International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 08 Issue: 06 | June - 2024 SJIF Rating: 8.448 ISSN: 2582-3930

SKIN HEALTH PARAMETER MONITORING SYSTEM

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Abstract - Skin conditions, influenced by both internal bodily factors and external environmental elements, affect millions worldwide. Among these, environmental factors play a vital role, impacting skin health in many ways. In response to this issue, the prototype system provides real-time data on environmental parameters crucial for skin wellness. It integrates sensors to monitor temperature, humidity, UV radiation, and skin moisture, all connected to a microcontroller. This data is displayed on an LCD screen and transmitted to a website and mobile application (APK). Users receive alerts when sensor readings exceed predefined thresholds, suggesting necessary precautions. Additionally, the system features an IP webcam for capturing skin images, which are analysed to provide insights and skincare recommendations. This innovative approach bridges the gap between environmental factors and skin health, promoting proactive measures against environmental stressors. By providing real-time data and actionable insights, the prototype empowers users to make informed decisions about their skincare regimen. The system represents a significant advancement in skincare technology, offering comprehensive monitoring and management of environmental conditions and skin health. With its real-time functionality, recommendations, and proactive alerts, the system has the potential to greatly enhance users' skincare routines and overall skin health.

***Key Words*:** Skin health, environmental monitoring, real time data, sensor integration, image analysis, proactive measures

INTRODUCTION

According to a community-based, observational study on the prevalence of skin diseases in rural central India, the most common dermatosis accounted for 22% of participants, and among them, almost 60% were female. Various causes such as environment, overcrowding, and poor living conditions are major factors, and not only adolescents or old age groups but also the entire population between 21 and 50 years of age were found to be suffering more commonly from infective dermatoses.[5]

Taking environmental factors into consideration, we developed a prototype model that integrates multiple sensors to monitor environmental conditions and skin health in real-time . By utilising sensors such as the DHT11 for temperature and humidity, the CJMCU GUVA S12SD for UV radiation, and the CJMCU 6701 GSR for skin moisture, connected to ESP32 microcontroller, data on temperature, humidity, UV radiation and skin moisture are collected, processed and displayed on an LCD screen. In addition to the local display, the system transmits this data to a website and a mobile application (APK). The system also provides precautionary measures allowing users to remotely monitor environmental conditions and skin health. Furthermore, the integration of an IP webcam allows users to capture images of their skin, which are then analysed to provide insights into their skin condition and also offers recommendations for skin care based on the detected condition on website and APK, helping users take proactive steps to protect themselves from potential risks.

One of the key motivations behind this project is to address the growing concern over skin health and environmental factors that contribute to skin damage and ageing. By providing users with real-time data and actionable insights, our prototype aims to raise awareness about the importance of skin protection and promote preventive measures to minimise the negative impact of environmental stressors.

In conclusion, our prototype model, which integrates multiple sensors to monitor environmental conditions and skin health in real-time, represents a significant advancement in addressing the prevalence of skin diseases worldwide. By leveraging technology to provide real-time data and actionable insights, we aim to empower users with the knowledge and tools necessary to protect their skin from environmental stressors. This innovative approach not only raises awareness about the importance of skin health but also promotes preventive measures, ultimately contributing to the overall well-being of individuals in affected communities.

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I.DESCRIPTION

A. Google Firebase

Google Firebase is a cloud platform offering a suite of backend services for application development. It includes a real-time database for data synchronisation, secure user authentication, and cloud messaging for notifications. Firebase Hosting provides fast, secure web hosting, while Firebase Storage handles user-generated content like images and videos. These services support various platforms, including Android, iOS, and web applications, enabling developers to build robust, scalable apps with ease.

B. Arduino IDE

The Arduino IDE (Integrated Development Environment) is a versatile software tool for programming microcontrollers. It supports languages like C and C++ and features a code editor with syntax highlighting and auto-completion. The IDE includes a library of pre-written code examples, making it easy to add functionalities to projects. Compatible with various Arduino boards, it supports cross-platform development on Windows, macOS, and Linux. The Arduino IDE simplifies the creation of embedded projects and prototypes, making it accessible to both beginners and advanced users.

C. IP Webcam

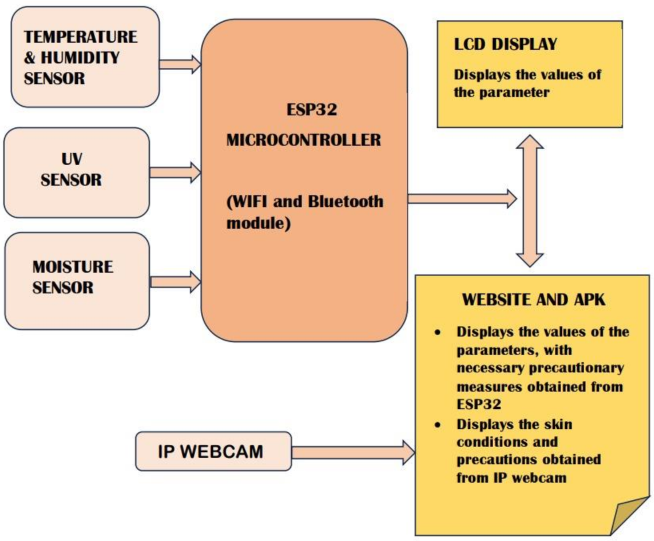
IP Webcam is an Android app that transforms a smartphone into a network camera. It streams video to a network, allowing remote viewing via web browsers or compatible applications. The app supports HD and Full HD resolutions, with adjustable frame rates and quality. Features include motion detection, night vision mode, and time-lapse recording. IP Webcam also offers cloud storage integration and multiple connection methods, such as Wi-Fi and USB tethering, making it a versatile tool for remote monitoring.

D. MIT App Inventor

MIT App Inventor is a web-based platform for creating Android apps without complex coding. It uses a visual, drag-and-drop interface to design user interfaces and define app behaviour. Users can incorporate components like buttons, text boxes, and sensors. The platform supports connectivity to services like Google Maps and Bluetooth. Emphasising rapid prototyping, App Inventor allows users to quickly build, test, and refine apps. It democratises app development, enabling users of all backgrounds to create functional Android apps.

E. Python IDLE

Python IDLE (Integrated Development and Learning Environment) is a tool for writing and executing Python code. It features a text editor with syntax highlighting, auto-indentation, and code completion. The Python shell allows interactive code execution with immediate results. IDLE integrates with Python's standard library, facilitating tasks like file handling and data processing. Customizable settings and code introspection features enhance productivity, making IDLE a powerful environment for both beginners and experienced Python developers.



II. PROPOSED SYSTEM

The proposed system monitors environmental parameters and skin conditions using an ESP32 microcontroller. It integrates a temperature & humidity sensor, UV sensor, and moisture sensor to collect data. The ESP32, processes and displays this data on an LCD screen. Data is transmitted to a website and an Android application (APK), providing real-time access and displaying precautionary measures. An IP webcam captures images for skin condition assessment, which are also

Fig 1. *Proposed System*

processed and shown on the website and APK. This dual local and remote data presentation leverages ESP32's connectivity for comprehensive real-time monitoring of environmental and health conditions.

III. METHODOLOGY AND IMPLEMENTATION

The prototype system is designed to monitor environmental parameters and skin conditions using an ESP32 microcontroller. The system includes the DHT11 sensor for temperature and humidity, the CJMCU GUVA-S12SD sensor for UV radiation, and the CJMCU 6701 GSR sensor for skin moisture. These sensors are connected to the ESP32 microcontroller, which utilises its Wi-Fi capability for data transmission.

A. Sensor Integration and Data Processing

The ESP32 microcontroller is programmed using the Arduino IDE. The DHT11 sensor provides digital output for temperature and humidity, while the CJMCU GUVA-S12SD and CJMCU 6701 GSR sensors provide analog values for UV radiation and skin moisture, respectively. The microcontroller processes these sensor outputs and converts them into standard units: degree Celsius for temperature, percentage for humidity, UV index for UV radiation [1], and conductance values for skin moisture. This data is displayed locally on an LCD screen.

B. Data Transmission and Website Integration

The system transmits the collected data to a website created using Google Firebase [3]. The website's API key is embedded in the Arduino IDE program, enabling the ESP32 to send data directly to the website. The program includes conditional statements to display respective precautionary measures based on threshold values. This ensures that the environmental parameters and corresponding precautions are shown on the website in real-time.

C. APK Development and Data Display

An Android application (APK) was developed using MIT App Inventor. The website's API token is integrated into the APK, allowing it to fetch and display the data transmitted by the ESP32. The APK shows the environmental data, precautionary measures, and skin condition assessments, providing users with comprehensive monitoring capabilities.

D. IP Webcam Integration and Image Analysis

An IP webcam installed on a smartphone captures images of the skin. The IP address of the IP webcam is integrated into the App Inventor program, enabling the APK to display the captured images. Image analysis is performed using a Convolutional Neural Network (CNN) method implemented in Python, utilising the Python IDLE environment [10]. The analysis program identifies skin conditions and provides corresponding precautions, which are displayed on both the website and the APK.

IV. MERITS AND DEMERITS

Merits

The prototype system offers significant advantages in skincare monitoring and management. It provides real-time monitoring of environmental parameters like temperature, humidity, and UV radiation, as well as skin moisture levels. This capability enables users to stay informed about their immediate surroundings and monitor changes in their skin health continuously. By alerting users to unsafe environmental conditions and offering skincare recommendations, the system promotes proactive skin health management, helping users prevent potential skin damage. The integrated LCD display presents monitored data in a clear and accessible format, enhancing user understanding and facilitating informed decision-making regarding skin care practices. Transmitting data to both a website and a mobile application extends accessibility, allowing users to monitor their skin health remotely with ease. Moreover, the inclusion of an IP webcam enables users to capture and analyse skin images, facilitating personalised skincare recommendations and early detection of skin issues.

Demerits

The prototype system does present some limitations. Firstly, its limited portability due to reliance on external power and a stable setup restricts its usability in outdoor or remote environments. Secondly, dependency on internet connectivity for data transmission to the website and mobile application may pose challenges in areas with unreliable or limited internet access. Lastly,the use of an IP webcam for skin condition analysis raises privacy considerations, implementing robust data security measures ensures user privacy and confidentiality.

RESULTS AND DISCUSSION

The prototype system successfully integrates multiple sensors with the ESP32 microcontroller to monitor environmental conditions and skin health in real-time. Data captured by these sensors are processed and displayed on an LCD screen in an easily comprehensible format, with temperature in Celsius, humidity in percentage, UV index categories (normal, high, extremely high), and skin moisture in conductance levels.

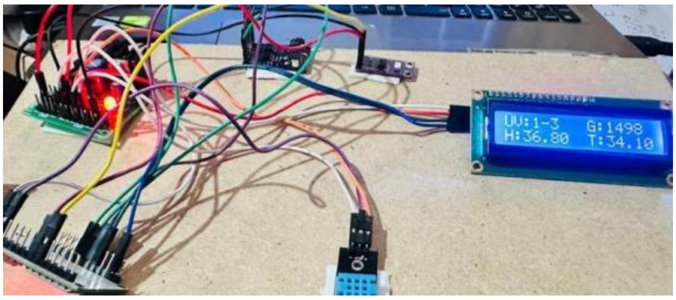


Fig 2. LCD Display

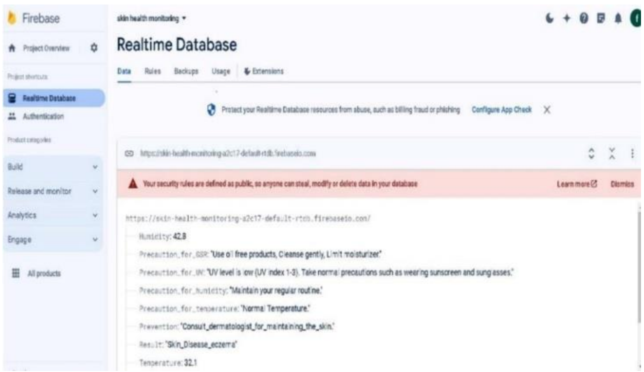


Fig 3. Website

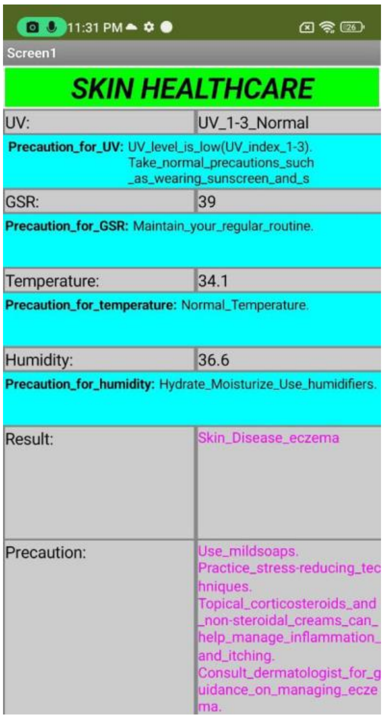


Fig 4. APK

The system transmits this data to a website and mobile application, allowing users to remotely monitor environmental conditions and skin health. When sensor readings exceed predefined thresholds, the system provides precautionary measures. The integration of an IP webcam enables users to capture and analyse skin images, offering personalised skincare recommendations.

Overall, the prototype demonstrates potential in raising awareness about skin health and promoting preventive measures against environmental stressors. By providing real-time data and actionable insights, the system empowers users to make informed decisions about their health, addressing concerns over skin damage and ageing.

CONCLUSION

The developed prototype system marks a significant advancement in skincare technology, offering comprehensive real-time monitoring and management of environmental conditions and skin health. By integrating sensors with an ESP32 microcontroller, the system provides users with crucial insights via an LCD display, website, and mobile application. The inclusion of threshold alerts and skin condition analysis empowers users to take proactive measures to protect their skin and maintain optimal skin health. This innovative system links environmental factors with skin health, enhancing awareness and encouraging proactive skin care management in the modern age.

Future Improvements: It includes integrating AI for enhanced skin analysis and recommendations, developing wearable technology for convenient monitoring, and enabling telemedicine for remote consultations. Collaborations with skincare brands could lead to tailored products and services. Additionally, educational initiatives and community outreach programs can raise awareness about proactive skin care practices, driving further research and innovation in skincare technology.

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