

Guardians of Health: Optimizing Medicine Storage with Environmental Data Monitoring

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Abstract: Throughout the transportation process from the factory to the end-user, many medicines and vaccines need to be kept under specific conditions to preserve their effectiveness. This involves passing through different phases like shaping time, storage time. Temperature, humidity, and light intensity are commonly utilized in a variety of industries nationwide, including agricultural research, food safety, pharmaceutical storage, the chemical industry, environmental protection, and other sectors. Environmental Data monitoring, also known as a temperature, humidity, and lux recorder, is primarily employed for monitoring and recording temperature, humidity, and light levels (lux) during the storage and transportation of food, medicine, and perishable goods. With the advancement of modern technology, temperature, humidity, and lux data loggers are increasingly crucial in our daily lives.

Keywords: temperature record, Humidity record, Illuminance record, ESP 23, DHT sensor and light sensor.

INTRODUCTION

Optimizing Medicine Storage with Environmental Data Monitoring" introduces a cutting-edge approach to ensuring the quality and effectiveness of medicine storage through the use of environmental data monitoring. This innovative system aims to safeguard the integrity of medications by leveraging real-time environmental data to create optimal storage conditions, ultimately enhancing patient safety and well-being.

A revolutionizes the healthcare industry by merging technology with medicine storage practices. By harnessing the power of environmental data monitoring, this pioneering solution offers a proactive approach to maintaining medication efficacy and safety. Through continuous surveillance and analysis of environmental factors, this system ensures that medications are stored under ideal conditions, guaranteeing their potency and reliability. Embracing this advanced methodology promises to elevate healthcare standards, prioritize patient care, and shape the future of pharmaceutical storage practices.[1]

In today's era of advanced technology, environmental monitoring plays a crucial role in ensuring the well-being of our surroundings. This introduction delves into the realm of data

logger, focusing on a sophisticated tool designed to capture and record key environmental parameters.

PROBLEM STATEMENT

During the journey from the factory to the end-user, numerous medicines and vaccines must be stored under specific conditions to maintain their efficacy. This includes navigating through various stages such as shaping time, storage time, and finally reaching the pharmacy for further storage. The critical aspect of ensuring these products remain viable and effective throughout this process underscores the importance of meticulous attention to spatial conditions and time-sensitive storage practices. Fig (1) shown one of the main problem which is the storage such as a kind medicine.

Form	Spray
Storage	Refrigerator (2 - 8 DegreeC). Do not freeze
Composition	Desmopressin 0.1mg/ml
Manufacturer	United Biotech Pvt Ltd
Brand	Dpressin Nasal Sprav

Fig (1) Capturing a part of the information for a specific medication (leaflet).[2]

Environmental parameters effected on medicine

Environmental parameters that can affect medicines include temperature, humidity, light exposure, and air quality. Fluctuations in these factors can impact the stability and efficacy of medications. Proper monitoring and control of these environmental parameters are crucial to ensure the quality and safety of medicines throughout their storage and transportation processes.

In addition to temperature, humidity, light exposure, and air quality, other environmental parameters that can affect medicines include vibration, pressure, and contamination. Vibration can lead to physical degradation of medications, while pressure changes may alter the composition of certain

drugs. Contamination from external sources can also compromise the integrity of medicines. Monitoring and managing these environmental parameters are essential to uphold the potency and effectiveness of medications from production to consumption.

In this work will consecrated on the first three parameters which are temperature, humidity, and light exposure.

Illuminance (light exposure) range

"Illuminance range" refers to the spectrum of light intensity levels measured on a surface, typically in units of lux or foot-candles. Lux is the metric unit used for illuminance in the International System of Units (SI).

The illuminance range can vary significantly based on the lighting conditions in a specific setting. For example, it can range from 0 lux in complete darkness to thousands of lux in direct sunlight or under bright artificial lighting, as shown fig (2)



Fig (2) deferent reading of light intensity levels

The lux is the unit of measurement for illuminance, which measures the amount of light that falls on a surface. The light range to vary from 0 lux (complete darkness) to 20,000 lux. Lux levels can indeed span a wide range depending on the lighting conditions present in a particular environment.

(0) lux represents total darkness where there is no light present. (200,000) lux signifies a very bright environment, comparable to direct sunlight on a clear day.

Temperature parameter

Temperature parameter is more important in our goal, the measurement of temperature using sensors with Arduino. Here

are some key notes about the temperature parameter measurement:

1. Accuracy: The accuracy of temperature measurements is crucial for parameter measurement used in various applications such as food storage, pharmaceuticals, and environmental monitoring. It is important to calibrate the temperature sensors regularly to ensure accurate readings.

2. Range: temperature measurements have a specified temperature range within which they can accurately measure temperature. It's essential to choose a temperature measurements with a temperature range that suits your specific monitoring needs.

3. Resolution: The resolution of a temperature measurements determines the smallest change in temperature that it can detect. Higher resolution data loggers can provide more detailed temperature readings.

4. Sampling Rate: The sampling rate of the measurement refers to how often it records temperature readings. It's important to select a sampling rate that captures temperature fluctuations accurately without overwhelming the data storage capacity.

5. Data Storage: temperature measurements store temperature readings over time, allowing users to analyze trends and fluctuations in temperature. Ensure that the data storage capacity is sufficient for your monitoring requirements.

6. Alarm Capabilities: Some temperature measurements have alarm features that notify users when temperature thresholds are exceeded. This is particularly important in applications where maintaining specific temperature ranges is critical.

7. Software Compatibility: temperature measurements often come with software for data analysis and visualization. Ensure that the data logger's software is compatible with your devices and meets your data analysis needs.

By considering these notes about the temperature parameter in storage with environmental data monitoring. That will effectively monitor and record temperature data for various applications.

Humidity measurement

Humidity refers to the quantity of moisture present in the air, typically expressed as a percentage.

Humidity plays a critical role in the storage of medicine, affecting its stability, efficacy, and shelf life. Here's a brief overview of how humidity impacts medicine storage:

Degradation of Active Ingredients: Many medications contain active ingredients that are sensitive to moisture. High humidity levels can accelerate chemical reactions within the medication, leading to the degradation of these active ingredients. This degradation can render the medicine ineffective or even harmful to consume.

Altered Physical Properties: Moisture absorption can cause physical changes in medications, such as softening or dissolution of tablets, alteration of coatings, or clumping of powdered medications. These changes can affect the dosage

accuracy and consistency of the medication, potentially leading to incorrect dosing or administration.

Microbial Growth: Moist environments provide ideal conditions for microbial growth, including bacteria, fungi, and mold. Contamination of medications with these microorganisms can compromise their safety and efficacy, posing risks of infection or other adverse reactions when consumed.[3]

Packaging Integrity: Humidity can also impact the integrity of medication packaging. Excessive moisture can cause packaging materials to degrade or become less effective at protecting the medication from environmental factors, such as light or oxygen. This can result in reduced stability and potency of the medication over time.

Hygroscopic Properties: Some medications have hygroscopic properties, meaning they readily absorb moisture from the surrounding environment. This can lead to changes in the concentration or formulation of the medication, affecting its therapeutic effects and bioavailability.

To mitigate the detrimental effects of humidity on medication storage, it is essential to store medications in appropriate conditions. This typically involves storing them in cool, dry environments away from direct sunlight and sources of moisture. Additionally, using sealed containers or packaging with desiccants can help maintain optimal humidity levels and preserve the integrity of the medication. Regular monitoring of storage conditions and adherence to recommended storage guidelines are crucial to ensuring the safety and effectiveness of stored medications.

The range of humidity

The ideal range of humidity for storing medications typically falls between 30% and 60%. This range helps to maintain the stability and integrity of the medications while minimizing the risk of degradation, microbial growth, and other adverse effects. As shown in fig (3), extremely low humidity levels below 30% can cause medications to dry out, leading to changes in their physical properties and potentially reducing their effectiveness. On the other hand, humidity levels above 60% create conditions conducive to moisture absorption, which can accelerate degradation, promote microbial growth, and compromise the safety and efficacy of the medications.[4]



Fig (3) Relative Humidity percentage scale

It's important to note that the optimal humidity range may vary slightly depending on the specific medication and its formulation. Manufacturers often provide guidelines for storage conditions, including recommended humidity levels, which should be followed to ensure the potency and safety of the medication.

Maintaining proper humidity levels in medication storage areas can be achieved through the use of climate-controlled environments, dehumidifiers, and moisture-absorbing agents such as silica gel packets. Regular monitoring of humidity levels and prompt action to address any deviations from the optimal range are essential for preserving the quality and effectiveness of stored medications.

Design consideration

Design considerations for Environmental Data monitoring, which are devices used to record and monitor environmental parameters such as temperature, humidity, pressure, and more, typically revolve around functionality, reliability, accuracy, ease of use, and durability. Here are some key design considerations:

Sensor Selection: Choosing appropriate sensors for the intended application is crucial. Sensors should be accurate, reliable, and have suitable measurement ranges for the parameters being monitored.

Accuracy and Precision: Environmental Data monitoring should provide accurate and precise measurements to ensure the reliability of the recorded data. Calibration and quality control measures are essential to maintain accuracy over time.

Data Storage Capacity: The Environmental Data monitoring should have sufficient storage capacity to record data for the desired duration without the need for frequent data offloading. Consideration should be given to the frequency of measurements and the size of data files.

Battery Life: Long battery life is essential, especially for applications where the Environmental Data monitoring needs to operate for extended periods without access to power sources. Energy-efficient designs and low-power components help maximize battery life.

Data Retrieval: Ease of data retrieval is important for user convenience. Environmental Data monitoring may feature various methods for accessing recorded data, such as USB connectivity, wireless communication, or memory card slots.

User Interface: Intuitive user interfaces facilitate easy setup, configuration, and operation of the Environmental Data monitoring, LCD displays, buttons, and menus should be user-friendly, especially for field use where access to a computer may be limited.

Design and Implementation Environmental Data monitoring system.

Based on the design considerations, the system design will consist of two parts (hardware and software) like any embedded system. The first part, which is related to hardware, is illustrated in figure 4, with a list of components provided along with their important specifications in table (1).

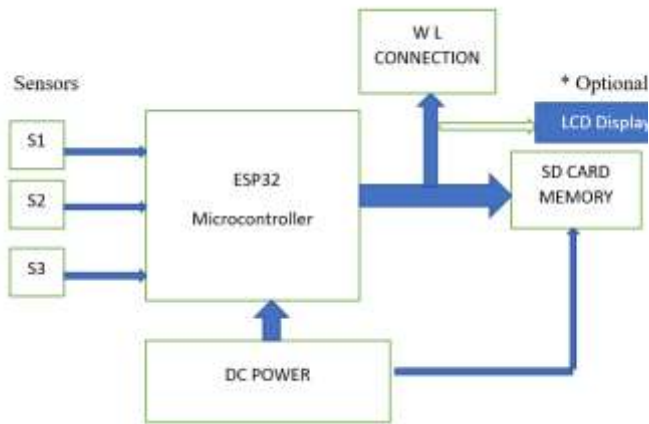
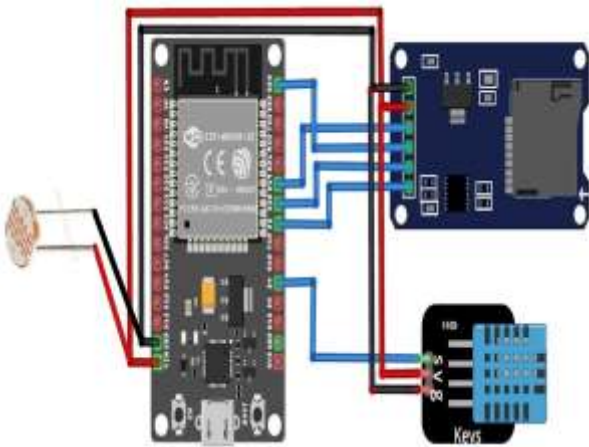


Fig (4) the hardware part of Environmental Data monitoring system

Circuit Diagram of the system

As depicted in the circuit diagram in Figure 5, the connections are straightforward as all components are utilized as modules, allowing for direct assembly on a breadboard. The SD card module is linked to the ESP32 via SPI communication using the SPI pins 5, 18, 19, and 23. Additionally, the DHT22 Sensor Module and the LDR Sensor are connected to specific pins.



Fig(5) circuit connection of the environmental data monitoring.

Table (1)

Elements	Main specification	Quantity
1 Esp32 Dev Board	Wi-Fi and Bluetooth connectivity clock rate 240 MHz, single core Tensilica Xtensa LX6 microprocessor	1
2 DHT 22 Sensor	air humidity and air temperature. very precise (2 seconds). Measurement range: 0-100%RH; -40~80 °C	1

		Accuracy: +-2%RH; +-0.5 °C	
3	LDR Sensor	Voltage divider with fix resistor	1
4	SD Card Module	Compatible with Arduino UNO/Mega or Esp32. SPI interface Support Micro SD Card (<=2G), Micro SDHC card (<=32G)	1

Programming part

Programming entails crafting instructions or code to set up an environmental data monitoring device to execute specific tasks like recording, storing, and at times transmitting data from various sensors or inputs. This programming typically encompasses configuring parameters such as sampling rate, data storage intervals, sensor calibration, triggering conditions, and data formatting. The programming process commonly involves specifying the sensor types in use, determining the frequency of data recording, choosing the data storage format, establishing alarms or notifications based on preset thresholds, and defining the data retrieval or communication method. Programmers utilize specialized software from the environmental data monitoring manufacturer or develop custom scripts in programming languages like C++. The primary aim of programming for environmental data monitoring is to ensure precise and efficient data collection and storage in alignment with the specific application or experiment requirements. Figure (6) illustrates the flow chart of the program. [5,6]

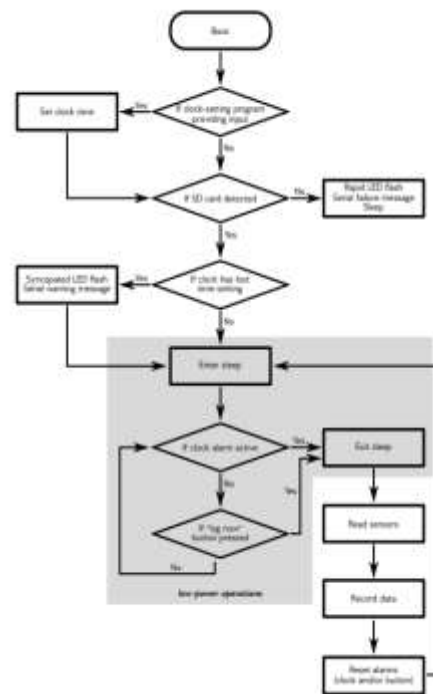


Fig (6) the flowchart of the program .[5,6]

. RESULTS OF THE RECODING FILE

Upon activating the project for a set periodically 5 mints time recoding in SD card , it can observe that all data has been successfully recorded on the SD card based on the sensor readings. Figure (7) illustrates the outcomes of the recording file. The data recording was done with 3 hours as test.

6. Adil Hussein Mohammed , Osama Abubakr Shafiq , ' Air Polluted: Ammonia and Co2 Measurement By Using Arduino', 4th International Conference on Architectural & Civil Engineering Sciences, 2022

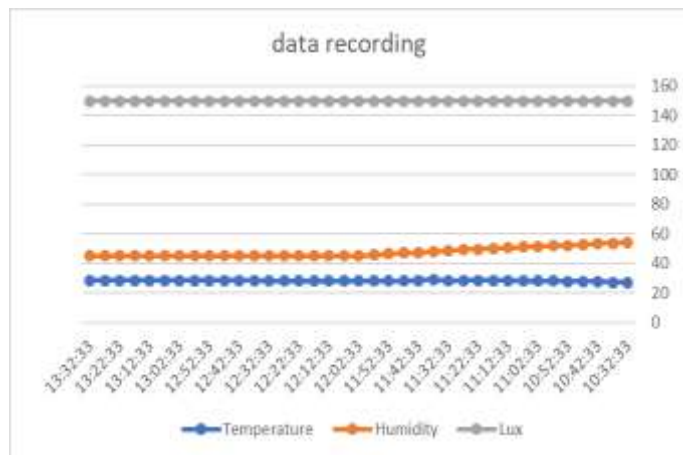


Fig (7) recoding data for 3 hours with sampling each 5 mints

CONCLUSION

The project successfully demonstrated the capability to record sensor data to an SD card at set intervals of 5 minutes over a duration of 3 hours. The Arduino-based system effectively collected and stored sensor readings, showcasing the ability to log data reliably for an extended period.

Through the implementation of environmental data monitoring functionality, valuable insights were captured based on the sensor readings, enabling analysis and monitoring of environmental conditions or other parameters over time. The recorded data can be utilized for further analysis, trend identification, and decision-making processes.

Overall, the project highlighted the feasibility and effectiveness of using Arduino in conjunction with an SD card module for continuous environmental data monitoring applications. The successful completion of the data recording process exemplifies the system's reliability and potential for various monitoring and recording tasks in real-world scenarios.

REFERENCES

- 1- Iqra Jan ,Shabir Sofi , ' Data management for resource optimization in medical IoT', .springe ,2023
- 2- <https://quotestrendynde.blogspot.com/2021/05/desmpressin-nasal-spray-for-bed-wetting.html>
- 3- Robert E. Davis, Glenn R. McGregor, Kyle B. Enfield , ' Humidity: A review and primer on atmospheric moisture and human health', Environmental Research journal, 2016
4. <https://afresherhome.com/what-humidity-set-my-dehumidifier-to>
5. Andrew D. Wickert, 'Open-source Arduino-compatible data loggers designed for field research',