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EXTENDED ABSTRACTS e-BOOK

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m-DAL v2 - MODULAR MULTI-CHANNEL DATA LOGGER WITH SMART MONITORING SYSTEM

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ABSTRACT

This project introduces the Modular Multichannel Data Logger (m-DAL), a versatile system tailored to assess herbaceous roof ecosystems' services. Unlike conventional and expensive data loggers, m-DAL allows for concurrent measurements across multiple channels at a fraction of the cost, while enhancing adaptability and modularity. It is capable of gathering real-time ambient plant temperature and relative humidity data, enabling the investigation of leaf transpiration cooling through water supply manipulation in tropical climates. Utilizing open-source technology, it incorporates an Arduino Giga R1 Wi-Fi microcontroller board interfaced with twelve channels, including type-K thermocouples with MAX6675 amplifiers and DHT22 sensors, with real-time monitoring via the Arduino IoT Cloud. Calibration is conducted using a two-point cross-calibration method with the Ambient Weather WH32B Thermometer-Barometer-Hygrometer for accuracy ranging from 96.15% to 99.72% for temperature sensors and 97.46% to 97.55% for humidity sensors. In field testing, it effectively demonstrates its capabilities in data collection, logging, real-time monitoring, environmental tracking, data storage, retrieval, validation, and cost-effectiveness. Finally, the recorded data offers opportunities for further analysis and modeling of herbaceous transpiration cooling as an ecosystem service. Embrace the versatility of the m-DAL for ecological research and beyond.

Keyword: Temperature sensor; Humidity sensor; Environmental data logger; Arduino IoT; Modular data logger system (m-DAL)

1. INTRODUCTION

Research on urban nature-based solutions, such as vegetated roofs, is increasingly recognized for its role in regulating ambient humidity and balancing urban temperatures. Sensors are essential for monitoring these benefits, but current data loggers are often limited by their lack of modularity and adaptability. Commercial loggers typically offer limited customization, fixed sampling rates, and restricted channels. This project introduces the Modular Multichannel Data Logger System (m-DAL), specifically designed to evaluate herbaceous roof ecosystem services. The m-DAL overcomes the limitations of existing loggers by providing concurrent measurements across multiple channels with greater adaptability and modularity at a lower cost. The goal is to create an affordable, modular data logger system for assessing vegetated roof plant ecosystem services. This system will support concurrent multi-channel measurements, utilize fast-reading sensors, offer programming flexibility, and be cost-effective to produce.

2. METHODOLOGY

We utilize open-source technology with the newly launched Arduino GIGA R1 Wi-Fi microcontroller board. This setup includes twelve channels, type-K thermocouples with MAX6675 amplifiers, and

DHT22 sensors. Real-time monitoring is achieved through the Arduino IoT Cloud, complemented by a dedicated SD card data logger. Sensor calibration was conducted using a two-point cross-calibration method with the Ambient Weather WH32B Thermometer-Barometer-Hygrometer for the WS-2000 weather station. Accuracy assessments revealed temperature sensor accuracy ranging from 96.15% to 99.72% and humidity sensor accuracy from 97.46% to 97.55%. The block diagram illustrating the conceptual system's flow is depicted in Figure 1 below.

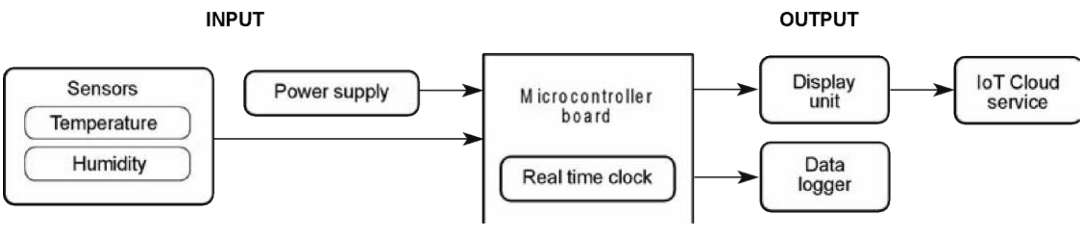

Figure 1 Block diagram of the developed system.

2.1 System algorithm

We created a system flow algorithm in this setup to guide programming activities from the device starting to shut down. The algorithm has two parts: "Void Setup" (run once) and "Void Loop" (repeatedly). It starts with initializing the serial monitor, RTC, sensors, and SPI for the micro-SD card. In "Void Setup," the system checks and prepares the SD card for logging, showing an error message if unsuccessful. Moving to "Void Loop," sensors transmit data every 5 seconds with timestamps. Data is sent to the serial monitor and IoT Cloud before logging on to the microSD card. "Void Loop" activities continue until the device is turned off.

2.2 Components

The configuration components are the Arduino Giga R1 Wi-Fi microcontroller board, Real-Time Clock (RTC), data logger, temperature sensor (MAX6675 module with K-Type thermocouple), temperature and humidity sensor (DHT22), power supply unit, and necessary assembly components sourced from reputable supplier.

2.3 Programming Code

Program code was written in Arduino IDE, involving downloading necessary function libraries, writing sketches based on the algorithm, selecting the microcontroller board and serial port in the IDE, compiling the code, and uploading it to the device, ensuring compatibility and functionality.

Figure 2: (**A**) The m-DAL system deployment. (**B**) Sensor's location for K-type thermocouple and (**C**) DHT22 for each planting plot.

3. FINDINGS

The m-DAL system effectively logged real-time ambient leaf temperature and relative humidity data for two Coleus species (herbs), showcasing its capabilities in data collection, logging, real-time monitoring, environmental tracking, data storage, retrieval, validation, and cost-effectiveness during field testing (Figure 2 and Figure 3). The collected data is available for further analysis and modeling of herbaceous transpiration cooling as an ecosystem service. However, the newly launched Arduino Giga R1 Wi-Fi poses a limitation as many function libraries and third-party shields have not yet been updated to accommodate the full functionality.

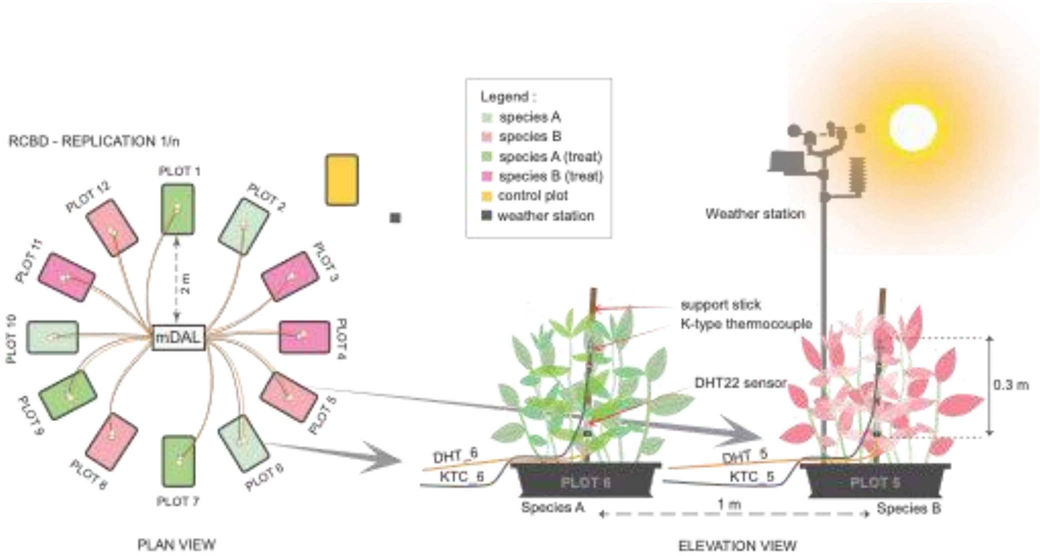

Figure 3: Field experimental setup and sensor positioning.

4. CONCLUSION

The system is highly effective, providing cost-efficient solutions for data collection, logging, real-time monitoring, and environmental tracking. Although the development process is time-consuming, it significantly enhances research skills and deepens the understanding of data and equipment. Future upgrades may include adding capacitive soil moisture sensors to expand the existing capability for data collection on plant-water relations for nature-based solution-related studies.

REFERENCES

Yılmaz GÜVEN, Ercan COŞGUN, 3Sıtkı KOCAOĞLU, Harun GEZİCİ and Eray YILMAZLAR. (2017) Understanding the concept of microcontroller-based systems to choose the best hardware for applications. *Research Inventy: International Journal of Engineering And Science*, **6**, 38–44.

Arduino GIGA R1 Cheat Sheet | Arduino Documentation [Internet].

Maxim Integrated Products, Inc. (2021). MAX6675-Cold-Junction-Compensated K-Thermocouple-to-Digital Converter (0°C to +1024°C) [Internet]. p. 1–8.

Aosong Electronics Co., L. Digital-output relative humidity & temperature sensor/module DHT22. Aosong Electronics Co.,Ltd. p. 1–10.

Vernia: Science Education. How do I calibrate the Relative Humidity Sensor? - Technical Information Library [Internet]. Vernia: Science Education.

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