Fabrics Wetness Detection Based on Humidity and Temperature

Abstract:

This project looks into fabric wetness detection using humidity and temperature data, with the goal of supporting people with weak sense of wet or dry and improving care for vulnerable groups like newborns. We collected detailed data on fabric and environmental factors using Arduino UNO and DHT22 sensors, including fabric humidity, fabric temperature, room temperature, and room humidity, across a variety of fabric kinds. Our study deals with the crucial need to aid persons who have lost the capacity to detect fabric water absorption owing to skin diseases or developmental issues, such as babies who are unable to express their discomfort. We showed promising results in fabric wetness detection by using logistic regression and decision tree techniques for model training and then logistic regression for testing. This study emphasizes the potential of technological solutions to improve quality of life and caring practices, with implications for healthcare

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Keywords: Fabric wetness detection, humidity, temperature, Arduino UNO, DHT22 sensors, logistic regression, decision tree, sensory impairment, infant care, diaper technology.

Introduction:

The capacity to detect fabric wetness is an important part of daily living that promotes comfort and cleanliness. Individuals with sensory impairments or developmental limits, such as those with particular skin disorders or babies who are unable to verbalize their discomfort, face considerable issues in the absence of this sensory input. The inability to tell whether a cloth is wet or dry can cause pain, skin irritation, and unhealthy conditions.

Recognizing the crucial relevance of tackling this issue, our study focuses on creating a fabric wetness detecting system that employs humidity and temperature sensors. We hope to deliver a system that not only properly detects fabric wetness but also offers practical applications for improving quality of life and caring practices by utilizing advances in sensor technology, including Arduino UNO and DHT22 sensors.

Our study is motivated by a desire to help people who have lost their capacity to feel fabric dry or wet because of a variety of circumstances, including sensory impairments and developmental issues. Individuals with certain skin diseases, such as diabetic neuropathy or paralysis, may have impaired sensory sensitivity, making it harder to detect wetness on cloth. Furthermore, babies, who are unable to express their displeasure vocally, rely on caregivers to meet their demands, such as keeping them dry for best health and comfort. Integrating fabric wetness detecting devices into newborn apparel promotes a proactive approach to parenting, allowing caregivers to respond quickly to the infant's needs.

Furthermore, our findings have larger implications beyond individual care, including textile production and environmental monitoring. By creating robust fabric wetness detecting algorithms and systems, we hope to enhance textile technology and promote the creation of creative products that prioritize user comfort and well-being. Furthermore, by measuring fabric wetness levels in real time, our technology has the potential to influence environmental management techniques, especially in settings where moisture control is crucial, such as healthcare facilities and manufacturing environments.

This article presents our methods to identify fabric wetness, which includes sensor selection, data gathering processes, and algorithm development. We also explore the importance of our study in meeting the requirements of vulnerable groups and developing technical solutions for detecting fabric dampness. Our study aims to contribute to the development of practical, user-centered solutions that improve quality of life and encourage inclusive care practices.

Data Collection:

Data gathering for our fabric wetness detection system included the use of Arduino UNO microcontrollers and DHT22 sensors to record essential environmental factors such as fabric humidity, fabric temperature, room temperature, and room humidity. To assure the accuracy of our readings, we thoroughly calibrated the sensors prior to data gathering. Furthermore, data gathering techniques were carried out under controlled settings to ensure consistency and reproducibility.

To capture a complete range of fabric qualities, we used a variety of materials in our dataset. This variety enabled us to account for any changes in fabric qualities and their impact on wetness detection. Fabrics with varying compositions, textures, and absorbency levels were chosen to generate a sample dataset that replicates situations from the real world.

To replicate varied degrees of cloth dampness, we used a methodical methodology. Initially, we determined the baseline humidity and temperature of each cloth sample in its dry condition. Following that, a specific area of each cloth was intentionally drenched to imitate moisture, while the rest of the fabric remained dry. This technique allowed us to collect unique data points for both wet and dry areas of the cloth, allowing for more accurate wetness detection analysis.

Throughout the data gathering process, considerable care was taken to ensure uniformity and standardization. Environmental variables, such as room temperature and humidity, were carefully monitored and managed to reduce external influences that may compromise the dataset's integrity. Furthermore, all data points were recorded precisely and accurately to confirm the validity of our findings.

Our dataset, which systematically captures fabric humidity and temperature data under diverse situations, including wet and dry states, serves as a solid platform for the development and assessment of fabric wetness detection algorithms. The systematic approach to dataset gathering assures that our system can reliably discern between wet and dry fabric states, allowing for proactive solutions to moisture-related issues in real-world applications.

Research Methodology:

Our research methodology included rigorous data gathering, model training, and assessment of fabric moisture detecting methods. The following highlights the essential steps used in our research.

1. **Dataset Preparation:** The dataset had 186 data points, with 96 dry fabric conditions and 86 wet fabric conditions. Each data point contained measures of fabric humidity, fabric temperature, room temperature, and room humidity, all gathered with Arduino UNO microcontrollers and DHT22 sensors. The dataset was separated into two sets: training and testing. Training took up 80% of the data, while testing took up 20%.
2. **Model Training:** Two machine learning techniques, logistic regression and decision tree, were used for model training. Logistic regression is a popular classification technique noted for its simplicity and efficacy, but decision trees are interpretable and easy to grasp. Both models were trained using the training data, which accounted for 80% of the total dataset.
3. **Model Evaluation:** Following training, the models' performance was assessed using the testing dataset. According to our methodology, logistic regression was the only model employed for testing. The accuracy of each model was determined by its ability to correctly distinguish cloth conditions as wet or dry.
4. **Result Analysis:** The performance of each model was evaluated based on its accuracy in identifying cloth moisture. We looked specifically at the accuracy metrics obtained during training and testing to measure the models' resilience and generalization capacity.
5. **Performance Metrics:** The models were evaluated mostly based on their accuracy. Accuracy is the fraction of properly categorized cases out of all instances. We also included other significant measures like accuracy, recall, and F1 score to offer a thorough assessment of model performance.

Results:

Logistic Regression Training Accuracy: 99.31%.

Testing data accuracy is 97.3%.

The Decision Tree achieved 98.62% accuracy in training data.

Discussion:

The results show that both logistic regression and decision tree methods are highly accurate in classifying fabric moisture. Logistic regression showed remarkable accuracy rates of 99.31% and 97.3% on training and testing data, respectively. These results show that logistic regression can reliably discriminate between wet and dry fabric conditions.

The decision tree model displayed great accuracy during training, however its performance on testing data was not supplied as it gave a bit lower accuracy in training than logistic regression.

Conclusion:

In this work, we created and tested a fabric wetness detection system using humidity and temperature sensors, with the goal of supporting people with impaired sensory perception and improving care practices for vulnerable groups. Using Arduino UNO microcontrollers and DHT22 sensors, we gathered extensive data on fabric and environmental characteristics such as fabric humidity, fabric temperature, ambient temperature, and humidity.

Our investigation yielded good findings for fabric wetness detection, with logistic regression obtaining 99.31% accuracy on the training dataset and 97.3% on the testing dataset. The confusion matrix confirms the model's performance, with 19 cases properly identified as wet and 17 as dry, resulting in a balanced classification conclusion.

The successful implementation of logistic regression indicates its usefulness as a classification system for detecting fabric dampness. The excellent accuracy rates recorded on both training and testing datasets demonstrate the model's resilience and generalization capabilities, showing its suitability for real-world applications.

Our findings have important implications for a variety of fields, including healthcare, textile production, and environmental monitoring. By offering a dependable and proactive solution for fabric wetness detection, our technology can improve the quality of life for people with sensory impairments and allow responsive caregiving practices, particularly for newborns who rely on caregivers to meet their requirements.

Future research might investigate the use of additional sensor modalities and sophisticated machine learning algorithms to improve the accuracy and efficiency of fabric moisture detecting systems. Furthermore, longitudinal studies might look at the long-term performance and usability of such systems in real-world contexts, offering vital insights into their practical viability and influence on user outcomes.

Finally, our research advances technology-driven solutions for fabric wetness detection, which have the potential to improve the lives of people with sensory impairments and vulnerable groups. Using new techniques and multidisciplinary partnerships, we can continue to create and develop inclusive solutions that promote well-being and improve quality of life.