RESEARCH PAPER

Non-Invasive Wearable Sweat Electrolyte Analyzer for Early Detection of Dehydration and Electrolyte Imbalance

P. Tryphena Prishiba[1], S. Nishalini[2], C. Renchjoslin[3], R. Lekha Sri[4]

[1] Professor, Department of Biomedical Engineering, KIT-Kalaignarkarunanidhi Institute of Technology, Coimbatore, India.
Email: princetryphena@gmail.com

[2] Department of Biomedical Engineering, KIT-Kalaignarkarunanidhi Institute of Technology, Coimbatore, India.
Email: kit27.bme44@gmail.com

[3] Department of Biomedical Engineering, KIT-Kalaignarkarunanidhi Institute of Technology, Coimbatore, India.
Email: kit27.bme48@gmail.com

[4] Department of Biomedical Engineering, KIT-Kalaignarkarunanidhi Institute of Technology, Coimbatore, India.
Email: kit27.bme26@gmail.com

How to cite this article: Tryphena Prishiba P, Nishalini S, Renchjoslin C, Lekha Sri R. Non-Invasive Wearable Sweat Electrolyte Analyzer for Early Detection of Dehydration and Electrolyte Imbalance. Int J Drug Deliv Technol. 2026;16(37s): 158-163. DOI: 10.25258/ijddt.16.37s.23

***Abstract*—** Sweat-based sensing is a recently developing non-invasive technology for constant health monitoring, especially for the measurement of the levels of hydration and electrolytes. In this paper, the design and implementation of a low-cost IoT- based system for the measurement of the levels of electrolytes in human sweat using pH and conductivity sensors is discussed. In the proposed system, a web-based analytics tool is developed, which works in conjunction with the NodeMCU-based embedded system. The proposed system is designed for the periodic acquisition of the sensor data and the transmission of the data to the PHP-based server for processing using the lightweight analytical model. In the proposed system, the risk score, severity index, and descriptions are provided to the users. In the proposed system, the live dashboard is developed for the display of the live data, trends, and recommendations to the users. In the proposed system, the closed-loop alert mechanism is developed, which activates the buzzer of the device for alerting the users. In the proposed system, the architecture is simple, intuitive, and easy to understand. In the proposed system, the experiment is conducted for the effectiveness of the proposed system. In the proposed system, the experiment is conducted for the effectiveness of the proposed system. In the proposed system, the experiment is conducted for the effectiveness of the proposed system.

Keywords—Sweat analysis, electrolyte monitoring, wearable sensors, real-time health monitoring, embedded systems, electrical conductivity, pH sensing, dehydration detection, and Internet of Things (IoT) are some of the keywords.

I. INTRODUCTION

The development in the field of wearable healthcare devices has identified the major advancement in the field of health care, which plays an important role in the digital health infrastructure of the present world for the non-invasive, real-time measurement of physiological parameters [1], [2]. Among all the body fluids, sweat has identified the promising potential for health assessment due to the presence of various electrolytes, metabolites, and biomarkers in the composition of sweat, which correlate with the internal status of the human body [3], [4]. Recent advancements in the field of flexible electronics, microfluidics, and smart materials have identified the promising potential for the development of wearable sweat sensors for health assessment and sports analytics[6],[7],[8].

Electrolyte imbalance and dehydration are one of the major concerns related to human health due to the presence of extensive physical activities, high-temperature conditions, and outdoor work activities. The conventional methods for the health assessment of electrolyte imbalance and dehydration have been identified as mostly reactive, invasive, or the analysis of the body fluids, which cannot be applicable for the health assessment purpose. In order to overcome the limitations of the conventional methods for the health assessment purpose, the development in the field of wearable sweat sensors has identified the potential for the analysis of various parameters for the convenience of the health assessment purpose [12], [13], [19].

In this context, it is worth mentioning that the integration of AI and IoT has led to the conversion of raw data into useful health information [9]. The current technology has focused on acquisition, processing, trends, and recommendations. The current technology has improved the usability of wearable technology. However, the current technology has limitations with respect to cost-effectiveness. Additionally, the current technology does not have real-time processing and explainability. These limitations have affected the usability of the current technology. It is important to resolve the challenges identified in the current technology. This paper has proposed a sweat-based electrolyte monitoring system. The proposed system has incorporated sensing technology, IoT, and analysis using the web. The proposed system has estimated the level of hydration and level of electrolytes using pH and conductivity sensors, respectively. The proposed system has used NodeMCU for transmitting information to the server. The analysis model is lightweight. The proposed analysis model has provided explainability. The proposed analysis model has provided results in the form of an interactive dashboard. The proposed system has provided real-time alerts. This has provided the user with immediate results. The proposed system has provided cost-effectiveness. Furthermore, the proposed system has provided scalability. The proposed system has provided continuous health monitoring. The proposed system has been applicable in the wellness domain, academia, and prototyping. The proposed system has extended the domain of wearable technology. The proposed system has used analysis, interaction, and sensing technologies. The proposed system has contributed to the expansion of the domain of wearable technology.

II. LITERATURE SURVEY

The domain of wearable health devices has witnessed significant innovations in the last few years with the increased need for health monitoring. It has been researched that there is a need to design health devices from simple devices to sophisticated devices with the integration of flexible technologies and smart connectivity features [1], [2]. In this context, it has been identified that sweat has the potential to be a biofluid for developing the next generation of digital biomarkers, considering the availability and potential for representing physiological states with respect to electrolytes and metabolites [3], [4] Significant research has been carried out for the development of wearable sweat sensors using flexible electronics and microfluidic devices. Recently, the application of the multimodal sensing approach for the sensing of different parameters, such as pH levels, ion concentrations, and sweat rates, has been demonstrated. Such sensing approaches are expected to enhance the overall accuracy of the health monitoring system. In addition, the use of textile sensors is also expected to enhance the overall comfort of the system. Microfluidic devices have contributed significantly to the overall development of the system. Recently, the application of microfluidic devices for the monitoring of pH levels in the sweat using autonomous fluid flow-based sensing has been demonstrated. In addition, the use of electrochemical sensing approaches for the sensing of sodium concentrations and ion concentrations in the sweat has been widely accepted. Such sensing approaches are expected to provide valuable information regarding the overall health of the individual. Significant advancements have been made in the application of material science for the overall development of the system. The use of fabric-based sensors and polymer-based sensors for the overall development of the system has been widely accepted.

The overall development of the system is expected to provide valuable information to the users. The overall development of the system is expected to enhance the overall quality of the health monitoring system. In addition, the overall development of the system is expected to provide valuable information to the users. Apart from the sensing technology, the integration of artificial intelligence technology and data analysis technology has also contributed significantly to the improvement of the functionality of the wearable devices. For instance, the use of artificial intelligence-based electrochemical sensors has been proposed for the improvement of the interpretation of signals and the provision of predictive health monitoring. In addition, the development of IoT-based technology has also contributed significantly to the provision of data transmission, remote monitoring, and the development of user-friendly visualization platforms. Despite the presence of certain benefits associated with the existing system, there are also certain limitations associated with the existing system. In most cases, the development of high-performance wearable devices has been restricted by the complexity of the fabrication process and the cost of the materials. In addition, the absence of user-friendly interfaces and the provision of easily interpretable results has also restricted the functionality of the existing system. In order to improve the functionality of the existing system and address the limitations of the existing system, the present work focuses on the development of a cost-effective and IoT-based system for the measurement of the level of the electrolyte using sweat. In the proposed system, the development of a user-friendly and easily interpretable system is expected to enhance the functionality of the system. Apart from this, research has also been conducted in the recent past in order to assess the applicability of the concept of sweat metabolomics in the context of determining various states of physiology, such as fatigue, stress, and other states, in relation to athletes who need to be trained in high-intensity training sessions. This has further enhanced the importance of the role of sweat in the measurement of health states in real time, at the same time validating the dynamic change in the composition of sweat in relation to the intensity of physical activities. Apart from this, the research conducted in the context of electrodermal activity and sweat rates has also led to further knowledge in the context of determining various physiological states in humans, at the same time facilitating a holistic approach to health and wellness states in humans. The incorporation of microfluidics and smart materials in the context of sweat sensors has also been a prominent feature in the context of sweat sensors, especially in the context of facilitating the sampling of sweat. The recent developments in the context of microfluidics in the context of sweat sensors have also included passive fluid transport and evaporation, which facilitates measurement in the context of sweat sensors. This has further enhanced the reliability and reproducibility of the measurements in the context of sweat sensors in relation to various environmental and physiological states. Apart from this, recent developments in the context of sweat sensors have also facilitated the development of a platform where the integration of the sensor is possible within clothing materials, along with the enhancement of wearability within the context of sweat sensors. Various research has been conducted to explore the application of the concept of utilizing sweat sensors within the context of utilizing conductive fabrics and polymer materials within the context of developing flexible, stretchable, and light sweat sensors.

In recent times, there has been an increase in terms of conducting research related to the utilization of autonomous and self-powered wearable systems. In some cases, it has also been noted that there is an emphasis on utilizing energy-efficient designs and power-saving communication protocols in terms of their application. This may also be useful in terms of the increased utilization of wearable systems in terms of their application in the near future.

Reference	Contribution of the Paper	Limitations Identified	Proposed Work
[3]	Focuses on sweat as a digital biomarker in non-invasive techniques used in health monitoring	No mechanism for implementation	It creates a real-time system for parameters such as sweat pH and conductivity
[6]	Introduces multifunctional wearable sensors using multimodal analysis of sweat	Too complex and expensive due to the integration of advanced materials	It creates a sensing system that is simple and affordable, both for practical purposes and academic purposes
[7]	Explores flexible wearable sensors used in sweat analysis with improved comfort and flexibility	Focus on sensor design but no incorporation of real-time analytics and feedback mechanisms	It combines sensing with IoT, analytics, and real-time alerts
[9]	Focuses on AI-assisted electrochemical sensors in advanced techniques used in health data analysis	High level of complexity associated with AI models, which might influence the interpretability of the system and the computation costs involved	It employs a lightweight and interpretable analytical model, which is efficient

In this case, it has also been noted that there are various gaps in terms of conducting research related to their application. In some cases, it has also been noted that the wearable systems developed in recent times and utilized in terms of wearable systems may also be related to the utilization of single-parameter sensing, data analytics, and real-time alerts. In addition to this, it may also be noted that due to the complexities related to recent advancements in terms of fabrication technology and materials utilized in terms of their application, it may also act as a barrier in terms of their application.

Considering all these aspects, it is also important to consider how the system can differentiate itself in relation to the recent and existing innovations in this regard. This can be done through an integrated approach in relation to multi-parameter sensing, IoT communication, data analytics, and real-time alerts. This not only enhances the usability of the proposed system, it also bridges the gap in relation to the recent and existing innovations.

III. METHODOLOGY

The proposed system is designed to work on a sweat-based system of electrolyte monitoring. The proposed system is designed to be integrated with data acquisition, IoT communication, and data analysis. The proposed methodology is designed to have four major stages of data sensing, transmission, processing, and interaction.

1. Sensor Data Acquisition

The proposed system is designed to use pH sensors and conductivity sensors to acquire the data from the sweat of a person. Such data from the sweat of a person is considered to be reliable data for the health monitoring of a person. Such data is correlated to the health of a person based on the presence of electrolytes in the sweat of a person [3], [4]. Such a sensing mechanism is previously used for the development of a biosensor for the real-time health monitoring of a person [12], [19]. Such data is acquired through a microcontroller.

2. Embedded System and Data Transmission

The proposed system is designed to use a NodeMCU (ESP8266) microcontroller for the data acquisition and transmission. Such a system is previously used for the development of a wearable IoT-based system for the real-time health monitoring of a person. IoT-based wearable systems are highly accepted for the health monitoring of a person due to the presence of the ability to transfer the data from a remote location [1], [8].

3. Data Processing and Analytical Model

The received data will be processed by the web server through a light-weighted analytical model. The state of hydration and electrolytes will be determined through the analysis of the pH and conductivity levels. The significance of artificial intelligence and data analytics in transforming the sensor data into useful health-related information is discussed in previous literature as well [9].

4. Web-Based Visualization and User Interface

The proposed system aims to develop a system which will enable the user to visualize the received and processed data. The proposed system will provide the user with valuable information through the visualization of the web-based interface. The significance of user interface is also proved while developing an effective healthcare system through wearable technology [2], [6].

5. Alert and Feedback Mechanism

In order to ensure timely responses to the user, the proposed system will be designed to develop an alert system. This will be done by sending a signal to the NodeMCU through the server if the risk level is high. The buzzer will be activated through the signal to alert the user. This will ensure the safety of the user. This concept of alerting the user in real-time is similar to the concept of proactive health monitoring through wearable technology [7].

6. System Integration and Validation

The proposed system will be designed to integrate the entire system as a whole. The proposed system will work effectively as proved through the experimental results. The proposed system will be cost-effective and applicable in various fields.

A. Block Diagram

The proposed block diagram for the electrolyte monitoring system using a sweat sensor is explained below. The proposed electrolyte monitoring system using a sweat sensor is designed as a system architecture. In this system, various blocks have been included. All the blocks included in this system have been designed to perform a particular function, thereby ensuring the health of a particular individual.

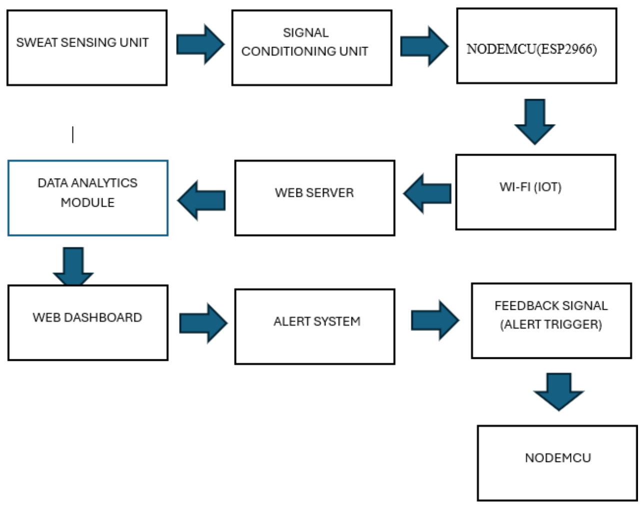

Figure 1: Block diagram of Hardware

1. Sweat Sensing Unit: This unit is designed to acquire the required data from the human body using a sweat sensor. This unit includes a pH sensor and an electrical conductivity sensor. The pH sensor is used to acquire the pH level of the sweat, which indicates the metabolic activity and hydration level of the human body. The pH sensor is used to acquire the level of electrolytes present in the sweat according to the ionic content. This is very useful for understanding the level of dehydration and electrolytes present in the human body.

2. Signal Conditioning Unit: The signals acquired from the sensor are not sufficient for the required operation. Therefore, a signal conditioning unit is included in this system, which will condition the signals acquired from the sensor for the required operation.

3. Node MCU (ESP8266) – Data Acquisition and Processing Unit: This microcontroller is a microcontroller-based unit designed for acquiring and processing the required data. This microcontroller is designed for acquiring the required data from the sensor in the form of an analog signal and converting it into a digital signal using the in-built analog-to-digital converter present in this microcontroller.

4. Wi-Fi Communication (IoT Layer): The processed information received from the sensor is sent to the remote web server using a wireless medium via Node MCU. This is an example of IoT communication, where the information is sent remotely. The information is sent in a periodic manner, and there is no significant time gap.

5. Web Server (PHP + Database): The web server is the major entity in the proposed system. In the proposed system, the server is used to receive information from Node MCU. The information received from Node MCU is stored in the database. The server is used to implement the scalability of the proposed system. The proposed system is able to serve multiple users at a time.

6. Data Analytics Module: The information stored in the proposed system is processed using a simple analytical model. This module processes the information and provides the expected results. Using the proposed system, the risk level of dehydration is calculated. The proposed system is simple, and the user understands the logic used in the result.

7. Web Dashboard (User Interface): The result is obtained using the data analytics module. The result obtained using the data analytics module is provided to the user using the web interface. Using the proposed system, a simple web interface is used. Using the proposed system, the user is able to view the result. The result provided to the user using the proposed system is in the form of a web interface, where the user is able to view the information in real time.

8. Alert System (Buzzer / Notification): The proposed system is developed in such a way that it includes a feature called the real-time notification system. In the proposed system, the calculation of the risk level is incorporated. The system will send a notification if the calculated risk level is greater than the threshold level.

9. Feedback Loop to Node MCU: The proposed system is developed in such a way that it includes an important feature. The server sends a signal to the Node MCU if the condition is critical. The buzzer is connected to the Node MCU, and it will send a notification to the user at an early stage.

IV. RESULT AND DISCUSION

System Implementation and Interface

It is pertinent to mention that the sweat-based electrolyte monitoring system implemented in the proposed system is implemented in an integrated IoT and web-based system that facilitates the monitoring of health-related parameters in real time. The implementation of such an integrated system is in line with the recent advancements in the development of smart health-related systems [1], [2]. The interface of the proposed system is clean and simple, as depicted in the dashboard of the proposed system.

It is pertinent to mention that the dashboard of the proposed system clearly depicts the title of the system, which is 'Sweat Electrolyte Monitoring,' and the subtitle of the system that clearly depicts the functionality of the system in monitoring the health of the user continuously and the risks of dehydration that can be posed to the user of the system. The interface of the proposed system is in line with the recent trends in implementing the wearable devices in the development of health-related systems, keeping in view the simplicity and ease of use of the system by the user of the system [6], [8].

The other important feature of the system is the real-time alert system. This is indicated in the interface by the 'Alert Active' icon. The alert is generated in real time and takes into consideration if the user is at any risk of dehydration based on the pH level of the sweat and the conductivity level. The factors are well recognized in the scientific community and are important in maintaining the balance of the body's electrolytes [3], [4], [12].

The interface also provides the user with the ability to view the data over a period of time. This provides the user with the ability to view the data over a period of time. This is important in that it provides the user with the ability to view the trends. The ability to view the trends is important in the wearable health devices. This provides the user with better information in comparison to the ability to view the data at any particular instance of time [7], [9].

The data that is collected by the system includes the sensor data, the classification of the data, and the recommendation of the data. This provides the user with the ability to view all the data that is collected by the system.

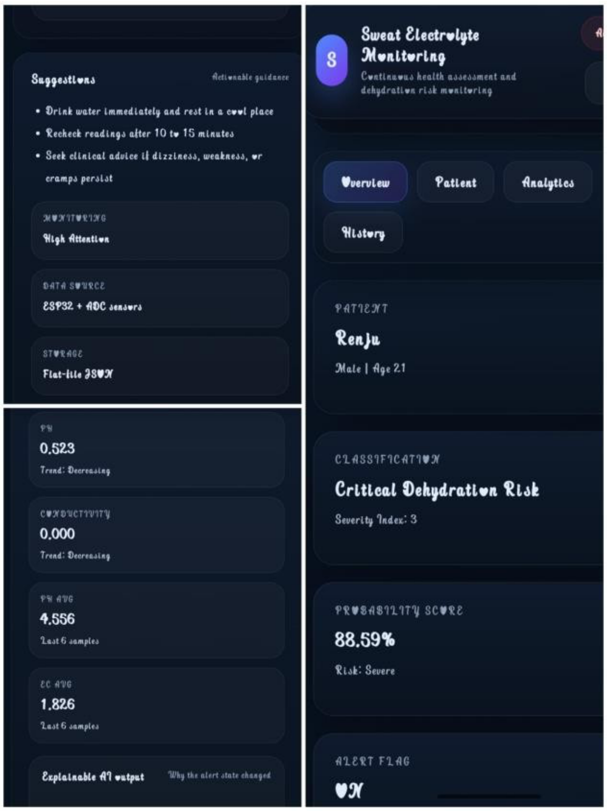

Figure 2.1: System Dashboard Showing Patient Data, Readings, and Risk Analysis

The developed system is implemented in such a way that it utilizes the NodeMCU device to collect the data. The data is then sent to the PHP-based web application. The application analyzes the data and provides the result in real time. This is in line with the current research in the area. The research indicates the utilization of IoT and intelligent analytics in developing such systems [9].

The interface developed in this project indicates the usability of the proposed system. The implementation of the system indicates the possibility of developing an affordable wearable health monitoring system. This is important in the development of wearable health technologies [1], [6].

B. HARDWARE DESIGN

The hardware part of the proposed system that relates to the sweat-based electrolyte monitoring system is designed in such a way that the most efficient data acquisition and processing are enabled. The hardware part of the system comprises sensing units, the microcontroller unit, communication interfaces, and the alert system.

The most important part of the system is the microcontroller unit. The microcontroller unit is implemented in the system with the NodeMCU ESP8266 module. The NodeMCU ESP8266 module is the brain of the system. The data processing and communication of the system are done with the NodeMCU ESP8266 module. The module is small in size and has low power consumption. However, the most important feature of the module is the availability of the wireless communication feature. The module can be utilized

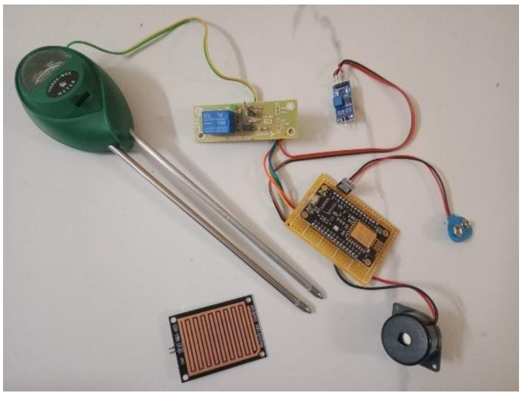

Figure 2.2: Hardware Setup of the Proposed System

in the development of various IoT-related applications with the wearable device.

The sensing unit of the system comprises pH sensor probe and conductivity measurement circuitry. The pH sensor probe is utilized in the system to measure the acidity or alkalinity of the sweat. The pH value of the sweat indicates the physiological state of the user. The sensor part of the system that relates to the conductivity is implemented with the electrode probes. The electrode probe is utilized in the system to measure the concentration of the ions in the sweat. The concentration of the ions in the sweat is directly proportional to the concentration of the electrolytes. The Rain/Moisture sensor module is integrated into the system. The reception of the analog signal from these sensors is further conditioned and then processed in the microcontroller. The interface circuit is designed in such a manner that components are added which include the signal conditioning components and the relay module. The relay module is used for maintaining the reliability of the system. The power supply of the system is also provided through a compact battery source. This makes the system even more portable, and this is further beneficial for the purpose of continuous monitoring.

For the purpose of sending notifications, another module is also added in the system, which is known as the buzzer module. This buzzer module is further used for sending real-time notifications whenever it is found that the parameters are crossing their defined limits, which further indicates dehydration and electrolyte imbalance in the body. This is also an efficient way of designing a system in which monitoring and sending notifications are carried out in parallel.

The components of the system are placed on a prototype PCB board. This makes the system even more compact, and this is further beneficial for efficient connectivity. The design of the system is also efficient, and this makes it even more suitable.

C.GRAPHICAL ANALYSIS

The system has been tested using a real-time data acquisition and visualization system using a web interface. It is designed to acquire real-time data and trends on different parameters like the pH level and electrical conductivity in order to monitor the level of hydration in a continuous manner for the user. It is evident from the results obtained using the above system that the efficiency of the system is high in monitoring physiological changes and acquiring valuable health information.

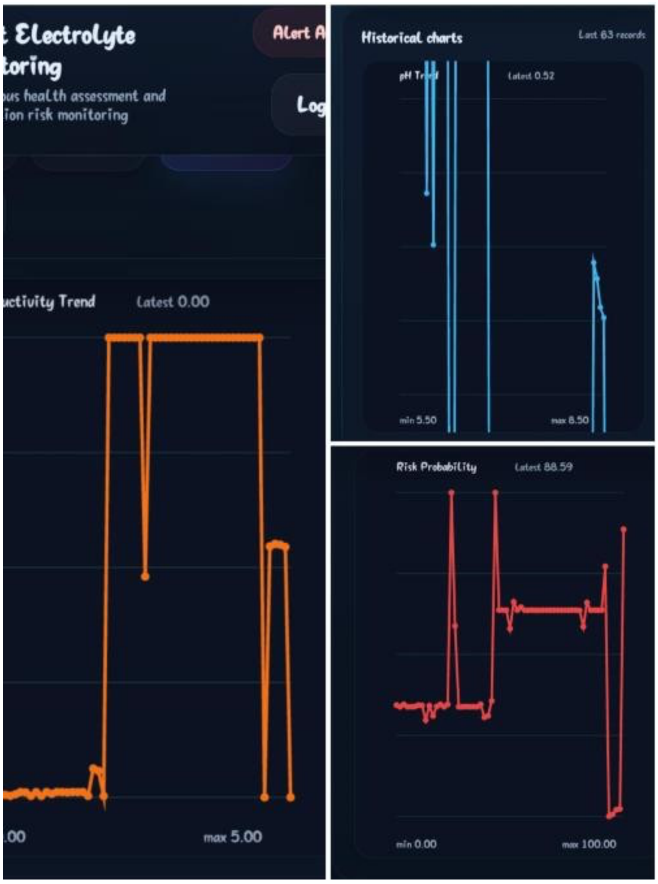

Figure 2.3: Sweat Electrolyte Monitoring Dashboard with Trends and Alerts

From the trend graph on the level of electrical conductivity, it is evident that different changes in the level of electrolytes in the human body can be identified. It is evident from the interface that the level of electrical conductivity is varying with different values, showing a sudden spike in the level. It is evident that the level is low; thus, the unstable level of electrolytes in the human body is shown in the interface. Moreover, the recent level recorded is near the minimum level, showing the deficiency in this particular aspect. It is significant in determining the level of dehydrations in the user, as it is directly proportional to the level of electrolytes in the sweat [3], [4].

In the case of the level of pH in the body, it is evident from the interface that different values are shown in a varying manner. It is evident from the interface that a sudden spike is shown in the level of pH in the body; thus, the level is high in this case. It is significant in determining the level of dehydrations in the user as well; however, in this case, it is inversely proportional to the level of electrolytes in the sweat.

V. CONCULSION

Based on the proposed system for monitoring sweat-based electrolytes, it is clear that it is effective in developing a system for human health monitoring. This is due to its ability to integrate all the concepts that have been discussed in the paper. The fact that it is able to leverage the levels of pH and conductivity in order to assess hydration levels is effective in converting sensed data into valuable information. Based on the implementation, it is clear that it is possible to develop an electrolyte monitoring system at a lower cost in real time using NodeMCU and PHP. The fact that it is able to leverage all the features is effective in enhancing system usability, which is likely to improve response. The approach is also effective in enhancing users' understanding of their health status, which is likely to bridge the gap that often exists between sensed data and users' understanding. Although it is not effective in clinical diagnosis, it is effective in developing a system that is comprehensive in order to enhance further development. Therefore, it is effective in developing a system that is likely to be effective in contributing to the advancement of wearable and IoT-based healthcare solutions

VI. REFERENCES

(1) Luo, X.; Tan, H.; Wen, W. Recent Advances in Wearable Healthcare Devices: From Material to Application. Bioengineering 2024, 11, 358.
(2) Frasier, K.; Li, V.; Sobotka, M.; Vinagolu-Baur, J.; Herrick, G. The Role of Wearable Technology in Real-time Skin Health Monitoring. JEADV Clin. Pract. 2025, 4, 21−29.
(3) Brasier, N.; Eckstein, J. Sweat as a Source of Next-Generation Digital Biomarkers. Digit. Biomarkers 2020, 3, 155−165.
(4) Clark, K. M.; Ray, T. R. Recent Advances in Skin-Interfaced Wearable Sweat Sensors: Opportunities for Equitable Personalized Medicine and Global Health Diagnostics. ACS Sensors 2023, 8, 3606−3622.
(5) Meihua, S.; Jiahui, J.; Yujia, L.; Shuang, Z.; Jingjing, Z. Research on Sweat Metabolomics of Athlete's Fatigue Induced by High Intensity Interval Training. Front. Physiol. 2023, 14, DOI: 10.3389/fphys.2023.1269885.
(6) Ma, C.-B.; Shang, X.; Sun, M.; Bo, X.; Bai, J.; Du, Y.; Zhou, M. Emerging Multifunctional Wearable Sensors: Integrating Multimodal Sweat Analysis and Advanced Material Technologies for Next-Generation Health Monitoring. ACS Sensors 2025, 10, 2388−2408.
(7) Heng, W.; Yang, G.; Kim, W. S.; Xu, K. Emerging Wearable Flexible Sensors for Sweat Analysis. Bio-Design Manuf. 2022, 5, 64−84.
(8) Apoorva, S.; Nguyen, N.-T.; Sreejith, K. R. Recent Developments and Future Perspectives of Microfluidics and Smart Technologies in Wearable Devices. Lab Chip 2024, 24, 1833−1866.
(9) Nashruddin, S. N. A. B. M.; Salleh, F. H. M.; Yunus, R. M.; Zaman, H. B. Artificial Intelligence-powered Electrochemical Sensor: Recent Advances, Challenges, and Prospects. Heliyon 2024, 10, No. e37964.
(10) van Eck, N. J.; Waltman, L. Software Survey: VOSviewer, a Computer Program for Bibliometric Mapping. Scientometrics 2010, 84, 523−538.
(11) Jiang, S.; Liu, Y.; Zheng, H.; Zhang, L.; Zhao, H.; Sang, X.; Xu, Y.; Lu, X. Evolutionary Patterns and Research Frontiers in Neoadjuvant Immunotherapy: A Bibliometric Analysis. Int. J. Surg. 2023, 109, 2774.
(12) Shi, Y.; Zhang, Z.; Huang, Q.; Lin, Y.; Zheng, Z. Wearable Sweat Biosensors on Textiles for Health Monitoring. J. Semicond. 2023, 44, 21601.
(13) Curto, V. F.; Coyle, S.; Byrne, R.; Angelov, N.; Diamond, D.; Benito-Lopez, F. Concept and Development of an Autonomous Wearable Micro-Fluidic Platform for Real Time PH Sweat Analysis. Sensors Actuators B Chem. 2012, 175, 263−270.
(14) Curto, V. F.; Fay, C.; Coyle, S.; Byrne, R.; O'Toole, C.; Barry, C.; Hughes, S.; Moyna, N.; Diamond, D.; Benito-Lopez, F. Real-Time Sweat PH Monitoring Based on a Wearable Chemical Barcode Micro-Fluidic Platform Incorporating Ionic Liquids. Sensors Actuators B Chem. 2012, 171−172, 1327−1334.
(15) Cheng, X. Y.; Leung, M. Y.; Tao, X. M.; Yuen, C. W.; Kwok, W. Y.; Xue, P. Effect of Liquids on the Electrical Resistance of Polypyrrole-Coated Fabrics. Res. J. Text. Appar. 2005, 9, 12−22.
(16) Morris, D.; Coyle, S.; Wu, Y.; Lau, K. T.; Wallace, G.; Diamond, D. Bio-Sensing Textile Based Patch with Integrated Optical Detection System for Sweat Monitoring. Sensors Actuators B Chem. 2009, 139, 231−236.