WINTER SEMESTER 2024-25

Course Code : BBMD102L
Course Name : Biomedical Instrumentation and Measurements.

PROJECT REPORT
HYDRATION MONITORING SYSTEM

Submitted By :

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SLOT : C2

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AIM OF THE PROJECT :

Hydration tracking is critical to overall health, especially for people who are physically active or have medical conditions that impact water retention. This project aims to create a hydration tracking system based on Arduino Uno and three home-made sensors. The system tracks hydration levels in terms of electrical conductivity and displays real-time data on an LCD display. Warnings, such as buzzer alerts, notify the user when hydration drops below a level. The focus is on providing a cost-effective and effective means for monitoring continuous hydration in order to avoid dehydration complications.

INTRODUCTION :

Adequate hydration is vital to proper functioning of the body, affecting metabolism, temperature regulation, and cardiovascular function. Severe medical conditions may result from dehydration, including kidney injury, heat stroke, and impaired mental status. Conventional hydration monitoring techniques, including urine color and thirst response tests, are subjective and unreliable. Therefore, a real-time, objective hydration monitoring system is needed. This project offers a non-invasive hydration monitor that senses moisture levels through sensor-based conductivity measurements. The system is intended for patients at risk of dehydration, including athletes, elderly patients, and patients with chronic diseases.

METHODOLOGIES :

The hydration monitor uses an Arduino Uno microcontroller, three sensors, an I2C LCD display, and an alert buzzer. The sensors were built using aluminum foil electrodes and graphite electrodes to capture electrical conductivity. The sensors were placed in optimal locations on the skin to measure hydration levels based on impedance changes. The LM358 operational amplifier was utilized to condition sensor signals for enhanced accuracy. Stable signals for repetitive readings were produced by the NE555 timer ICs.

Brief Explanation of Each Sensor :

1. **Sensor 1 – Conductivity-Based Hydration Sensor**
   This sensor utilizes **aluminum foil electrodes** to measure the electrical conductivity of the skin. Hydration levels affect the **skin's impedance**, meaning higher water content results in lower resistance and better conductivity. The sensor's readings fluctuate based on moisture levels, and it plays a key role in detecting hydration variations by capturing real-time conductivity changes.

2. **Sensor 2 – Graphite Electrode Sensor**
   Using **graphite electrodes (0.7mm leads)**, this sensor operates similarly to Sensor 1 but provides a more stable signal with minimal oxidation issues. It is designed to measure hydration by monitoring how electrical resistance varies with changes in skin moisture. The use of graphite ensures improved longevity and accuracy compared to metallic electrodes.

3. **Sensor 3 – Capacitive Hydration Sensor**
   This sensor functions by detecting changes in capacitance, which are influenced by moisture levels on the skin. It employs an **NE555 timer circuit** to generate a signal, which varies based on the skin's hydration status. This method allows for a more **sensitive and dynamic** measurement, enhancing the overall accuracy of the hydration monitoring system.

The sensor data collected is averaged by the Arduino, and the result is mapped to a percentage of hydration. The value is outputted to the Serial Monitor for diagnostic purposes and also displayed on the LCD for convenience. If the percentage of hydration is less than 30%, the buzzer sounds to alert the user. Calibration was achieved through varying states of hydration such that the system correctly discriminates between hydrated and dehydrated conditions.

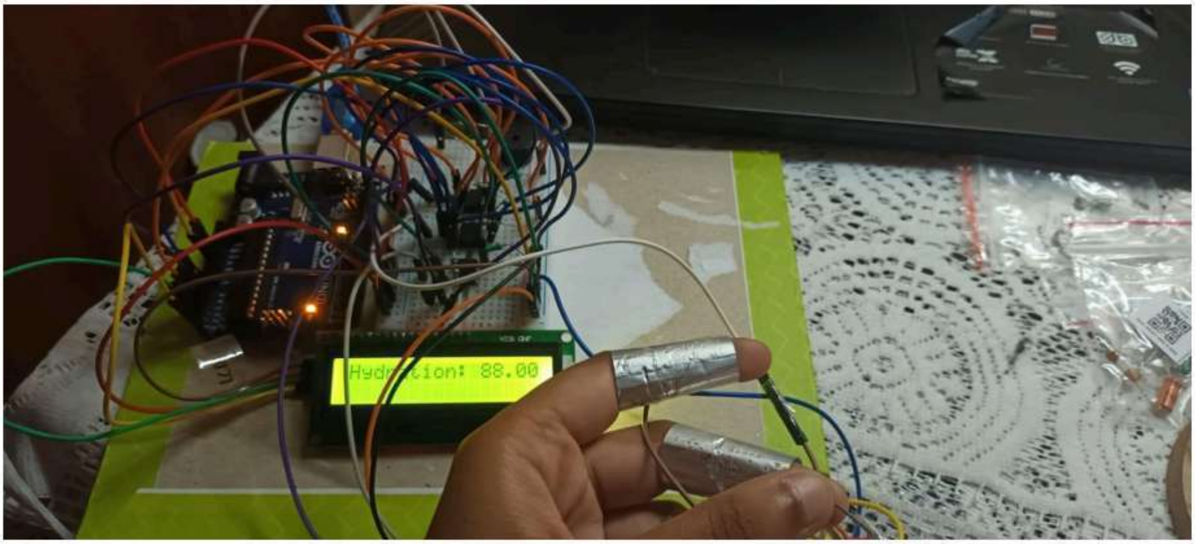
OBSERVATIONS :

Under testing, the hydration monitor gave stable and consistent results. The sensors reacted to changing levels of hydration, indicating lower conductivity when moisture was low. Raw sensor values ranged from about 850 to 1000 under initial calibration, necessitating proper mapping to a 0-100% hydration range. Mapping range adjustment enhanced the accuracy of hydration percentage calculations. The LCD read real-time hydration levels well, and the buzzer effectively signaled users when hydration dipped below a certain level. Environmental conditions like temperature and perspiration levels did affect readings, suggesting the need for further optimization.

CONCLUSION :

The constructed hydration monitoring system showcases a cost-effective and practical method of real-time hydration monitoring. Utilizing sensor-based conductivity measurements, the system gives users an objective view of their hydration status. The addition of an LCD display and buzzer ensures convenience and timely notifications. Although the prototype accurately distinguishes between hydration states, sensor design and calibration enhancements can be made to its performance. Subsequent versions can include more parameters, like temperature and humidity, in order to further optimize the measurement process. In total, this project provides a basis for affordable and trustworthy hydration monitoring that can potentially be helpful to many users.

HARDWARE SET-UP :



SOFTWARE SIMULATION :