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Research Article

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Designing and Building A Cloth Drying System for Malaysian Climate

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Abstract: This research is appropriate for Malaysia's equatorial climate because the equator get five time more rain than temperate countries, making it 500 % more difficult to dry laundry in the sun. Time and consciousness that parents should focus on bringing up children are diverted to watching out for the rainfall over their laundry. Because of the difficulty in drying clothes in the Malaysian climate, increasingly families are investing in cloth dryers which worldwide is the highest electricity consuming device used in homes. The overall impact of all homes in the world using the system developed in this research is a large reduction in electricity consumption and parents being able to spend more time with their children, which are two priorities of the world today. The system built in this research works but the rain sensor did not detect rain properly, it needed to be submerged in water; a more expensive sensor needs to be sourced. Because much thought was made over the time to build this system, an optimum design was developed beyond what was built in this research. The Sustainable Development Goals worked upon in this research are SDG 3, 4, 7, 11, 12 and 13.

Keywords: laundry, drying, sun, electric cloth dryer, microcontroller, induction motor, VFD.

INTRODUCTION

The unpredictable rainfall in Malaysia's equatorial climate makes drying clothes a persistent concern. While utilizing solar heat by hanging clothes outdoors is economical, it requires constant attention, placing a mental burden on adults. This constant attention can be equated to a parasite for the human adult householder in terms of taking away quality time and attention they could have focused on their children. If the adults are working away from home, it is totally not possible to hang laundry outside on hangers. It is because of this that many householders are investing in cloth dryers, which are statistically the highest consumer of electricity in most homes worldwide. It is therefore imperative that technology be utilized to solve this problem.

In this research the problem was studied, and a solution was formulated, designed and built. The prototype we built is not the final solution, but has all the aspects of the final solution, only slight modifications need to be done to achieve the final solution.

The solution is to suspend a 1 1 HP induction motor at the car poach beam found in all homes and a triangle comes down as shown in Fig. 1

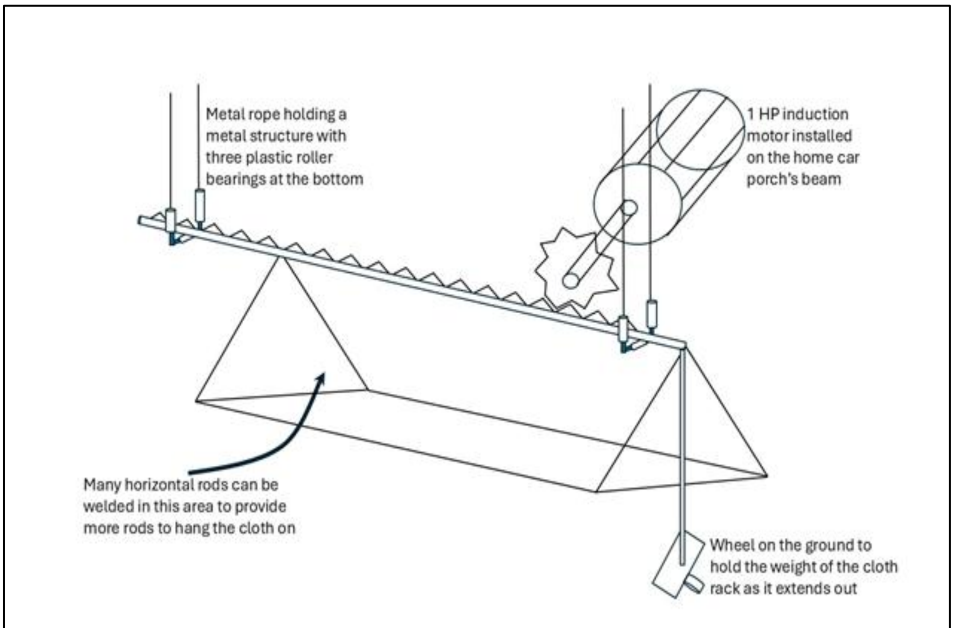

Fig. 1: The general structure of the retractable cloth hanger.

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LITERATURE REVIEW

In the USA 80 % of cloth drying is done with cloth dryers which has become standard equipment for homes.

Europeans tend to be more environmentally conscious, therefore in Southern Europe homes tend to hang their clothes outside for three reasons, firstly it is the cheapest method, secondly it enables clothes to last longer and thirdly is their conscience in causing climate change. Therefore cloth dryers are used mostly in the coldest regions of northern Europe but the dryers trend to be not as powerful as the ones used in the USA. In Europe many householders may share a cloth drying area in balconies or a dedicated to cloth drying areas which have a roof. These occur mostly in the colder portions of norther Europe where sunlight is much less. In Southern Europe clothes tend to be hung outside without roofs. Placed tend to not be covered but cloth hanging gardens tend to not have a roof.

In Japan cost of electricity is relatively high therefore even if homes have a cloth dryer, they tend to prefer air drying in balconies and indoors. Indoor drying is particularly done during the rainy season or winter. One method unique in Japan is bathroom drying named "Yokushitsu Kansouki." Note this is done in the bathroom which is separated from the toilet. Here air comes down from the ceiling at one point and goes up to the ceiling at another.

METHODOLOGY AND RESULTS

The first activity in building this project was to get the 3Φ, 1 HP induction motor to move in and out the clothes. Wet clothes can be quite heavy and therefore a reliable 3 Φ, 1HP motor was chosen. This motor was the invention of Nicola Tesla, it is very reliable and one such motor used by the Western Digital (WD) factory in Kuching has been running without maintenance for 27 years. The only parts that can fail are the bearing and the varnish around the copper coils in the stator. If Class H varnish is used and bearing are sources from the likes of SKF (Svenska Kullagerfabriken) from Sweden it is possible for such motors to last for long span of years. In case it fails it is just a matter of changing the bearings. In the experience of this author, it is typically the bearing that fails after a decade or two of continuous operation and coil of good brand motors such as Baldor do not fail. He has not come across a Baldor motor stator coil failing in 14 years of working in the WD factory of Kuching. Class H varnish typically is made from silicone-based resin or other high-temperature resistant polymers. The motor purchased is shown in Fig. 2.

The next thing done was to purchase a 3 Φ,1 HP capable VFD (Variable Frequency Drive) as shown in Fig. 3. But after a few testing operations it failed, therefore the VFD of Fig. 3 was purchased for a higher price. Both the VFD of Fig. 3 and Fig.4 are 1 Φ in and 3Φ out ones. Meaning the incoming is 240V and the output is 220V per phase. Note in Malaysia the 1Φ voltage is 240V therefore the 3 Φ voltage is:

Fig. 2: The induction motor 3 Φ, 1 HP

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Fig. 3: The first VFD purchased and tried

Fig. 4: The second VFD purchased and tried

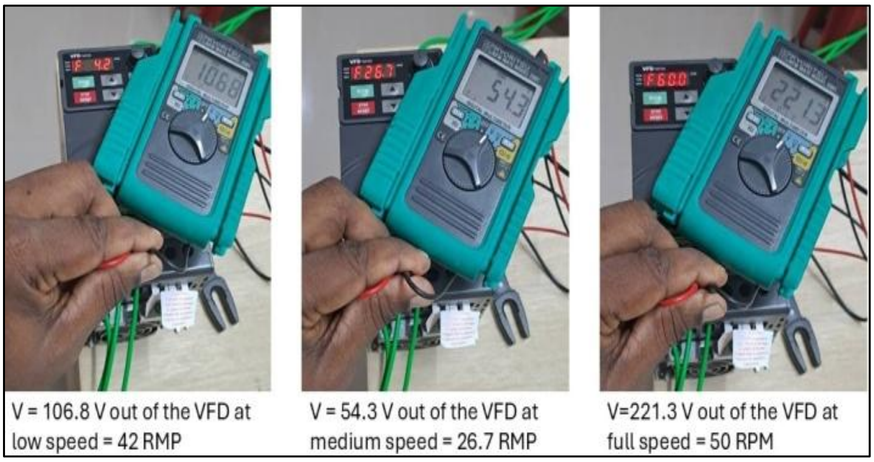

Fig. 5: The voltage out of the Delta VFD caries as the RPM changes

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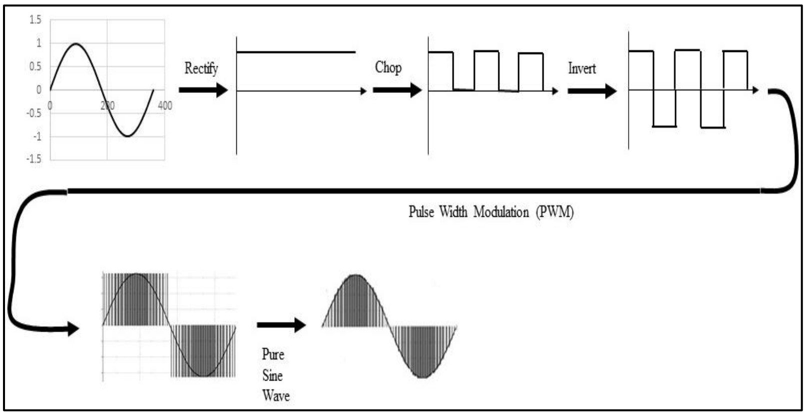

Fig. 6: The block diagram of how the VFD works

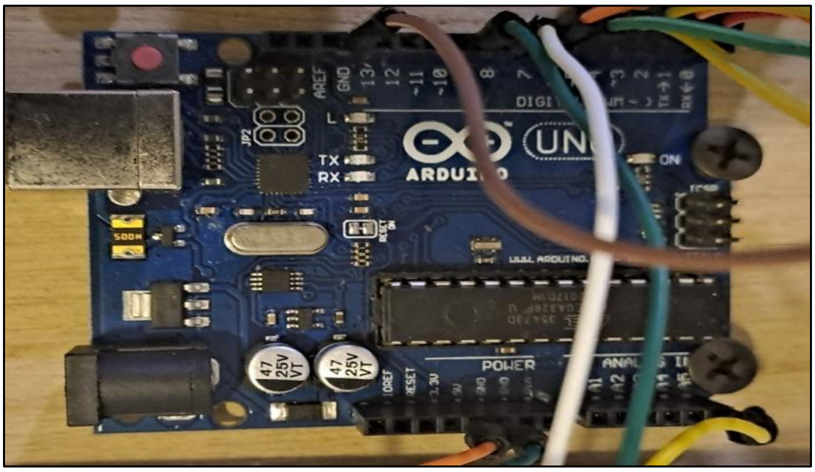

Fig. 7: The microcontroller used

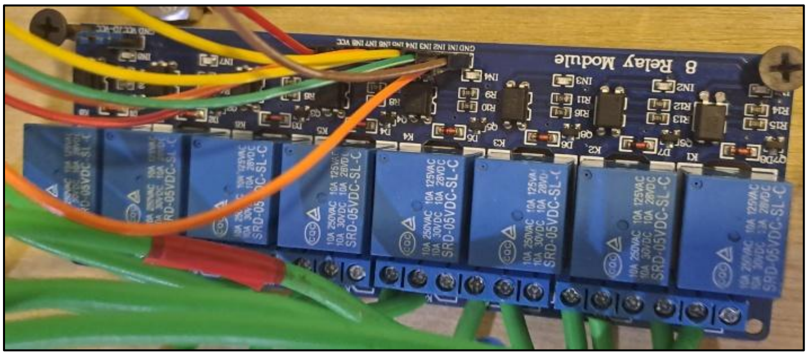

Fig. 8: The relay used

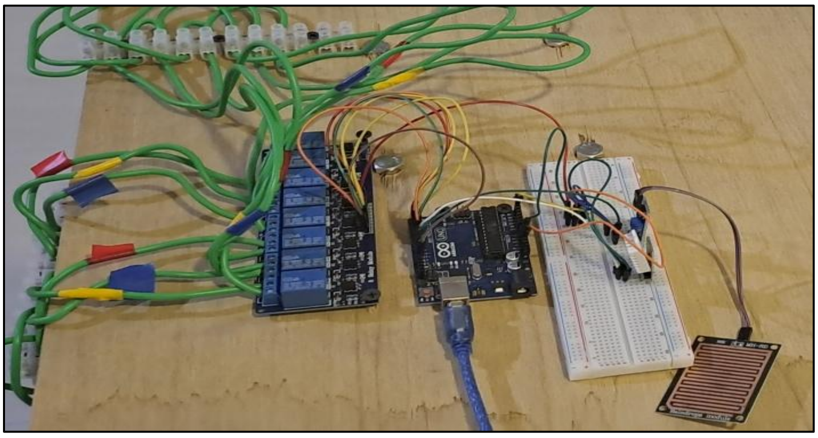

Fig. 9: The whole circuit including the rain sensor on the bottom left

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Fig. 10: The gear attached to the induction motor turning the toothed rail which will hold the clothes

Fig. 11: How this system used the drawer slides of the cupboard drawer holder system

Fig. 12: The whole system

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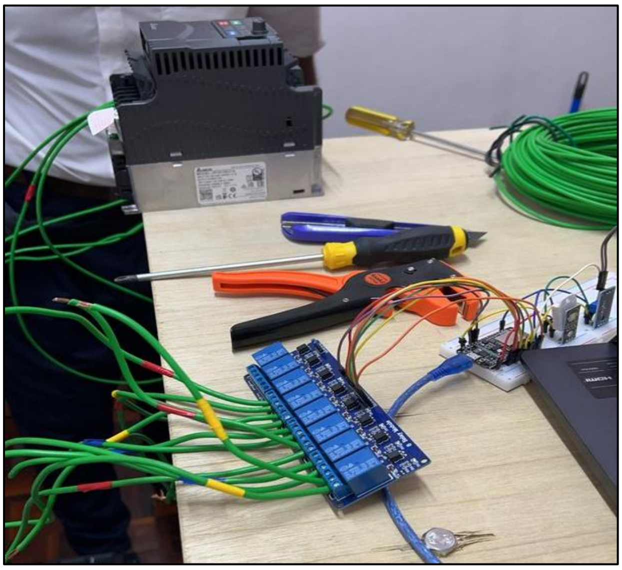

Fig. 13: Building the circuit

```
// Read digital output from rain sensor (HIGH = no rain, LOW = rain detected)
int rainDetected = digitalRead(rainSensorDigitalPin);

// Read analog output from rain sensor (indicates rain intensity)
int rainIntensity = analogRead(rainSensorAnalogPin);

// Print rain sensor data (Digital and Analog Output)
if (rainDetected == LOW) {
  Serial.println("Rain Detected (Digital Output): YES");
} else {
  Serial.println("Rain Detected (Digital Output): NO");
}

// Print the rain intensity (Analog Output) to Serial Monitor
Serial.print("Rain Intensity (Analog Output): ");
Serial.println(rainIntensity);
```

Fig. 14: The code used for the rain sensotr toe detect rain

```
// **Condition 1**: If rainDetected == HIGH (no rain detected)
if (!relay1_activated && rainDetected == HIGH) {
  // Turn ON Relays 1, 2, 3 for 3 seconds
  digitalWrite(relay1, LOW);  // Relay 1 ON
  digitalWrite(relay2, LOW);  // Relay 2 ON
  digitalWrite(relay3, LOW);  // Relay 3 ON
  delay(2000);                // Keep them ON for 3 seconds
  // Turn OFF Relays 1, 2, 3
  digitalWrite(relay1, HIGH); // Relay 1 OFF
  digitalWrite(relay2, HIGH); // Relay 2 OFF
  digitalWrite(relay3, HIGH); // Relay 3 OFF

  // Mark relays as activated
  relay1_activated = true;
  // Reset relay4_activated because Condition 2 will not be triggered until Condition 1 is reset
  relay4_activated = false;
}

// **Condition 2**: If rainDetected == LOW (rain detected)
if (!relay4_activated && rainDetected == LOW) {
  // Turn ON Relays 4, 5, 6 for 3 seconds
  digitalWrite(relay4, LOW);  // Relay 4 ON
  digitalWrite(relay5, LOW);  // Relay 5 ON
  digitalWrite(relay6, LOW);  // Relay 6 ON
  delay(2000);                // Keep them ON for 3 seconds
  // Turn OFF Relays 4, 5, 6
  digitalWrite(relay4, HIGH); // Relay 4 OFF
  digitalWrite(relay5, HIGH); // Relay 5 OFF
  digitalWrite(relay6, HIGH); // Relay 6 OFF

  // Mark relays as activated
  relay4_activated = true;
  // Reset relay1_activated because Condition 1 will not be triggered until Condition 2 is reset
  relay1_activated = false;
}

// Reset the relay activation states if the rain condition changes
// Reset relay1_activated when rainDetected == LOW (rain detected)
if (rainDetected == LOW) {
  relay1_activated = false;  // Reset relay1_activated state
}

// Reset relay4_activated if rainDetected == HIGH (no rain detected)
if (rainDetected == HIGH) {
  relay4_activated = false;  // Reset relay4_activated state
}
```

Fig. 15: The code used to extend and retract the cloth holder

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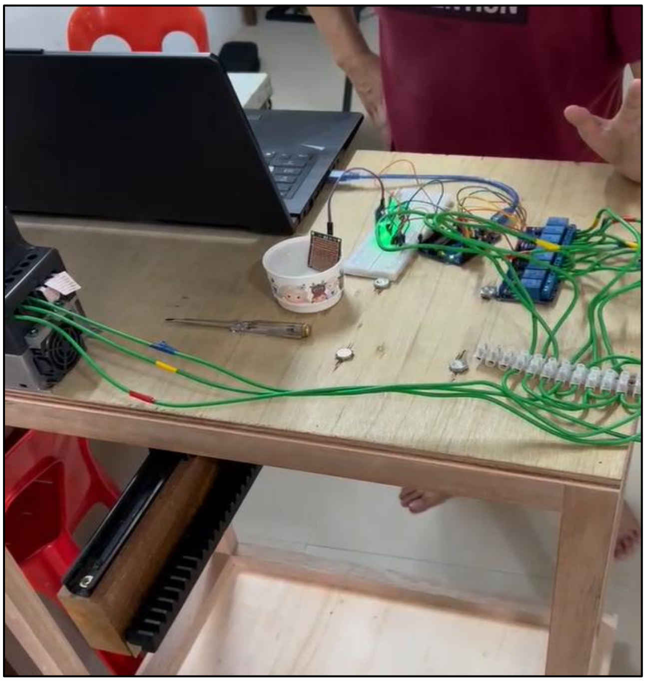

Fig. 16: The cloth holder fulley extended

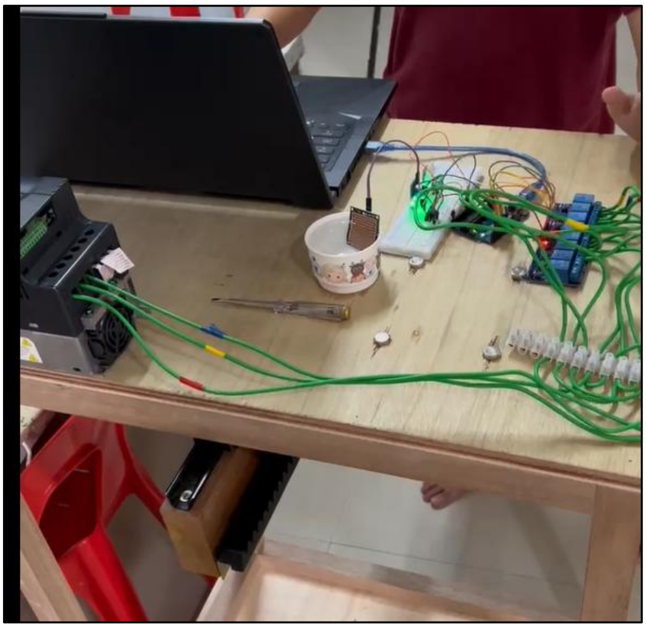

Fig. 17: The cloth holder fulley retracted upon detecting rain

CONCLUSION

This study successfully developed an automated cloth drying system designed for Malaysia's unpredictable rainy climate. By integrating a 3Φ, 1 HP induction motor, VFD, microcontroller controls, and a rain-sensing retractable mechanism, the prototype effectively reduces manual effort and prevents clothes from getting wet during sudden rainfall. While the model functions well, minor design refinements can further improve efficiency and durability. Overall, the system offers a practical, low-energy alternative to conventional electric dryers and provides a reliable solution for weather-dependent household drying needs

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