IoT Smart Wardrobe System

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***Abstract*—Everyone desires to have their favourite clothes last long, enabling them to look their best in public. The quality of clothing is closely linked to how they are stored and the surrounding factors that can affect them. Factors such as air quality, temperature, and humidity can have a significant impact on the quality of clothes stored in a wardrobe. High levels of humidity can cause mold to grow on clothes, which can damage them. Therefore, it is important to maintain optimal air quality, which can be achieved automatically and monitored regularly using a mobile device. The system will provide real- time information about the status of the wardrobe, and users will be able to adjust the settings as per their preference. The proposed IoT smart wardrobe is expected to provide a convenient and efficient solution for storing clothes. It will ensure that the clothes are protected from odour and humidity, and will also prevent overcrowding.**

Keywords— IoT, air quality, sensor, smart system, wardrobe

I.INTRODUCTION

The field of information technology is constantly advancing, and one of the latest developments is the Internet of Things (IoT). This concept originated after the discovery of Radio Frequency Identification (RFID) and Wireless Sensor Networks (WSN) technology in 1999. IoT or the Internet of Things is becoming increasingly important in our daily lives and in various industries. It is a network of interconnected devices that are embedded with sensors, software, and connectivity to enable them to collect and exchange data. One of the latest inventions in IoT is the Amazon Sidewalk. It is a new type of low-bandwidth network that uses Bluetooth and other wireless signals to connect devices such as smart home gadgets, lights, and sensors. It was developed by Amazon and was first launched in the United States in 2021. Sidewalk allows devices to connect to each other, creating a network that extends beyond the range of a single device. This enables devices to stay connected even when they are out of range of the owner's home Wi-Fi network, leading to greater coverage and connectivity for IoT devices.

Our project, which intends to build a smart wardrobe using an Arduino Uno, a DHT11 sensor, an odour sensor, and a load sensor to monitor and manage the wardrobe, is similarly based on such an example. The odour sensor will identify any unfavourable odours that may be present, and the DHT11 sensor will measure the temperature and humidity level inside the closet. The load sensor will also assess each shelf's load to identify the least-used shelf.

Users will be able to access real-time information from the smart wardrobe on the atmosphere within the wardrobe as well as the state of their garments. Users will be able to remotely monitor their clothing using this information via a smartphone app or website. The smart wardrobe will also send notifications to the user when it is time to wash or dry clean clothes or when the humidity or temperature inside the wardrobe needs adjustment. The load sensor will allow the user to determine which shelf is less used, making it easier to organize the wardrobe and plan storage. The smart wardrobe can also detect when a particular shelf is overloaded and notify the user to prevent damage to the wardrobe or clothes.

Overall, the use of an Arduino Uno, a DHT11 sensor, an odour sensor, and a load sensor will allow for the creation of a smart wardrobe that can monitor and control the wardrobe environment, detect odours, and check the load for each shelf. The smart wardrobe will be a convenient and innovative solution for maintaining a wardrobe and making the best use of the available space.

This paper have 5 section 1 is an introduction and the rest is as follows: Section 2 discusses IoT and Air Quality from another literature review, section 3 about how system work, Section 4, describe system design architecture and result. The last section 5 is a conclusion about this system and future work.

II.RELATED WORK

IoT can be applied to various fields, one of which is in the field of environmental care. This can be seen from the many studies that discuss air quality, air pollution, and research on ozone pollution[8]. IoT- Based Air Pollution Monitoring and Forecasting System. Rekha Arumugam, Madhurikkha are the author of the paper. This paper deals with measuring the Air Quality using the MQ135 sensor along with Carbon Monoxide CO using the MQ7 sensor. Measuring Air Quality is an important element for bringing awareness to take care of future generations and for a healthier life. Based on this, the Government of India has already taken certain measures to ban Single Stroke and Two Stroke Engine-based motorcycles which are emitting high pollution.

Proposed Blueprint of an Automated Smart Wardrobe Using Digital Image Processing published in 2019 by Nabila Shahnaz Khan, Sanjida Nasreen Tumpa The proposed model will then be able to predict the air quality for future days. A web and mobile application interface will help the users to check and understand the air quality at their current location. The mobile application will also notify the user about severe toxicity. People with respiratory problems will be able to get personalized notifications for poor conditions.

Based on the literature above, air quality can be detected, controlled, and monitored by using sensors. So this research will use some of the sensor to make a system for a wardrobe that can maintain air quality and make clothes more durable and healthier.

III.PROPOSED METHOD

This research employs diverse sensors, including those intended for use with the Arduino microcontroller. The Arduino microcontroller is a board design that includes 14 digital input and output pins, a reset button, a USB port, and power. The utilization of the Arduino microcontroller and sensors aims to minimize product costs. As these cabinets are essential commodities for human use, it is imperative to keep their production cost at a minimum, enabling mass production.

A. Sensor

The smart wardrobe consists of six sensors and a linear actuator. Among the sensors, three are dedicated to detecting humidity and temperature, one to detect odor, and one to detect the weight of the clothes. Table 1 presents a summary of all the sensors in the wardrobe. The wardrobe's air quality function is managed by the temperature, humidity, and dust sensors. To control these functions, an Arduino Uno microcontroller and an Arduino WiFi module are required.

1) DHT11 Digital Relative Humidity and Temperature Sensor Module for Arduino

The DHT11 is a low-cost digital temperature and humidity sensor that is commonly used with microcontrollers such as the Arduino. It can measure temperatures ranging from 0 to 50 degrees Celsius with an accuracy of ±2°C, and relative humidity ranging from 20 to 80% with an accuracy of ±5%. To use the DHT11 with an Arduino, you'll need to connect the VCC pin to 5V, the GND pin to GND, and the Data pin to one of the digital pins on the Arduino board. You can then use a library such as the DHT library to read temperature and humidity data from the sensor.

The DHT11 sensor is not suitable for Applications that require high accuracy or precision, as it has relatively low accuracy and resolution compared to other sensors. However, it is a good choice for hobbyist projects and other applications where cost is a primary consideration.

1) Half-bridge Weight Sensor Load Cell:

A half-bridge load cell is a type of weight sensor that measures weight or force by converting mechanical strain into an electrical signal. It is commonly used in weighing applications such as scales and force measurement devices.

1) Air quality sensor v1.3

The Grove Air quality sensor v1.3 is compatible with the Grove system, which is a modular, plug- and-play system for building electronic prototypes. It can be connected to a microcontroller board such as Arduino or Raspberry Pi via a Grove Base Shield or a Grove Hat. The sensor module communicates with the microcontroller board through an I2C interface, and the data can be read and processed using a software library provided by SeeedStudio.

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TABLE 1. ARDUINO SENSOR NEEDED

Wardrobe Function	Sensor
Air Quality	Temperature
	Humidity
	Odour
Load detection	Load cell

B. How it works

1) setting up steps of arduino kit with sensors :

- Connect the Arduino board to your computer: Use the USB cable provided in the kit to connect the Arduino board to your computer. The Arduino board should be detected by your computer as a new device.
- Install the Arduino IDE: Download and install the Arduino IDE from the official website. The IDE is available for Windows, Mac, and Linux operating systems.
- Install the sensor libraries: Depending on the type of sensors included in the kit, you may need to install specific libraries for the sensors. These libraries can be downloaded from the Arduino library manager or from the sensor manufacturer's website.
- Connect the sensors to the breadboard: Connect the sensors to the breadboard using the wires provided in the kit. Make sure to connect the sensors to the correct pins on the breadboard.
- Connect the sensors to the Arduino board: Connect the sensors to the appropriate pins on the Arduino board. Consult the sensor datasheet to determine which pins should be used.
- Write and upload the code: Use the Arduino IDE to write and upload code to the Arduino board. Use the sensor libraries to communicate with the sensors and obtain readings.
- Test the sensors: Once the code is uploaded to the Arduino board, test the sensors by observing the output on the serial monitor or on an attached display. Make sure that the readings obtained are accurate and consistent.
- Assemble the project: Once the sensors are working correctly, assemble the project according to the design specifications. Make sure that all components are securely connected and that the project is functional

2) Air quality:

The smart wardrobe includes an air quality function that focuses on regulating the humidity levels and odour intensity within the wardrobe. To achieve this, wireless air quality sensors are utilized to measure airborne particles. The process of this function is depicted in a flowchart shown in Figure 1.

The flowchart outlines the following steps: Firstly, the temperature and humidity sensors will monitor the temperature and humidity levels inside the wardrobe. This is necessary to maintain an optimalhumidity level. If the humidity levels are too high and while if the levels are too low, the user will take action accordingly to maintain the optimal humidity levels.

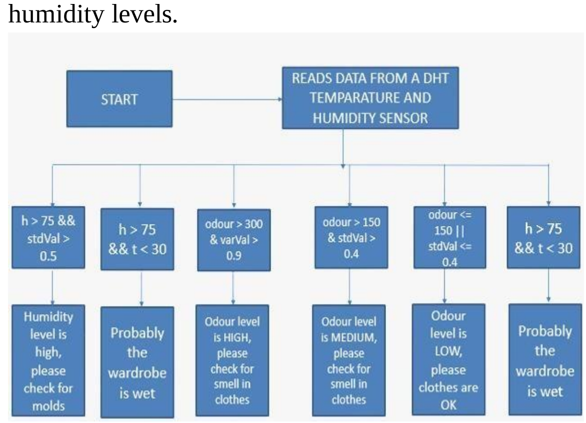

Fig 1

3) Load monitoring:

Load monitoring in an IoT wardrobe can also be utilized to determine which shelf is used the most and which is used less frequently. By installing load sensors on each shelf, the system can collect data on the weight of items placed on each shelf over time.

Using this data, the system can determine which shelves are consistently holding heavier items and which are not. This information can be used to optimize the wardrobe's storage capacity and make adjustments to the shelving layout accordingly. For instance, shelves that are used less frequently or hold lighter items could be adjusted to accommodate more items, while heavily used shelves could be reinforced or adjusted to prevent damage or collapse.

Overall, load monitoring in an IoT wardrobe can provide valuable insights into how the wardrobe is used, allowing for efficient and effective storage management. It also helps to prolong the life of the wardrobe by ensuring that shelves are not overloaded or used beyond their capacity.

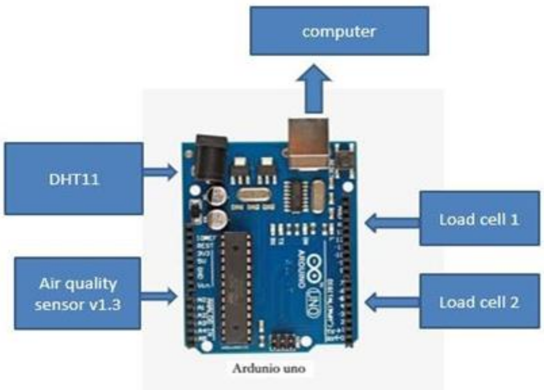

Fig 2

IV.WORK DONE

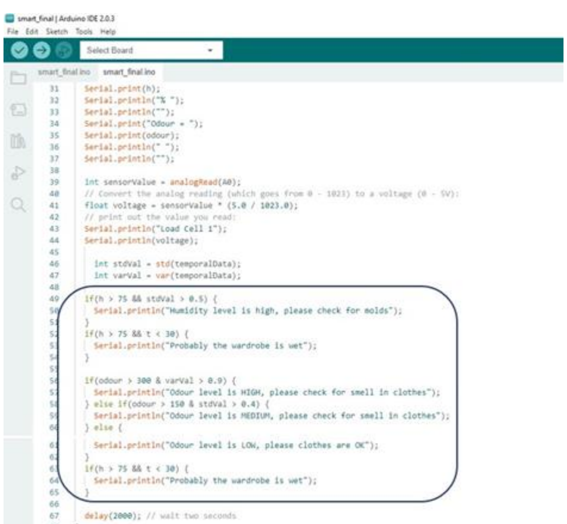

Fig 3

This code reads the temperature and humidity from the DHT11 sensor and the odour level from the SeeedStudio Grove Air quality sensor v1.3, and then uses conditional statements to give the result accordingly. If the temperature is above 30° C and the humidity is above 75, the system will tell you to check for molds. If the temperature is below 30° C and the humidity is above 75, it will tell you that the wardrobe might be wet. And there are more such conditions for checking of the wardrobe which can be seen in the above figure of code.

V.RESULT

Here are the testing results on different inputs

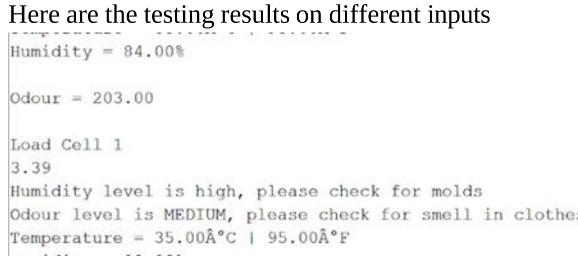

Fig 4 When humidity and odour level is high

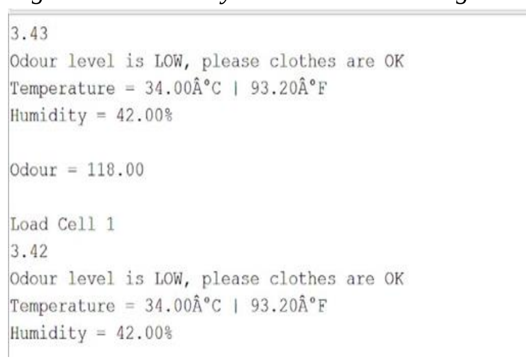

Fig 5 When humidity and odour level is low

The temperature and humidity of the wardrobe would be continuously monitored and displayed on the serial monitor of the Arduino IDE.

- If the humidity level in the wardrobe is above 75%, a warning message will be displayed on the serial monitor, indicating that there may be molds in the wardrobe. If both the humidity level is above 75% and the temperature is below 30°C, a message will be displayed on the serial monitor indicating that the wardrobe is probably wet.
- The code also checks for bad odour in the wardrobe using an odor sensor, but since that part of the code is missing, I cannot provide the result for that 29
- The output of the load sensor in the system would typically be in the form of weight measurements

VI CONCLUSION AND FUTURE SCOPE

In conclusion, the development of a smart wardrobe using an Arduino Uno, DHT11 sensor, odour sensor, and load sensor is a promising application of IoT in the wardrobe systems. The aim of the project was to create a system that can monitor and control the environment inside the wardrobe, detect odours, and check the load for each shelf. The project has demonstrated the potential of using IoT in wardrobe systems to create a more efficient and convenient solution for maintaining a wardrobe. With the use of sensors and an Arduino Uno, users can monitor and control their wardrobes remotely, making their lives easier and more convenient.

Future improvements to the smart wardrobe system could include the integration of machine learning algorithms to predict when clothes need washing or dry cleaning based on their condition and usage. Additionally, the use of RFID tags on clothes could enable the system to track each item of clothing and provide users with more detailed information on their wardrobe inventory.

Overall, the smart wardrobe system developed in this project is a promising application of IoT in wardrobe systems that has the potential to enhance the functionality of the wardrobe and make it more efficient and convenient for users.

REFERENCE

[1] J. Gubbi, R. Buyya, S. Marusic, and M. Palaniswamia, "Internet of Things (IoT): A Vision, Architectural Elements, and Future Directions," *Futur. Gener. Comput. Syst.*, vol. 29, no. 7, pp. 1645– 1660, 2013.

[2] O. Salman, I. Elhajj, A. Kayssi, and A. Chehab, "An architecture for the Internet of Things with decentralized data and centralized control," in *Conference: 2015 IEEE/ACS 12th International Conference of Computer Systems and Applications (AICCSA)*, 2015, pp. 603–608.

[3] S. Albishi, B. Soh, A. Ullah, and F. Algarni, "Challenges and Solutions for Applications and Technologies in the Internet of Things," *Procedia Comput. Sci.*, vol. 124, pp. 608–614, 2017.

[4] D. C. Yacchirema, D. Sarabia-Jacome, C. E. Palau, and M. Esteve, "A smart system for sleep monitoring by integrating IoT with big data analytics," *IEEE Access*, vol. 6, pp. 35988–36001, 2018.

[5] R. Ullah, Y. Faheem, and B. S. Kim, "Energy and congestion-aware routing metric for smart grid ami networks in smart city," *IEEE Access*, vol. 5, pp. 13799–13810, 2017.

[6] C. Gonzalez-Amarillo *et al.*, "A Traceability System To Crop Of Seedlings In Greenhouse, Based IoT," *IEEE Access*, vol. XX, pp. 1–9, 2017.

[7] A. Schieweck *et al.*, "Smart homes and the control of indoor air quality," *Renew. Sustain. Energy Rev.*, vol. 94, no. May, pp. 705–718, 2018.

[8] A. Ripoll *et al.*, "Testing the performance of sensors for ozone pollution monitoring in a citizen science approach," *Sci. Total Environ.*, vol. 651, pp. 1166–1179, 2019.

[9] F. Corno, T. Montanaro, C. Migliore, and P. Castrogiovanni, "SmartBike: An IoT crowd sensing platform for monitoring city air pollution," *Int. J. Electr. Comput. Eng.*, vol. 7, no. 6, pp. 3602–3612, 2017.

[10] Y. Mehta, M. M. M. Pai, S. Mallissery, and S. Singh, "Cloud enabled air quality detection, analysis and prediction - A smart city application for smart health," in *2016 3rd MEC International Conference on Big Data and Smart City, ICBDSC 2016*, 2016, no. May, pp. 272–278.

[11] P. Kumar *et al.*, "Real-time sensors for indoor air monitoring and challenges ahead in deploying them to urban buildings," *Sci. Total Environ.*, vol. 560–561, pp. 150–159, 2016.

[12] A. Schütze, "Integrated sensor systems for indoor applications: Ubiquitous monitoring for improved health, comfort and safety," in *Procedia Engineering*, 2015, vol. 120, pp. 492–495.

[13] M. I. Mead *et al.*, "The use of electrochemical sensors for monitoring urban air quality in low-cost, high-density networks," *Atmos. Environ.*, vol. 70, no. 2, pp. 186–203, 2013.

[14] A. Riahi Sfar, E. Natalizio, Y. Challal, and Z. Chtourou, "A roadmap for security challenges in the Internet of Things," *Digit. Commun. Networks*, vol. 4, no. 2, pp. 118–137, 2018.

[15] M. Shanmugam and M. Singh, "Arduino based IOT platform for remote monitoring of heart attacks and patients falls," *J. Comput. Sci.*, vol. 14, no. 4, pp. 574–584, 2018.

[16] D. Hernández-Rivera, G. Rodríguez-Roldán, R. Mora-Martínez, and E. Suaste-Gómez, "A capacitive humidity sensor based on an electrospun PVDF/graphene membrane," *Sensors*

(Switzerland), vol. 17, no. 5, 2017.

[17] H. Farahani, R. Wagiran, and M. N. Hamidon, *Humidity sensors principle, mechanism, and fabrication technologies: A comprehensive review*, vol. 14, no. 5. 2014.

[18] R. N. Dean, A. K. Rane, M. E. Baginski, J. Richard, Z. Hartzog, and D. J. Elton, “A capacitive fringing field sensor design for moisture measurement based on printed circuit board technology,” *IEEE Trans. Instrum. Meas.*, vol. 61, no. 4, pp. 1105–1112, 2012.

[19] N. N. Xiong, Y. Shen, K. Yang, C. Lee, and C. Wu, “Color sensors and their applications based on real-time color image segmentationfor cyber physical systems,” in *EURASIP Journal on Image andVideo Processing*, 2018, vol. 23, pp. 1–16.

[20] H. Hojaiji, H. Kalantarian, A. A. T. Bui, C. E. King, and M. Sarrafzadeh, “Temperature and humidity calibration of a low-cost wireless dust sensor for real-time monitoring,” *SAS 2017 - 2017 IEEE Sensors Appl. Symp. Proc.*, pp. 3–8, 2017.

[21] C.A. Proietti, F. Leccese, M. Caciotta, F. Morresi, U. Santamaria, and Malomo, “A new dusts sensor for cultural heritage applications based on image processing,” *Sensors (Switzerland)*, vol. 14, no. 6, pp. 9813–9832, 2014.