2024 ENGINEERING INSTITUTION OF ZAMBIA SYMPOSIUM

Implementation of an Intelligent Greenhouse Control And Monitoring System

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INTRODUCATION

- A smart greenhouse integrates advanced technologies such as sensors, actuators, and IoT systems to create an optimal environment for plant growth and maximize agricultural productivity.
- IoT technology facilitates remote monitoring, data collection, and control of greenhouse conditions, enabling farmers to make informed decisions and improve crop yields.
- This project aims to develop and deploy a cost-effective smart greenhouse system in Zambia, leveraging IoT and sensor technologies to address challenges in agriculture and enhance food security.

PROBLEM STATEMENT

- **Manual Labor Dependency**: The current Zambian greenhouses heavily rely on manual labor for maintenance, particularly in the labor-intensive tasks of managing irrigation and aeration processes.
- **Motivational Dependency**: The need for a highly motivated workforce to manage the manual processes poses a challenge, as maintaining consistent motivation levels becomes crucial for effective greenhouse management.
- **Operational Inefficiencies**: The absence of automated monitoring and control procedures results in increased operational expenses and suboptimal environmental conditions, hindering the potential for maximum crop production.
- **Environmental Factors**: The lack of a self-operating system prevents growers from effectively managing key environmental factors such as temperature, humidity, and light levels, adversely affecting crop growth.

MAIN OBJECTIVE

- The overall goal of this project is to develop, build, and deploy a microcontroller-based prototype to monitor and control greenhouse conditions utilizing sensors and IoT technologies.
- The Intelligent Greenhouse System aims at:
  - Monitoring and controlling humidity, Temperature, Soil moisture, ventilation equipment and applying the proposed modified environmental parameters and data.
  - Evaluating the performance of the modified environmental parameter

Methodology and Research Design

INTELLIGENT GREENHOUSE CONTROL AND MONITORING SYSTEM

1. DESIGN RESEARCH
2. MATERIAL RESEARCH
3. REVIEW EXISTING GREENHOUSE ELECTRONIC SYSTEMS
4. IMPLEMENTATION AND TESTING

WORKING PROTYPE

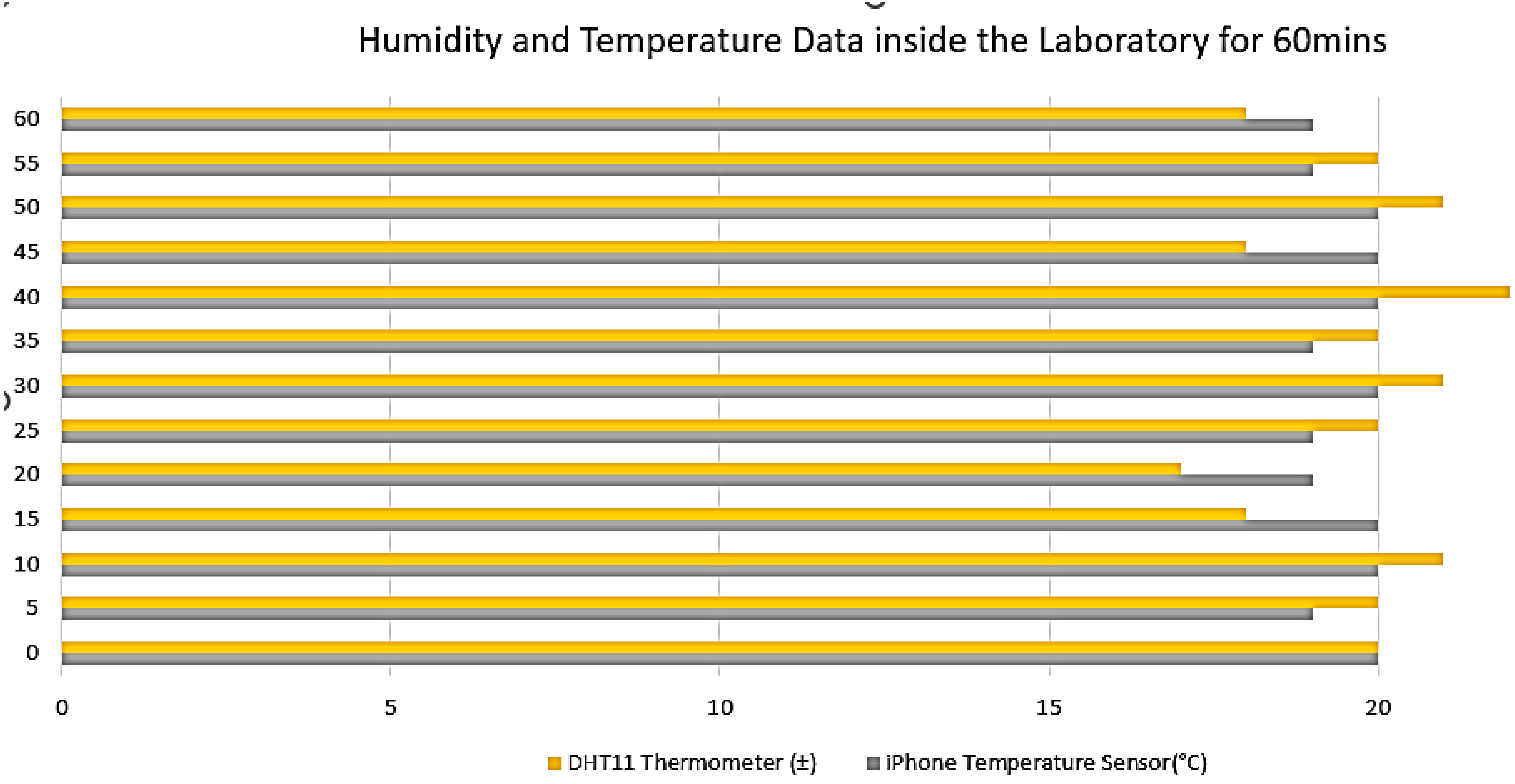
- The central program enables seamless coordination of electronic components, sensors, and actuators for real-time monitoring and control, optimising plant growth conditions.
- The smart greenhouse system integrates various electronic components including microcontrollers (e.g., Arduino), sensors (e.g., DHT11, soil moisture sensor), actuators, Wi-Fi modules, and power supply units to create a comprehensive monitoring and control system.

PROBLEM STATEMENT

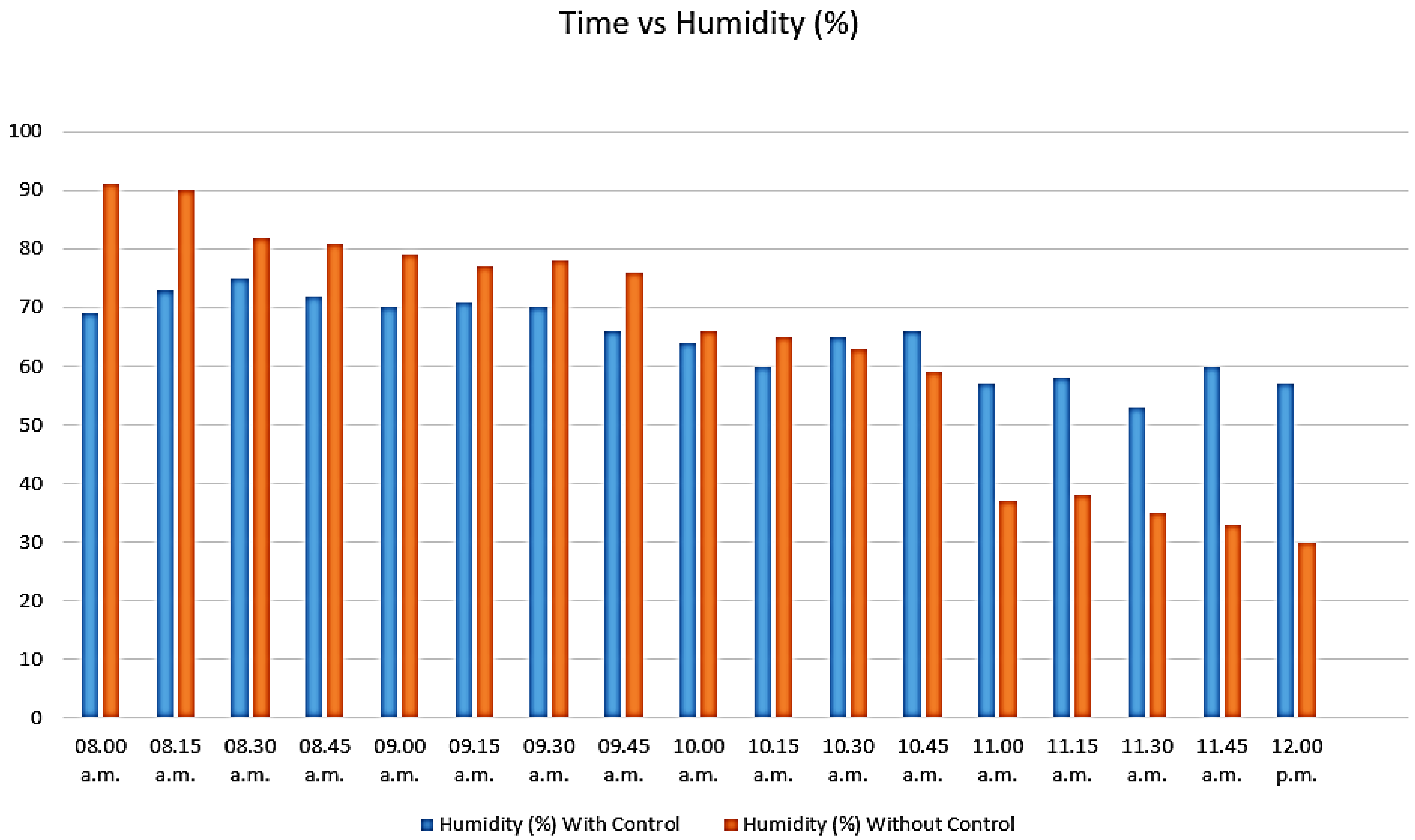
The project conducted rigorous experimental studies to evaluate the performance of the smart greenhouse system in maintaining optimal environmental conditions for plant growth.

- **Impact of Control System on Greenhouse Parameters**: Results demonstrate the effectiveness of the control system in regulating temperature, humidity, and soil moisture levels within desired ranges, ensuring optimal conditions for crop growth and development.

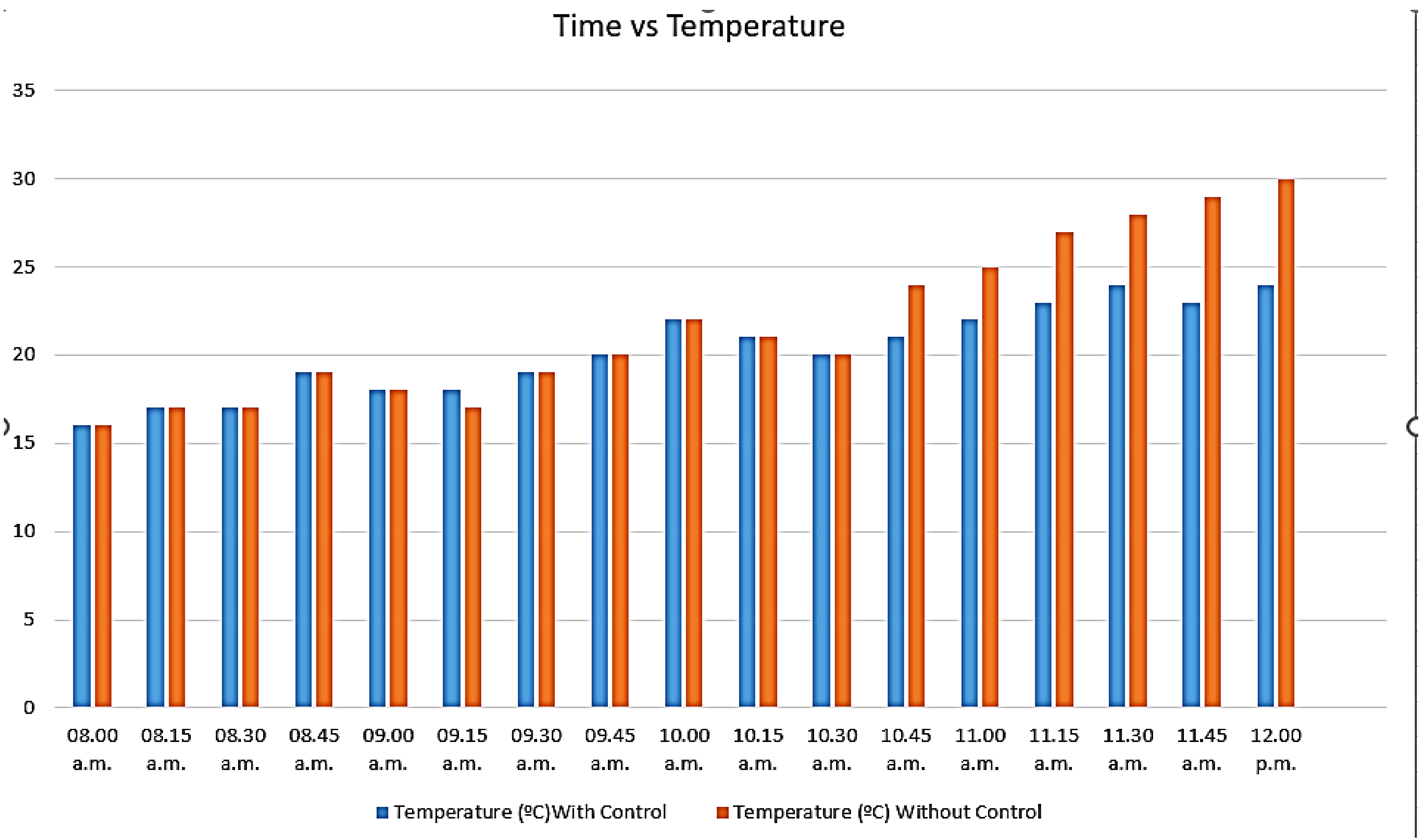
RESULT ANALYSIS



HUMIDITY WITH & WITHOUT CONTROL RESULTS



TEMPERATURE WITH & WITHOUT CONTROL RESULTS



CONCLUSION

- **Successful System Development:** The study achieved its objectives by successfully designing and constructing a microcontroller-based system that utilizes sensors and Wi-Fi technology for tracking and managing greenhouse parameters. This system effectively monitors and controls key factors such as humidity, temperature, soil moisture, and ventilation equipment, while also applying modified environmental parameters and collecting relevant data.
- **Challenges in Implementation:** Despite the successful development of the system, several challenges were encountered during the implementation phase. Time constraints played a significant role, necessitating extensive research and component analysis. The unavailability of specific components in Zambia posed a funding and resource challenge, leading to the importation of a majority of the required components. Additionally, network access issues, particularly in uploading data to the ThingSpeak database for analysis due to the IoT element, were addressed by resorting to a wired internet connection.

Future Directions

- **Power Backup Integration**: Enhance the system's resilience by incorporating a power backup system, such as solar cells. This addition will mitigate operational costs during power outages, ensuring continuous functionality and data monitoring in the greenhouse.
- **Deployment in Agriculture**: Consider utilizing the designed prototype greenhouse for practical applications in the agricultural industry. Deploying smart greenhouses at scale can demonstrate the system's efficacy in real-world conditions, allowing for valuable insights and improvements based on practical use.
- **Real-Time Camera Implementation**: Integrate a real-time camera for monitoring plant growth within the greenhouse. This addition provides visual insights into the development of crops, enabling more comprehensive data collection and analysis. Real-time imaging can contribute to better decision-making and optimization of crop management practices.

The End

THANK YOU FOR YOUR ATTENTION.

the Engineering Institution of Zambia