



# SMART BAND FOR WOUND MONITORING USING TEMPERATURE AND MOISTURE SENSOR

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**Abstract :** This study describes the creation of a smart band that uses moisture and temperature sensors to continuously monitor wounds.

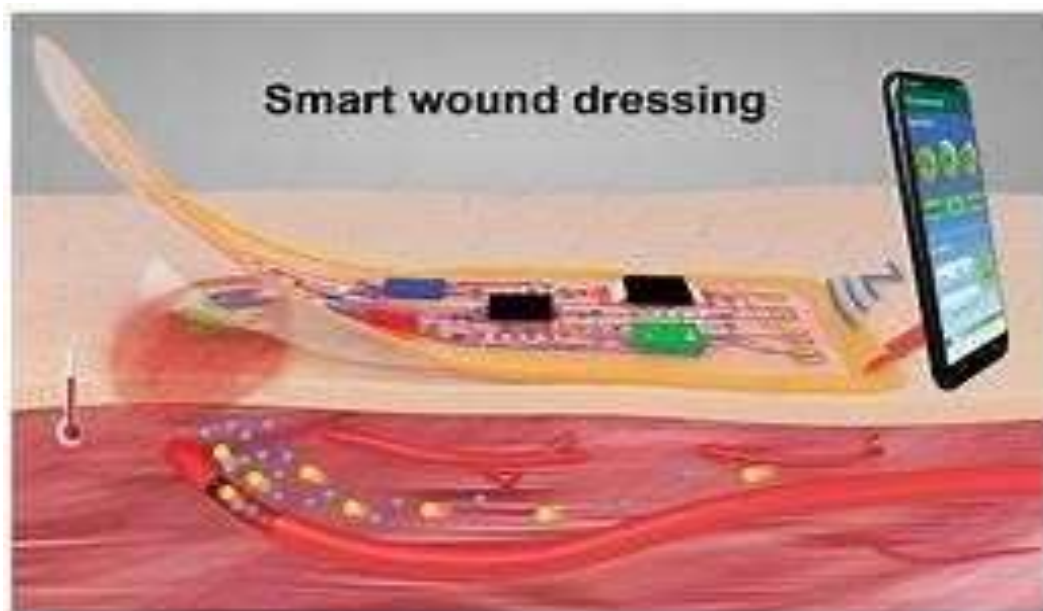
By recording important physiological indicators that point to infection or a delayed recovery, the suggested method seeks to provide real-time evaluation of wound healing conditions. Through implanted sensors, temperature and moisture data are gathered from the wound site and wirelessly sent to a monitoring program for analysis. Changes in these metrics are utilized to identify anomalous circumstances, allowing for prompt medical attention and minimizing complications. Wearable design combined with sensor technology guarantees comfort, portability, and ongoing monitoring without requiring regular clinical examinations. By offering an automated, affordable, and easily accessible way to monitor the healing process of wounds, this method has the potential to improve patient care by lowering healthcare costs and increasing treatment results.

**Index terms:** Wearable wound monitoring, Integrated temperature and moisture sensors, Smart biomedical patch, Continuous wound assessment, Remote health monitoring

## INTRODUCTION

In order to guarantee appropriate healing and prevent infection, wound management is one of the most important areas of healthcare and requires constant monitoring. Conventional wound inspection techniques need manual examination and frequent dressing changes, which raises the risk of infection and contamination in addition to making patients more uncomfortable. As technology advances, it is more crucial than ever to have intelligent and automated wound monitoring systems in order to enhance patient outcomes and healthcare efficiency. A smart bandage continuously monitors wound parameters including temperature and wetness, which are important markers of the wound's healing state, by combining digital technology and biological sensors. Inappropriate moisture levels, either too wet or too dry, can slow healing and raise the chance of bacterial growth, while an unusual increase in temperature can indicate infection or inflammation. Effective wound care thus requires keeping an eye on temperature patterns and maintaining an ideal moisture balance. Temperature and moisture sensors built within the dressing material are used by the suggested Smart Bandage for Wound Monitoring to deliver real-time information about the wound environment. For ongoing monitoring, this data can be wirelessly sent to a medical professional or a mobile application.

The approach reduces hospital visits, improves treatment choices, and minimizes medical supply misuse by facilitating early detection of issues. Further more, by lowering the frequency of dressing changes and needless usage of medical supplies, the deployment of such intelligent systems aids in the control of biomedical waste. This strategy is in line with sustainable healthcare standards and promotes patient-centered treatment. The overall goal of this project is to design and create a smart bandage system that is affordable, portable, and dependable. It will be able to use temperature and moisture sensors to monitor the conditions of wound healing. The system promotes efficient healing, increases patient safety, and facilitates efficient biological waste reduction in healthcare institutions through ongoing monitoring and rapid alarms.



### NEED OF THE STUDY.

In contemporary healthcare environments, the treatment of wounds continues to pose a considerable difficulty. Individuals with long-lasting wounds, post-operative wounds, or burns need regular observation to avoid infections and enhance healing speed. Conventional methods for wound care, which depend on regular manual examinations and frequent changes of dressings, can be time-consuming, uncomfortable for patients, and may lead to delays in identifying complications. Healthcare workers, such as nurses, ward aides, and laboratory personnel, often come into contact with contaminated wound dressings while performing inspections and changing dressings. This raises the likelihood of being exposed to infectious substances in the workplace and adds to the creation of biomedical waste. Inadequate management or too frequent replacement of dressings raises healthcare expenses and contributes to environmental issues connected to the management of biomedical waste.

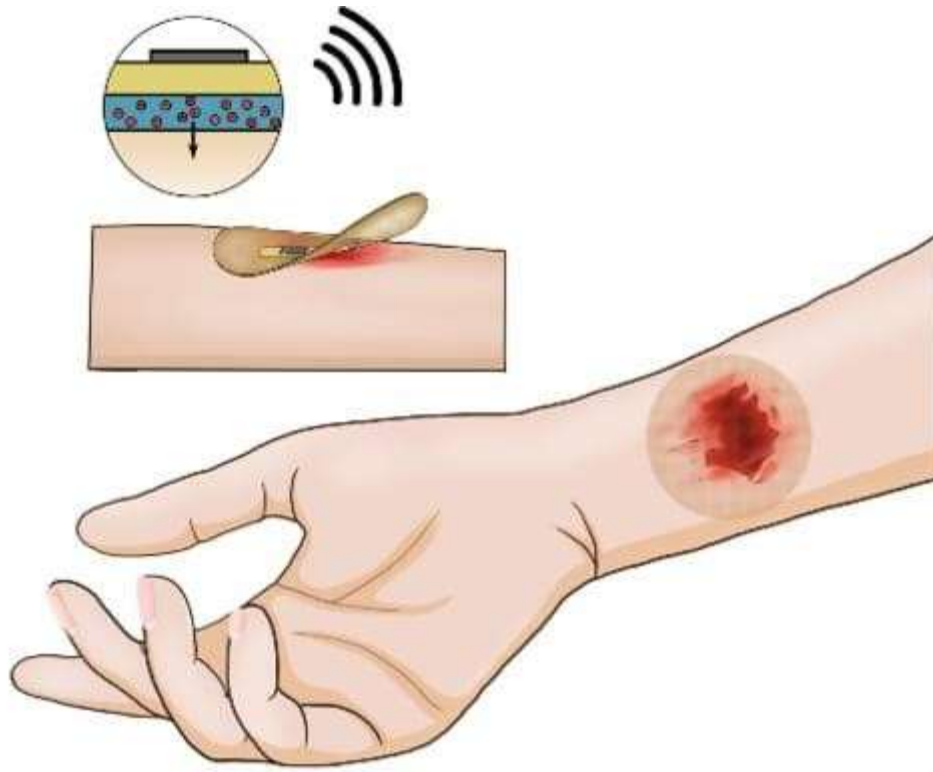
An advanced bandage system with sensors for temperature and moisture can solve these issues by offering immediate monitoring of wound conditions. Unusual temperature may signal an infection, while incorrect moisture levels can hinder healing or encourage the growth of bacteria. Ongoing observation decreases the frequency of dressing modifications, lowers the chance of infection, and enables prompt medical action. Thus, researching smart bandages is crucial to advance patient care, boost the effectiveness of wound healing, minimize occupational risks for healthcare professionals, and promote sustainable biomedical waste management strategies in medical facilities and clinics.

### PROPOSED SYSTEM

Chronic wounds, diabetic ulcers, burns, and post-surgical wounds require constant monitoring to ensure proper healing and to prevent complications such as infection or delayed recovery. In traditional wound care, patients rely on visual inspection and periodic clinical evaluation, which often fail to detect early signs of infection or abnormal healing conditions. Minor changes in temperature and moisture around the wound area are critical indicators of healing progress, but these parameters are not continuously measured in conventional dressings.

To address this issue, a smart bandage system is proposed that integrates temperature and moisture sensors into a flexible, biocompatible bandage material. The temperature sensor helps identify local inflammation or infection through elevated temperature readings, while the moisture sensor monitors exudate levels to maintain an optimal healing environment. The data collected by these sensors can be processed and transmitted wirelessly (e.g., via Bluetooth) to a smartphone or monitoring device, allowing patients and healthcare professionals to track wound conditions in real time.

This smart bandage not only enables continuous, non-invasive wound monitoring, but also reduces the need for frequent dressing changes and hospital visits. Early detection of abnormal wound conditions can lead to faster treatment decisions, minimizing the risk of infection, discomfort, and healthcare costs. Hence, this project aims to design a low-cost, efficient, and reliable wound monitoring system that enhances patient safety and improves the overall wound healing process.



## METHODOLOGY

To allow for continuous monitoring of wound healing using temperature and moisture sensors, the intelligent bandage system was created and deployed in a series of steps. The approach consists of many steps, such as system design, sensor integration, data collecting, wireless communication, calibration, and performance testing.

### 1. Component Choice and System Design

The initial step was to create the smart bandage's general system architecture. Temperature and humidity sensors, an LCD display, a Bluetooth communication module, and an ESP32 microcontroller were the main components chosen for the design. The ESP32 was selected due to its low power usage, small footprint, and integrated wireless functionality. A soft, flexible, and biocompatible bandage material was used to make sure it is comfy and secure when worn on the skin. The sensors were placed carefully inside the bandage to maintain contact with the wound surface while reducing irritation.

### 2. Sensor Integration

Changes in wound temperature, which might be a sign of infection or inflammation, are detected by the temperature sensor. To prevent dryness or excessive exudate accumulation, the moisture sensor keeps an eye on the wound's hydration level. The microcontroller is connected to both sensors via flexible conductive traces that are buried inside the bandage's inner layer. To protect electronic components from moisture and to maintain hygiene, proper insulation was guaranteed.

### 3. Data Gathering and Processing

The sensors constantly gather data on temperature and humidity at regular intervals after they are integrated. The data from the sensors is sent to the ESP32 microcontroller, which analyzes it and transforms it into understandable digital numbers. These readings are compared by the microcontroller to predetermined threshold values in order to spot unusual circumstances like excessive moisture (indicating inadequate wound drainage) or high temperature (suggesting a potential infection).

### 4. Wireless Display and Communication

The processed data is sent through Bluetooth to a smartphone or computer, where a specialized application interface displays it in real time. The software offers a simple picture of how wound temperature and moisture change over time. Furthermore, the bandage includes an LCD screen that displays real-time readings and visual alerts, providing quick feedback to patients and caregivers even in the absence of a smartphone connection.

## 5. Testing and Calibration

To guarantee measurement accuracy, all sensors go through a calibration procedure before they are used in practice. The moisture sensor is tested using varying humidity levels, whereas the temperature sensor is calibrated using a thermometer reference and regulated heat source. The system is also assessed for its power efficiency, response time, and communication range to ensure consistent performance throughout extended usage. The microcontroller saves the calibration data so that it can make real-time adjustments while it's running.

## 6. Prototype Evaluation and Validation

The complete smart bandage prototype is tested on a sample wound model that simulates different wound conditions such as infection, dryness, and excessive exudate. The results are monitored to verify that the system accurately detects abnormal conditions and triggers appropriate alerts. Comfort testing is also conducted to ensure that the flexible materials and embedded electronics do not cause discomfort or irritation during extended wear.

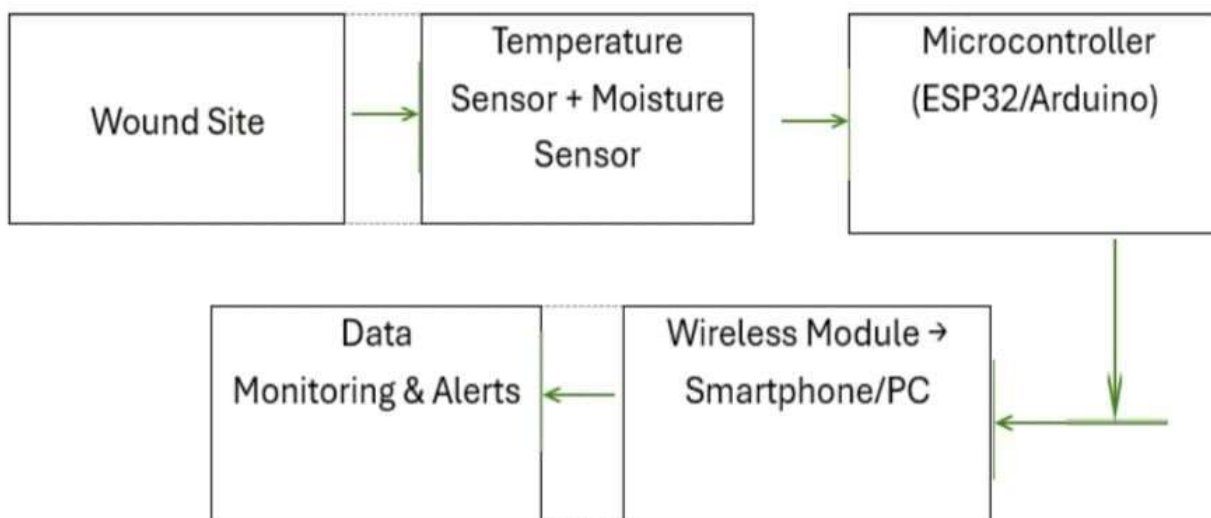
## 7. Data Analysis and Alert Mechanism

Collected data from the sensors are analyzed to identify patterns in wound healing. When any parameter exceeds the safe threshold—such as a sudden rise in temperature or high moisture retention—the system generates an automatic alert message through the mobile app. This ensures that medical intervention can be provided promptly, minimizing the risk of infection and promoting faster healing.

## 8. Continuous Monitoring and Improvement

The final step involves continuous evaluation of system performance in real-world conditions. Feedback from users and healthcare professionals is used to enhance sensor placement, improve data accuracy, and optimize the mobile interface. Future iterations may integrate additional biosensors or machine learning algorithms to predict wound healing progress more accurately.

## BLOCK DIAGRAM



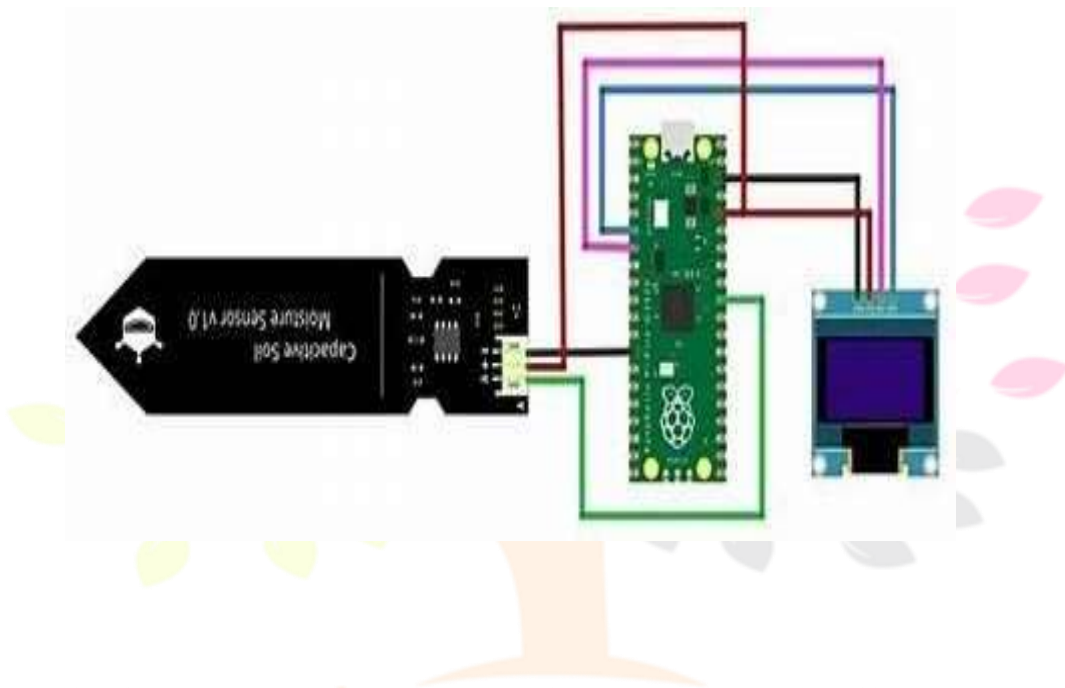
## HARDWARE DESCRIPTION

The proposed smart wound monitoring band features a range of hardware components specifically aimed at providing ongoing assessment of wound conditions along with real-time feedback. The temperature sensor is essential for assessing the local temperature at the wound site leading to early detection of potential infections or signs of inflammation. Any irregular changes in temperature are swiftly identified and conveyed to the microcontroller to ensure timely alerts for medical assistance. Furthermore the moisture sensor

evaluates the wound's moisture or exudate levels ensuring an ideal healing environment. It checks whether the wound is too dry or overly moist and relays this information to the microcontroller triggering alerts when necessary to prevent complications or infections.

At the heart of the system is the ESP32 microcontroller, acting as the primary unit for processing and communication. It gathers live data from the temperature and moisture sensors and sends this information wirelessly through Bluetooth or Wi-Fi to a paired mobile device for ongoing observation. This allows healthcare professionals or patients to monitor the wound status from a distance and get notifications if any unusual readings occur. To make it user-friendly, the smart band includes an LCD screen that shows current temperature and moisture levels right on the device. The screen also gives instant visual warnings whenever the system identifies situations that fall outside the ideal healing range.

### Circuit diagram



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