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A Non- Invasive Smart Sensor System for Early Detection of Dehydration in Medical Application

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ABSTRACT*: Dehydration is a serious health condition that can lead to fatigue, dizziness, kidney problems, and life-threatening complications if not detected early. This project presents an AI-based IoT dehydration monitoring system that continuously monitors physiological parameters and predicts dehydration levels in real time. The system integrates biomedical sensors such as GSR, ECG, SpO_2, and DS18B20 temperature sensor. The collected data is processed using an Arduino Uno, and an AI-based classification algorithm categorizes dehydration into Low, Medium, and High levels. The system includes an LCD display for real-time monitoring and uses an ESP32 module to send data to the Blynk IoT platform for remote monitoring and alerts. The proposed system is portable, wearable, and cost-effective, suitable for healthcare, sports, and elderly monitoring.*

Keywords— Arduino Uno, IoT, Dehydration Monitoring, GSR Sensor, ECG, SpO_2, ESP32, AI, Blynk

1. INTRODUCTION

Dehydration is a serious health condition caused by excessive loss of body fluids, leading to symptoms such as fatigue, dizziness, confusion, rapid heart rate, low blood pressure, and in severe cases, organ failure. It affects individuals of all ages, particularly elderly people, athletes, outdoor workers, and patients with chronic illnesses. Early detection is essential; however, conventional methods rely on manual observation or laboratory testing, which are not suitable for continuous monitoring. Advancements in biomedical sensors, Internet of Things (IoT), and Artificial Intelligence (AI) enable continuous monitoring of physiological parameters and real-time health prediction.

Parameters such as heart rate, skin conductivity, body temperature, and oxygen saturation vary with dehydration and can be used for early detection. IoT facilitates real-time transmission of health data to cloud platforms for remote monitoring, analysis, and alert generation. AI techniques analyse sensor data and classify dehydration levels based on physiological patterns. The integration of biomedical sensors, IoT, and AI enables the development of an intelligent system

for automatic dehydration detection and timely alerts. This project proposes an AI-based IoT dehydration monitoring system that integrates GSR, ECG, SpO_2, and DS18B20 temperature sensors to continuously monitor physiological parameters. An Arduino Uno performs data processing and feature extraction, while an AI-based algorithm classifies dehydration levels into Low, Medium, and High. The system includes an LCD for local monitoring and an ESP32 module for transmitting data to the Blynk IoT platform, enabling remote monitoring and alert notifications. The proposed system is designed to be portable, wearable, battery-powered, and cost-effective, making it suitable for healthcare, sports, elderly care, industrial safety, and remote health monitoring applications.

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1.1 EXISTING METHOD:

The existing system uses a passive UHF RFID tag–antenna sensor integrated into textile materials for hydration monitoring. It operates without a battery, powered by RF energy from an RFID reader. Sweat absorption changes the fabric's dielectric properties, causing variations in the antenna's resonant response. The RFID reader measures the RSSI, and its slope is analysed using linear regression to determine hydration status. The system provides a binary output: Euhydration or Dehydrated. It supports ETSI and FCC UHF bands and uses a T50 T-match dipole design for improved sensitivity and performance.

1.1 Drawbacks in Existing System:

1. Requires external RFID reader
2. Works only in controlled conditions
3. Accuracy depends on sweat level
4. Affected by environment (Temperature, Humidity)
5. Not suitable for real-time wearable monitoring

1.2 PROPOSED SYSTEM:

The proposed system uses multi-sensor integration with AI and IoT for accurate dehydration detection. The sensors are consists of Arduino Uno, GSR Sensor, ECG Sensor, SpO_2 Sensor, DS18B20 Temperature Sensor, ESP32(IoT module) & LCD Display.

II.WORKING:

The system operates by continuously collecting physiological data from multiple sensors such as GSR, ECG, SpO_2, and temperature sensors. These sensors measure important body parameters including skin conductivity, heart rate, oxygen saturation, and body temperature. The collected data is then transmitted to the Arduino Uno, which acts as the central processing unit of the system. The Arduino processes the raw sensor data and performs feature extraction to obtain meaningful values. These extracted features are essential for determining the hydra on status of the user. The processed data is then provided to an AI-based model, which analyses the pa erns in the physiological parameters. Based on this analysis, the AI model classifies the dehydration level into categories such as Low, Medium, or High. This intelligent decision-making helps in early detection and prevention of dehydration-related health risks. The system also includes an LCD display that provides real-me information to the user. It displays the current physiological parameters along with the detected dehydration level, allowing immediate monitoring. In addition to local display, the system uses an ESP32 module for wireless communication. The ESP32 transmits the processed data to the cloud platform, specifically the Blynk IoT platform. Through the cloud, users and healthcare providers can monitor the data remotely in real me. The platform also enables graphical visualization and alert notifications when critical conditions are detected. This complete process ensures continuous monitoring, real- me analysis, and remote accessibility, making the system efficient and user-friendly.

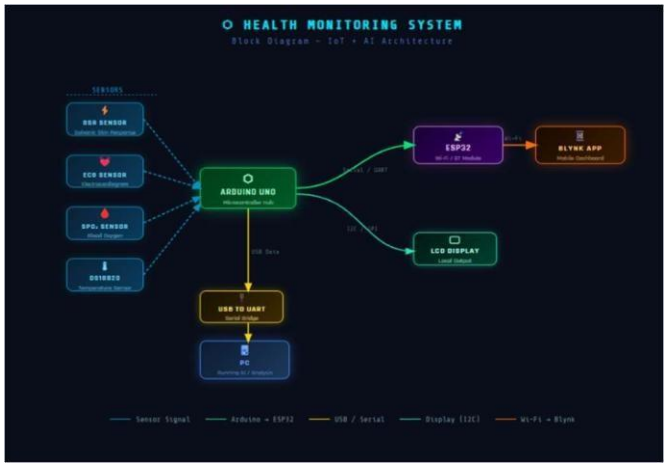


FIG 2.1(a) BLOCK DIAGRAM

i) **Arduino uno:**

Arduino Uno is the main microcontroller used in this system. It collects data from all sensors and processes it. It acts as the brain of the project by controlling operations. It sends processed data to display and IoT module. Figure 2.1.1 shows Arduino uno

Figure 2.1.1 Arduino uno

ii) **ESP32 module:**

ESP32 is used for wireless communication in the system. It sends sensor data to the cloud using Wi-Fi. It helps in real-time monitoring through IoT platforms. It also supports Bluetooth and low power operation. Figure 2.1.2 shows ESP32 module

Figure 2.1.2 ESP32 module

iii) **GSR sensor:**

GSR sensor measures skin conductivity of the body. It helps to detect dehydration based on sweat levels. Higher conductivity indicates higher moisture on skin. It is useful for stress and hydration monitoring. Figure 2.1.3 shows GSR sensor

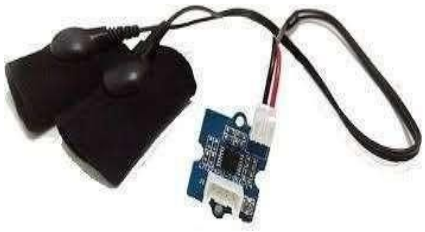


Figure 2.1.3 GSR sensor

iv) **ECG sensor:**

ECG sensor monitors the electrical activity of the heart. It measures heart rate and rhythm continuously. Changes in heart rate can indicate dehydration. It provides important health-related data. Figure 2.1.4 ECG sensor

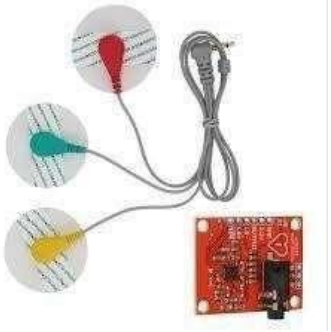


Figure 2.1.4 ECG sensor.

iv) **SpO2 sensor:**

SpO_2 sensor measures oxygen level in the blood. It also provides pulse rate information. Low oxygen levels may indicate health issues. It is widely used in medical monitoring systems. Figure 2.1.5 SpO2 sensor

Figure 2.1.5 SpO2 sensor

v) **DS18B20 Temperature sensor:**

DS18B20 measures body temperature accurately. It provides digital temperature output. Temperature variation helps detect dehydration. It is reliable and easy to interface Figure 2.1.6 DS18B20

Figure 2.1.6
DS18B20 Temperature sensor

vii) **LCD Display:**

LCD display shows real-time sensor values. It displays dehydration level and parameters. It helps users monitor health instantly. It is simple and easy to use. 2.1.7 LCD Display

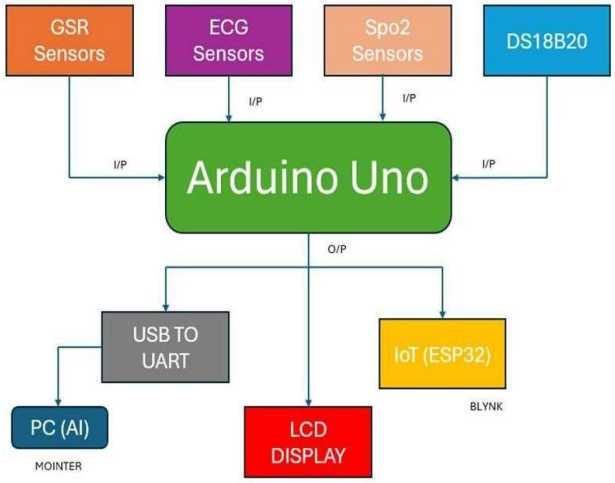
Figure 2.1.7 LCD Display

viii) **Battery:**

Battery supplies power to the entire system. It makes the device portable and wearable. It ensures continuous operation without interruption. Rechargeable batteries are commonly used. Figure 2.1.8 Battery

Figure 2.1.8 Battery

1.2.1 FLOWCHART FOE PROPOSED SYSTEM:



HARDWARE USED:

- Arduino Uno
- ESP32 Module
- GSR Sensor
- ECG Sensor
- SpO_2 Sensor
- DS18B20 Temperature Sensor
- LCD Display
- Battery

SOFTWARE USED:

- Arduino IDE
- Python (for AI model)
- Blynk IoT Platform

SOFTWARE RESULT:

ADVANTAGES:

- Real-time monitoring
- Early dehydration detection
- Portable and wearable
- Remote monitoring via IoT
- Cost-effective

APPLICATIONS:

- Healthcare monitoring
- Sports & fitness tracking
- Elderly care
- Industrial worker safety
- Remote patient monitoring

CONCLUSION:

The proposed AI-based IoT dehydration monitoring system provides an efficient solution for continuous health monitoring. By combining sensors, Arduino, AI, and IoT, the system enables early detection of dehydration and reduces health risks.

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