IoT and FNN, this Smart Healthcare System enables continuous monitoring and enhances the accuracy of condition assessments, offering potential benefits such as timely interventions and reduced workload for healthcare professionals through intelligent decision support. Evaluation of the system's performance, impact on healthcare professionals, identification of challenges, and exploration of potential enhancements are key areas of analysis in assessing the efficacy and implications of this innovative healthcare solution.

IV. RESULTS AND DISCUSSION

The intelligent system that monitors and manages patients in healthcare is supposed to be smart. Fuzzy logic is an easy-to-use and implement approach for making decisions, and it was beneficial to the suggested system. The suggested system is organized in a very novel way, utilizing sensor data and fuzzy-based decision-making. The fuzzy-based decision-making produces the following output on the condition of the patient:



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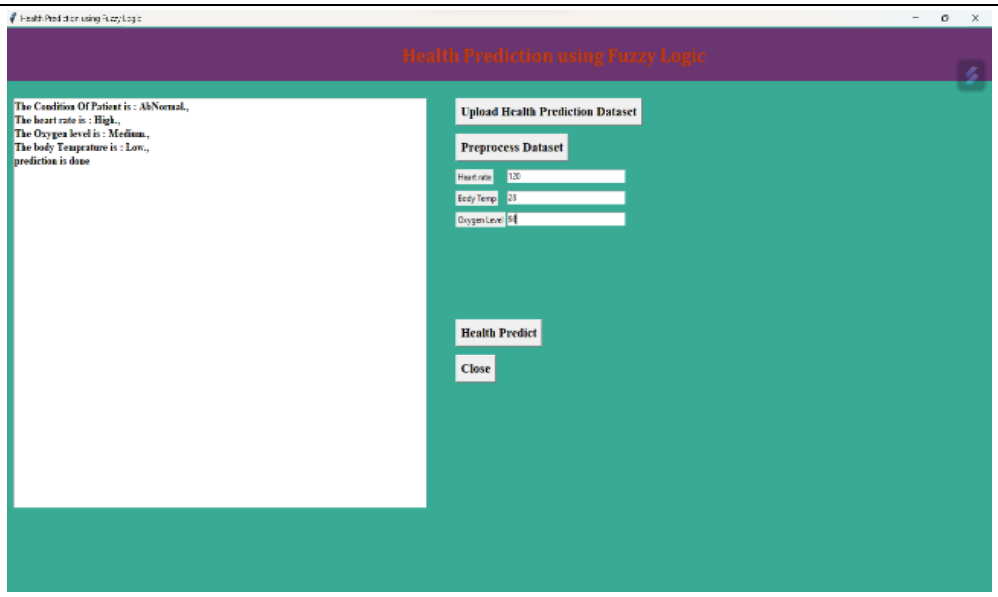

Figure 3: Decision on the condition of the patient.

V. CONCLUSION

In summary, the integration of MLX90614 and MAX30100 sensors with the ESP8266 microcontroller establishes a robust foundation for a smart healthcare system, facilitating the seamless collection and transmission of body temperature, SpO2, and heart rate data to the cloud for efficient storage and retrieval. The accompanying mobile app enhances user interaction by allowing real-time monitoring of health parameters. The incorporation of Fuzzy Logic, driven by user-inputted values, intelligently determines the normalcy or abnormality of health conditions, adding adaptability to individual health profiles. The output of the Fuzzy Logic system is presented on a user-friendly web interface, providing a comprehensive snapshot of health status for informed decision-making by both users and healthcare professionals. This holistic approach fosters proactive healthcare management, empowering individuals with valuable insights into their well-being.

VI. REFERENCES

[1] Kashif Hameed, Imran Sarwar Bajwa, Shabana Ramzan, Waheed Anwar, Akmal Khan, "An Intelligent IoT Based Healthcare System Using Fuzzy Neural Networks", Scientific Programming, vol. 2020, Article ID 8836927, 15 pages, 2020.

[2] C.-T. Lin and C. S. G. Lee, “Neural-network-based fuzzy logic control and decision system,” IEEE Transactions on Computers, vol. 40, no. 12, pp. 1320–1336, 1991.

[3] D. Metcalf, S. T. J. Milliard, M. Gomez, and M. Schwartz, “Wearables and the internet of things for health: wearable, interconnected devices promise more efficient and comprehensive health care,” IEEE Pulse, vol. 7, no. 5, pp. 35–39, 2016.

[4] S. B. Baker, W. Xiang, and I. Atkinson, “Internet of things for smart healthcare: technologies, challenges, and opportunities,” IEEE Access, vol. 5, pp. 26521–26544, 2017.