THE SMART CLOTH RACKER

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ABSTRACT

The project, titled "The Smart Cloth Racker," aims to enhance the traditional practice of drying clothes, which often faces challenges from unpredictable weather such as rain and intense sunlight that can damage garments. While some current smart clothes racks feature automated mechanisms to shield clothes from rain, they frequently do not include the capacity to avert over-drying, which can lead to deterioration of fabric and color loss. This paper presents an advanced and automated clothes drying system that overcomes these drawbacks. The Smart Cloth Racker expands on the idea of smart racks by introducing a novel mechanism to prevent over-drying. The system combines weather detection (to identify rain and sunlight), humidity tracking (to recognize mist), and moisture assessment (to evaluate how dry the clothes are). When rain or high humidity is detected, the rack automatically retracts into a protective area. Importantly, it also pulls back when the clothes are dry, thus avoiding extended exposure to sunlight. Additionally, the system is equipped with a solar panel and battery to improve energy efficiency and promote sustainability. This paper outlines the proposed system architecture, detailing the hardware components (including moisture sensors, weather sensors, humidity sensors, a solar panel, motors, and a microcontroller) along with the control algorithms for managing the automated movements of the rack and preventing over-drying. Anticipated benefits include enhanced drying efficiency, protection of clothing quality from both rain and over-drying, greater user convenience, and lower energy usage through solar energy.

1. INTRODUCTION

The conventional method of hanging clothes outside to dry may seem straightforward, but it is fraught with difficulties due to the unpredictable nature of weather. Rain can cause already drying clothes to become wet again, which leads to repeated drying sessions and can promote mildew or unpleasant smells. On the other hand, too much direct sunlight can be harmful even after the clothes are dry. Over-drying is a common issue when clothes are left in the sun for too long, resulting in damage to the fabric, including weakened fibers, decreased tensile strength, and a higher likelihood of brittleness. Additionally, exposure to ultraviolet (UV) rays from the sun can lead to color fading as it breaks down dye molecules, especially in vibrant fabrics. This fading not only impacts the visual appeal of the clothing but also affects its value and durability. Moreover, over-drying can change the texture of fabrics, making them feel stiff and coarse, which can reduce comfort and potentially harm more delicate materials. While some modern "smart" clothes drying racks can automatically retract when it rains, they often fall short in managing the equally harmful effects of over-drying. These systems mainly prioritize protection from rain, leaving garments exposed to the risks of extended sunlight. This paper addresses this significant oversight by introducing the "Smart Cloth Racker," an advanced and automated clothes drying system that optimizes the drying process while preventing damage from both rain and over-drying. The Smart Cloth Racker enhances the existing smart drying rack concept by introducing an innovative mechanism to prevent over-drying, delivering a more comprehensive and intelligent solution for clothes drying. The goal is to provide an easy-to-use, efficient, and sustainable method for drying clothes, thus extending the life of garments and maintaining their quality.

2. LITERATURE SURVEY

Chairul Fahmi Nasution; Maksum Pinem; Suherman "Automatic Control Circuit Design for a Clothes Dryer"(2021). This paper designed a low-cost automatic dryer system that relies on cheap microcontroller, sensor, motor, and algorithm to automatically sheds the clothes when it is rainy. The system is designed by using ESP32 and fuzzy logic controller that can be controlled in distance by using Android device. The designed system is able to respond weather with relatively low error up to 0.88% and with reporting delay of 1.859 s. [1].

Dennis L. Heidner ;Amy Fuchs Heidner "A field study of the residential clothes drying process" (2016). A new physics-based drying model accounts for fabric type and size using probability functions and latent heat. Normalized drying efficiency is introduced for consistent comparison across load sizes and cycle times. Percolation theory explains load size effects via the probability of air-fabric interaction. Model validation uses experimental and literature data. This model aids development of energy-efficient moisture removal for next-gen dryers. [2].

Muhammad Zharfan Mulawa;Ir. Dwi Nur Fitriyanah |"Design of Portable Automatic Clothes Dryer with Fuzzy Logic Controller"(2023) .This research presents an automatic portable clothes dryer cupboard for Indonesia, addressing challenges posed by erratic weather and limited drying space. The system uses fuzzy logic control, a DHT22 sensor, heating lamp, and exhaust fan for optimized drying. An ESP32 microcontroller implements the control, and Thingspeak provides internet-based monitoring. This design improves daily life by minimizing drying time and maximizing space efficiency in densely populated areas.[3].

Rodney H. G. Tan;Y. Q. Wong;Y. H. Goh;V. H. Mok "Design of Garment Hanger Dryer"(2010). GHDryer is a portable indoor garment hanger designed for efficient drying, targeting high-rise residents and travelers. 1 It features cool and heat dry options using axial fans and a heating element,respectively. Four operating modes (Fan, Heat, Fan+Heat, Alternating) cater to various needs, with user-set drying durations. GHDryer is a low-cost, user-friendly, and environmentally friendly solution.[4].

Taeil Yi; Joshua C. Dye; Molly E. Shircliff; Farhad Ashrafzadeh "A New Physics-Based Drying Model of Thin Clothes in Air-Vented Clothes Dryers"(2016) . A new physics-based drying model uses probability functions and latent heat to account for fabric size and type. Normalized drying efficiency enables consistent comparison across varying load sizes and cycle times. Percolation theory explains load size effects via the probability of hot air interaction with the clothes. Validated with experimental and literature data, the model aids development of energy-efficient moisture removal for next-generation dryers.[5].

Yang Wuzhou;Chen Liang "Key design technologies of the dry-mixed mortar production line"(2012). China's infrastructure boom fuels high demand for dry-mixed mortar production lines. This paper analyzes the production process and reviews domestic/foreign research and applications. Key design technologies for such lines are presented. These designs have been successfully implemented and are currently in operation.[6].

3. PROPOSED SYSTEM

The Smart Cloth Racker system is crafted to automate the of clothes while ensuring garment protection against rain and excessive drying. This is accomplished through an array of sensors, a central processing unit, and a mechanical setup designed for rack management. The system architecture, shown in the block diagram, includes several essential components:

3.1 System Architecture

This system functions using a closed-loop feedback approach. An assortment of sensors gathers environmental data, which is then sent to the Arduino Uno microcontroller. This microcontroller interprets the data according to established algorithms and thresholds. Following analysis, it issues control signals to the driver motor, which adjusts the cloth rack accordingly extending it for drying or retracting it for safeguarding. A dedicated power supply unit provides the necessary energy for the system

3.2 Hardware Components

3.2.1 Sensing Unit:

Rain Sensor: A rain sensor, probably of the conductivity type, is utilized to identify rainfall. When rainfall occurs, the conductivity between the sensor's traces increases, activating a digital signal to the Arduino.

Humidity Sensor: A humidity sensor, likely a capacitive type because of its accuracy and range, gauges the relative humidity in the environment. This information is essential for detecting mist or conditions of high humidity that might dampen garments. The sensor sends an analog signal that the Arduino reads and converts into a digital value.

Moisture Sensor: A moisture sensor is placed on a sample piece of clothing on the rack. This sensor evaluates the moisture level in the fabric, offering a direct measurement of how dry the clothes are. It may be a resistive type, which changes resistance according to the moisture content. The Arduino processes this analog signal to determine when the garments are dry.

3.2.2 Processing Unit:

Arduino Uno Microcontroller: The Arduino Uno serves as the key processing unit of the system. It collects signals from all the sensors, implements the control algorithms, and sends commands to the motor driver. Its affordability, ease of programming, and the availability of analog-to-digital converters make it ideal for this use.

3.2.3 Actuation Unit:

Driver Motor: A driver motor, possibly a DC motor with suitable gearing, is employed to manage the movement of the cloth rack. This motor gets signals from the Arduino through a motor driver circuit. The rotational motion of the motor is converted into linear motion of the rack, allowing for extension and retraction.

Cloth Rack: The cloth rack is a mechanical structure meant to hold clothes for drying. It is linked to the driver motor so that it can be extended outwards for drying purposes and retracted to provide shelter when needed.

3.2.4 Power Supply Unit:

Power Supply: A power supply unit delivers the necessary electrical power to all system components. This may be a mains adapter, or for greater portability and sustainability, a solar panel connected to a battery charging circuit.

3.3 Software/Control Algorithm

The control algorithm embedded in the Arduino defines how the system. This algorithm consistently observes the sensor inputs and responds appropriately based on set thresholds and established logic.

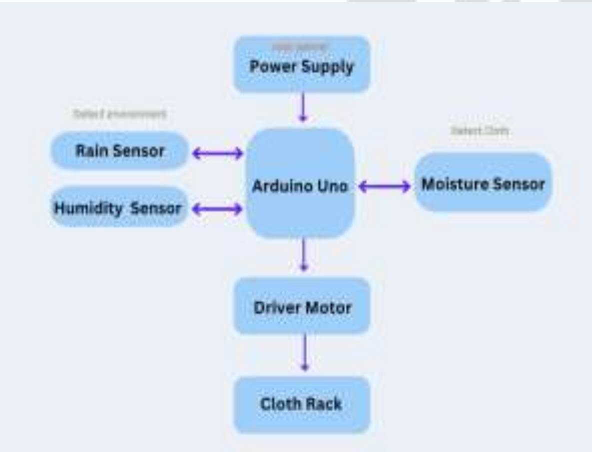
1. **Initialization:** When the system starts, it initializes the sensors, establishes the initial positions for the rack, and begins to track the sensor data.
2. **Rain Detection:** The algorithm consistently monitors the status of the rain sensor. If it detects rain (indicated by a digital signal HIGH), the rack immediately retracts.
3. **Humidity Monitoring:** The system periodically checks the humidity levels. If the humidity surpasses a predetermined limit (e.g., 90% relative humidity), the rack retracts to stop the clothes from absorbing moisture from the environment.
4. **Drying Level Assessment:** The moisture content of clothes is evaluated at regular intervals. The algorithm transforms the analog reading from the moisture sensor into a percentage of moisture content. When this percentage drops below a set target (indicating the clothes are dry), the system moves to the next step.
5. **Over-Drying Prevention:** After the clothes have dried, the rack retracts to avoid excessive sun exposure.
6. **Sunlight Detection (Optional):** In a more advanced model, a light sensor could be implemented to gauge the sunlight intensity. The rack could then be programmed to extend only when sunlight exceeds a certain level, enhancing the drying effectiveness.
7. **Rack Control:** The Arduino transmits the necessary signals to the motor driver to manage the motor's rotation in both direction and duration, thus extending or retracting the rack as required.

3.4 Over-Drying Prevention Mechanism:

The key feature of the Smart Cloth Racker is its system for preventing over-drying. This is accomplished through the combination of a moisture sensor and a control algorithm. The moisture sensor offers real-time insights into how dry the clothes are. The control algorithm consistently tracks this information and, as soon as it identifies that the clothes have reached a set dryness level, initiates the retraction of the rack, thus averting further sunlight exposure. This feedback-driven methodology guarantees that the clothes are taken out of the sun right when they are dry, significantly reducing the chance of over-drying.

This thorough explanation of the proposed system offers a complete view of the Smart Cloth Racker's capabilities and its innovative methods for drying clothes. The incorporation of various sensors, a sophisticated control algorithm, and a reliable mechanical design ensures efficient, dependable, and fabric-friendly drying of garments.

4. BLOCK DIAGRAM



4.1 WORKING

The Smart Cloth Racker automates clothes drying, responding to environmental conditions and fabric dryness to prevent damage. A rain sensor triggers rack retraction upon detecting rain.

A humidity sensor retracts the rack if humidity levels are high, preventing moisture absorption. A moisture sensor monitors fabric dryness, retracting the rack when clothes are dry to prevent over-drying.

Specifically, when the moisture sensor indicates the clothes have reached a pre-defined dryness level, the Arduino signals the motor to retract the rack under the shelter, thus preventing further sun exposure and over-drying. The Arduino Uno processes all sensor data and controls the driver motor. A solar panel powers the system, charging a battery for continuous operation.

This automated approach reduces manual inspection and improves fault response time. The system aims to enhance maintenance efficiency for underground power cables. The use of IoT provides remote monitoring capabilities, allowing faster issue resolution.

4.2 COMPONENTS

4.2.1 HARDWARE COMPONENTS

Fig (1). Rain Sensor

This sensor detects the presence of rain by measuring changes in conductivity. When raindrops fall on the sensor's surface, they bridge the gap between conductive tracks, increasing the current flow. This change in conductivity is registered by the Arduino as an indication of rain. The Arduino then triggers the retraction of the cloth rack to protect the drying clothes.

Fig (2). Humidity Sensor

The humidity sensor measures the relative humidity in the surrounding environment. It works by detecting changes in the electrical capacitance of a material as it absorbs moisture from the air. This capacitance change is converted into a reading that reflects the humidity level. The

Arduino uses this information to determine if the humidity is high enough to potentially dampen the clothes, even without rain.

Fig(3) . Moisture Sensor

Attached to a piece of clothing, this sensor measures the moisture content within the fabric itself. It operates on the principle of electrical resistance, where the resistance of the sensor changes based on the amount of moisture in the cloth. As the clothes dry, the resistance increases, and the Arduino monitors this change to determine the dryness level. Once the resistance reaches a certain threshold, indicating the clothes are dry, the Arduino initiates the over-drying prevention process.

Fig (4). Arduino Uno Microcontroller

The brain of the system, the Arduino Uno, receives signals from all the sensors – rain, humidity, and moisture. It processes these signals using a pre-programmed algorithm to make decisions about the rack's position. Based on the sensor inputs and the programmed logic, it sends control signals to the driver motor to either extend or retract the cloth rack.

Fig (5).Racker

The cloth rack serves as the platform to hold the clothes while they are drying. It is mechanically linked to the driver motor, allowing it to extend outwards into the open air when the weather is suitable and retract inwards when protection is needed. The design of the rack ensures clothes are spaced appropriately for efficient drying.

Fig (6). Power Supply (Solar Panel & Battery)

The solar panel converts sunlight into electrical energy, providing a sustainable power source for the system. This energy charges a battery, which stores power for use when sunlight is unavailable. The power supply unit ensures a continuous and reliable power source for all components, promoting energy efficiency and reducing reliance on traditional power sources.

4.2.2 SOFTWARE COMPONENTS

Fig (7). Arduino IDE

The Arduino integrated development environment (IDE) is a cross-platform application (for Microsoft

Windows, mac-OS, and Linux) that is written in the java programming language. It originated from the IDE for the languages processing and writing. It includes a code editor with features such as text cutting and pasting, searching and replacing text, automatic indenting, brace matching, and syntax highlighting, and provides simple one-click mechanisms to compile and upload programs to an Arduino board. It also contains a message area, a text console, a toolbar with buttons for common functions, and a hierarchy of operations menus.

Fig (8). Language C

The C code continuously monitors sensor inputs (rain, humidity, moisture) via analog and digital pins. If rain or high humidity is detected, the code triggers the motor to retract the rack. The moisture sensor reading is compared against a dryness threshold; exceeding it initiates rack retraction under shelter. The Arduino's logic, programmed in C, manages sensor readings, motor control, and power management. Solar panel charging and battery status are also monitored and managed within the C code-base.

5. CONCLUSION

In conclusion, The Smart Cloth Racker presents a significant advancement in automated clothes drying technology, addressing the limitations of traditional methods and existing smart rack systems. By integrating rain, humidity, and, crucially, moisture sensing, the system provides comprehensive protection against both weather-related damage and the detrimental effects of over-drying. The innovative over-drying prevention mechanism, triggered by real-time fabric moisture analysis, ensures that clothes are removed from sunlight exposure at the optimal dryness level, preserving fabric integrity and color vibrancy . Furthermore, the incorporation of a solar panel and battery promotes energy efficiency and sustainable operation, reducing

reliance on conventional power sources. The Smart Cloth Racker offers a user-friendly, automated solution that enhances convenience, extends garment lifespan, and minimizes environmental impact, representing a practical step towards smarter and more responsible clothes drying practices.

5.1 FUTURE SCOPE

Future enhancements include integrating a light sensor for solar intensity-based drying optimization and developing a mobile app for remote monitoring and control. Exploring advanced moisture sensing techniques and smart home platform integration could further improve accuracy and user experience. Investigating rack design and materials, along with real-world trials, will refine performance and durability. Finally, cost-benefit analysis and market research will support commercialization efforts.

6. REFERENCE

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