

Web Enabled IoT in a Wireless Sensor Network Used to Monitor and Control Reptile Terrariums

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1. Introduction, Aim and Objectives

Background

Reptiles are ectothermic, meaning they rely on the environment around them to regulate their body temperature. In addition to this, many also need adequate humidity and ultraviolet levels to thrive.

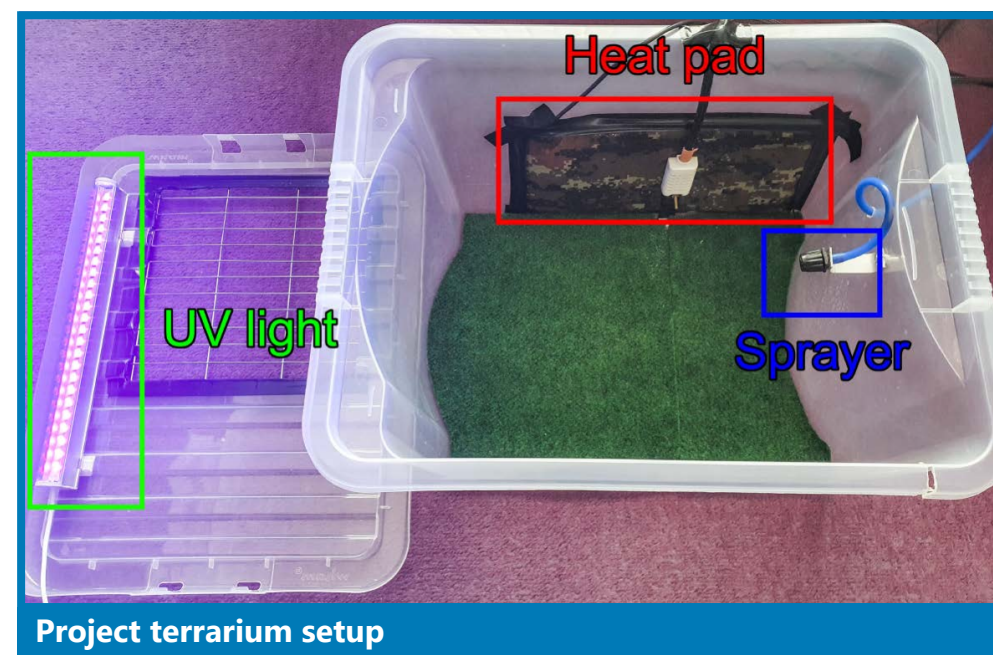
Commercial products such as thermostats are too expensive to use in bulk, and many lack advanced monitoring and control features. This project aimed to address that. The implemented system controls a heat pad, sprayer and ultraviolet light.



The Madagascar Giant Day Gecko

Aim:

To design and develop a web-enabled system to automatically monitor and control temperature, humidity and ultraviolet exposure in multiple networked reptile terrariums.



Project terrarium setup

Objectives:

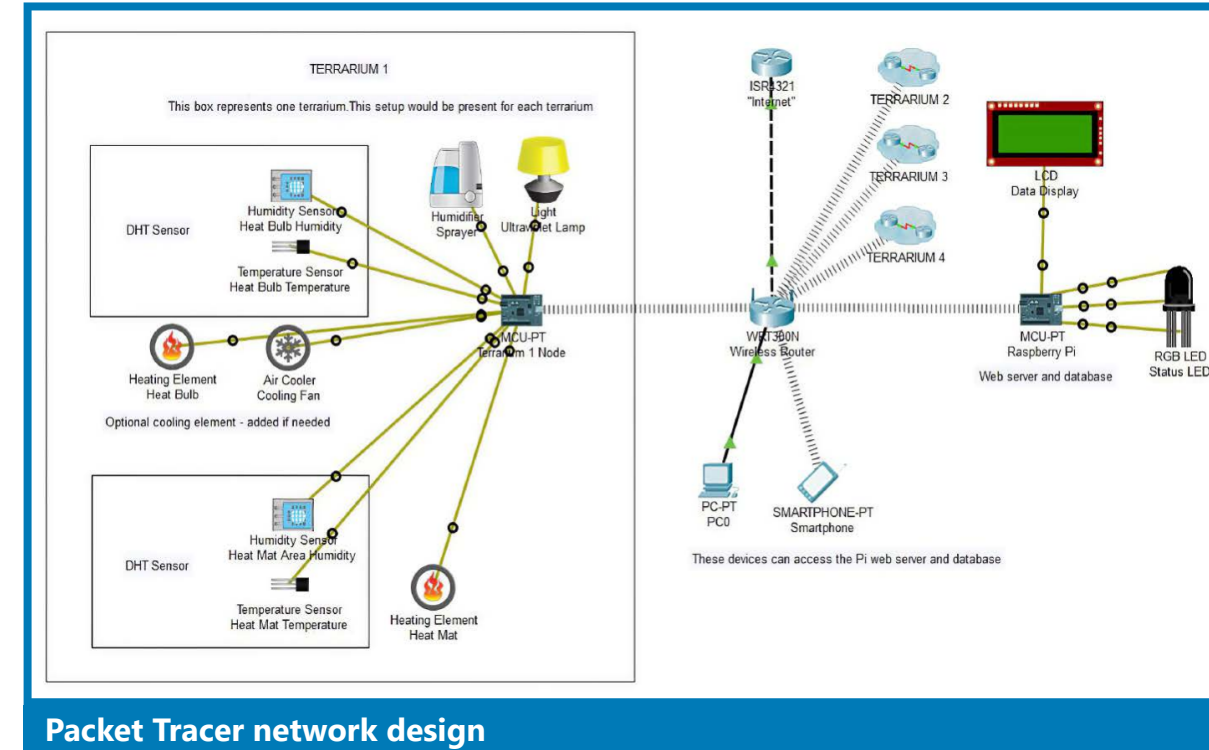
- Conduct a literature review as secondary research
- Conduct interviews with a pet shop as primary research
- Design and develop an ESP8266 (Arduino) based monitoring and control system
- Design and develop a PHP progressive web app to monitor and control nodes
- Test and evaluate the system against existing products

2. Literature Review

The literature review identified some key areas that IoT and web technologies have been applied to, relevant to the project:

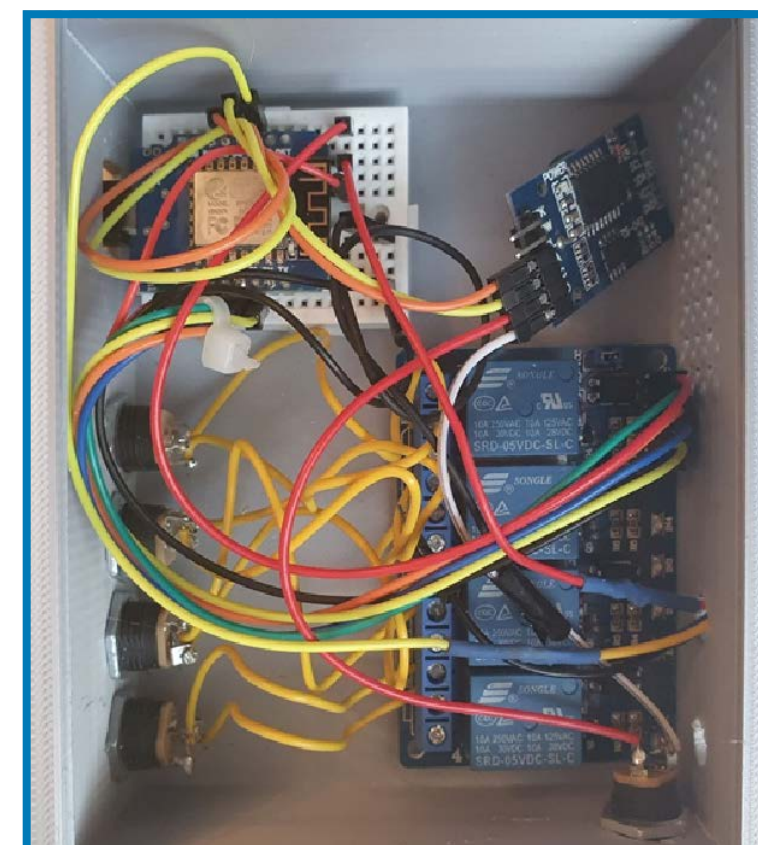
- Reptile terrarium temperature control [1]
- Energy saving in zoos [2]
- Honeybee hive monitoring in a network [3]
- Henhouse monitoring [4]
- Fishpond monitoring [5]
- Greenhouse monitoring and control [6], [7]
- Water and air quality monitoring [8]

3. Design and Development

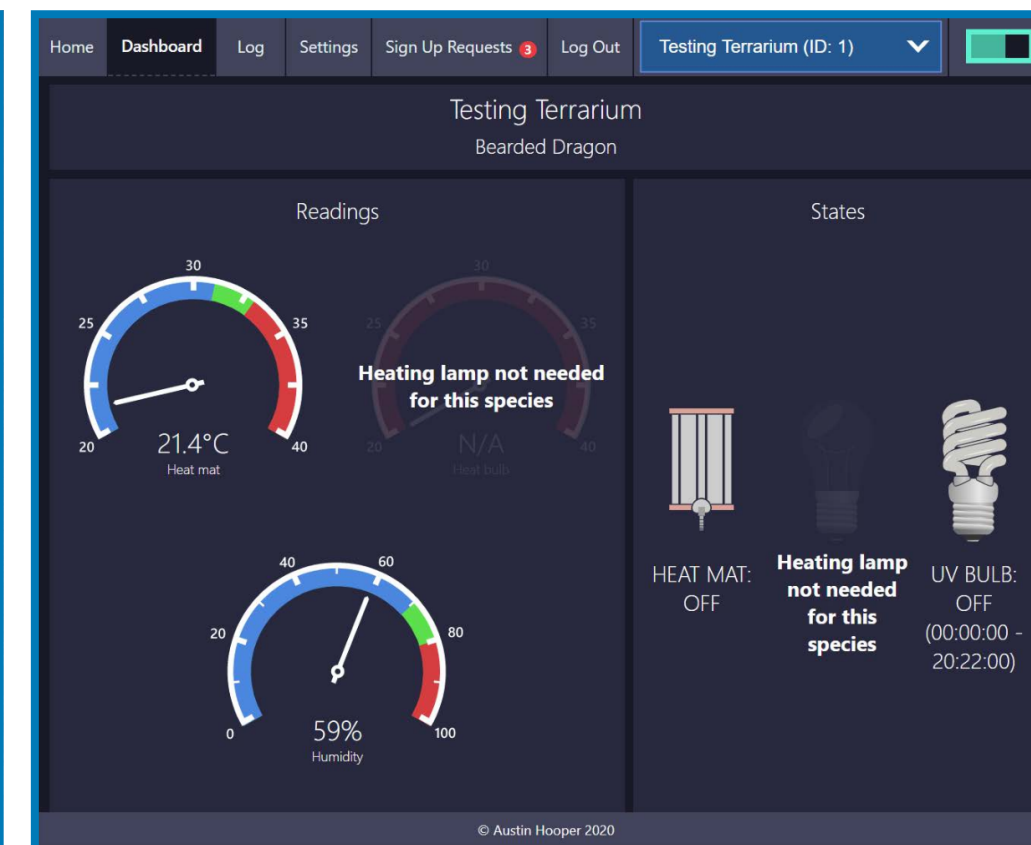


Packet Tracer network design

A web application using PHP and MySQL was developed for users to interact with the node devices, which were based on ESP8266 microcontrollers, using DHT22 sensors. The network was first designed in Cisco Packet Tracer. A node device is shown below in the 3D printed case, along with one of the pages of the web application.



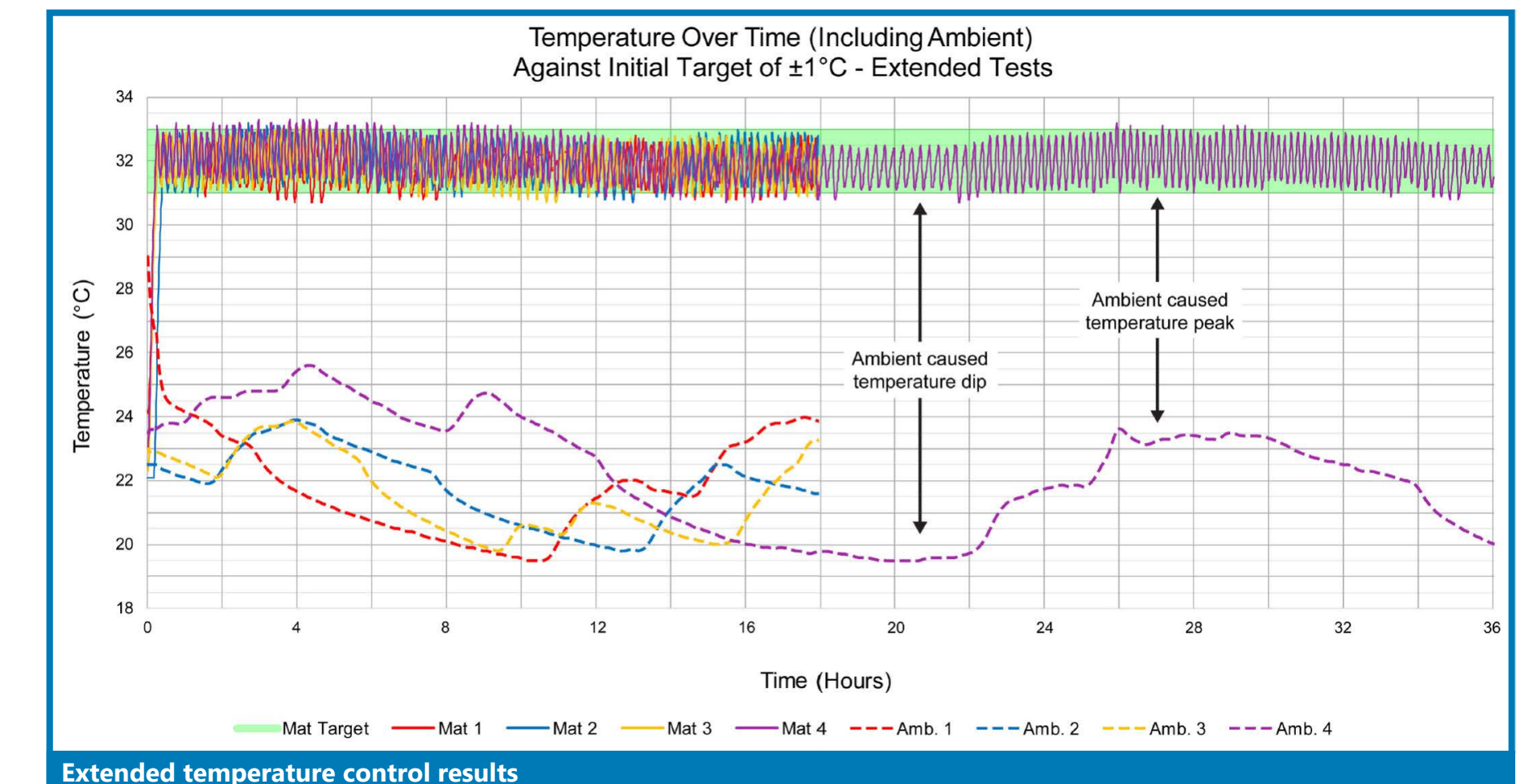
Node device hardware



Dashboard page of the web application

5. Functional Testing

Temperature control at 32°C target kept temperatures within $\pm 1.4^\circ\text{C}$, with a mean of 31.95°C over four 36-hour tests. In two sets of humidity control testing with different code, mean humidities at a target of 75% were 69.2% and 78.7%. Humidity and temperature control together was not successful as the heating pad overpowered the humidity.



Extended temperature control results

6. Conclusions and Future Work

The project was very successful overall. The objectives were met well, having designed and implemented a full system based on research findings. Temperature and humidity control were effective, though combining the two was not. In user experience testing, the application was well received.

The project has many areas for future work, primarily:

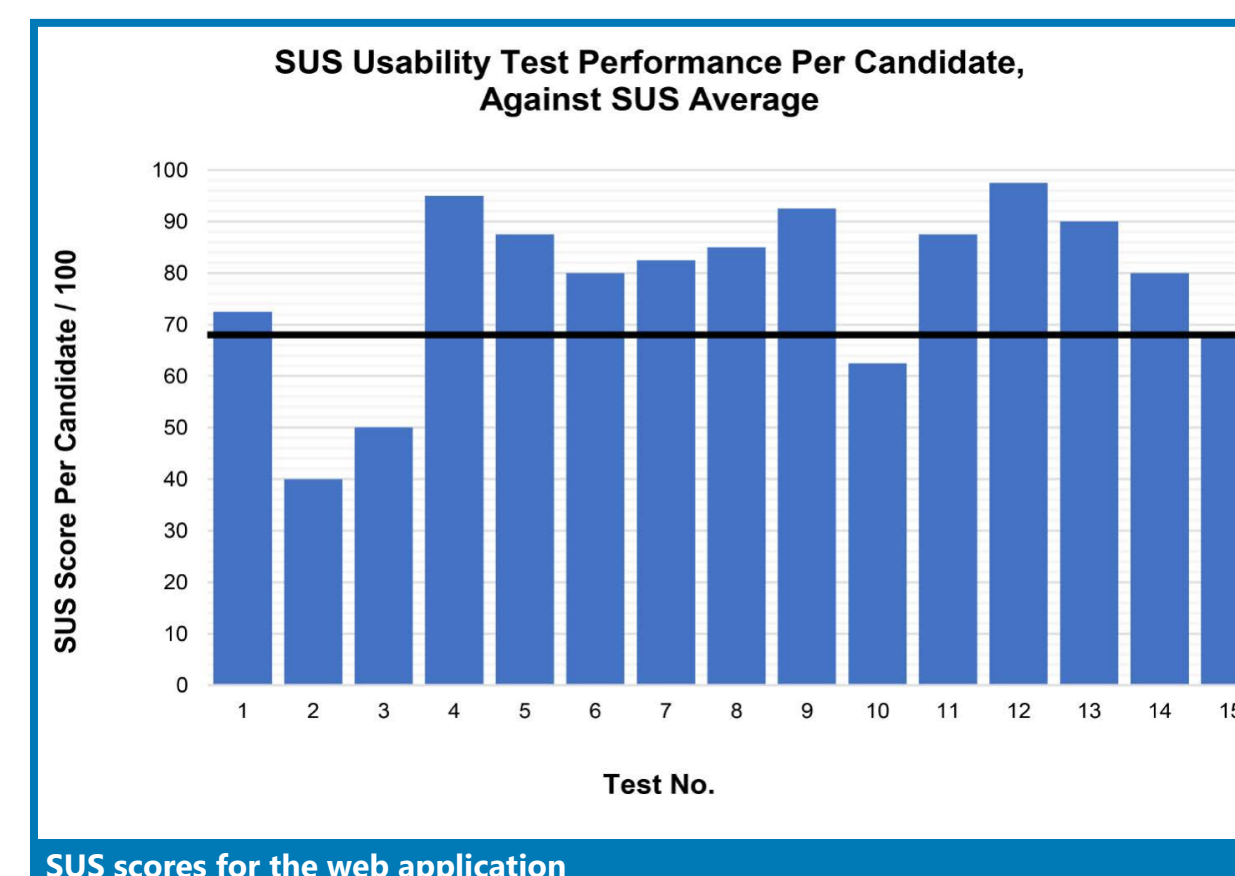
- Building on the core concept
- Expanding to more general smart cities concepts
- Expanding to other animals - terrapins, amphibians, fish etc.
- Custom protocol implementation, socket programming or Zigbee

References

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4. User Experience (UX) Testing

The web application's usability was tested using observation of instructions, and System Usability Scale (SUS) [9] questions. The application scored 78/100 against the SUS average of 68/100. Analysing responses by question highlighted the site's strengths and weaknesses.



SUS scores for the web application