Infant Wildlife Incubator

BME 400 Poster Presentation 12/08/2023

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Motivation

- Aim of wildlife rehabilitation is to treat sick, injured, orphaned, or otherwise distressed wildlife and then release them back to their natural habitat [1].
- Many animals at rehabilitation centers are young neonates who are unable to regulate their own body temperature.
- While there are a number of wildlife incubators on the market today, the high price point of many create a barrier for private parties to pursue their own wildlife rehabilitation efforts.

Problem Statement

- Many private parties frequently contribute to wildlife rehabilitation efforts, but often do not have the financial resources to purchase an incubator.
- This incubator will have a positive impact by increasing accessibility to proper equipment for individuals passionate about wildlife rehabilitation.
  - Incubator must be/have:
    - Low cost
    - Durable
    - Modular
    - Easy to clean
    - Precise humidity and temperature control

Background

- Infant wildlife lacks the ability to self-regulate temperature sufficiently.[2].
  - Heat regulation differs based on age, gender, and season [3].
- For most mammals, the acceptable humidity range is 30-70% [4].
  - For infant wildlife, humidity between 60-70% is ideal.
- TLC-50 Zoologica II (25" x 18" x 14") – $1199.99
  - Includes accurate digital temperature control with a screen for adjustments, alarms that signify temperatures that are too high or too low, automatic humidity control, air filtration and exchange, and variable fan speeds [5].
- TLC-30 Eco (9.5" x 9.5" x 6.5) – $309.99
  - Includes similar components, but no humidity control [6].

Figure 1: TLC-50 Zoologica II

Design Criteria

- Dimensions should be 18" x 18" x 18" and break into a box that is 20" x 20" x 8" or smaller for shipping.
- Must be under $100/unit to manufacture.
- Should involve modular parts allowing for easy replacement.
- Must maintain a temperature of 95°F with a buffer of +/- 2 degrees.
- Ability to increase humidity up to 60%.
- No sharp edges on the interior surface.
- Life in service of 10 years.
- Easily withstand regular operational use and cleaning regimen.

Final Design

- Temperature system final design consisted of:
  - DS18B20 temperature sensor
  - 12V DC adapter
  - 4.7kΩ resistor
  - Beefcake relay
  - Ceramic heating element
- Temperature feedback: heating element turns on when the temperature is under 93℉ and off above 97℉.
- Humidity system final design consisted of:
  - DHT11 humidity sensor
  - Beefcake relay
  - Power supply
- Humidity feedback: when humidity is below 60%, the circuit turns on a water atomizer to humidify air
- Currently using commercial dog cage.
  - Mimics desired insulation and ventilation features to provide adequate testing environment

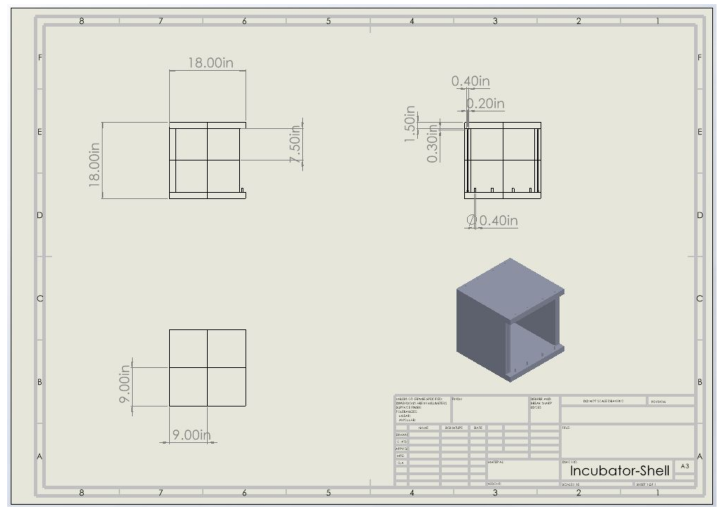

Figure 2: SolidWorks Incubator Shell

Figure 3: Final Prototype

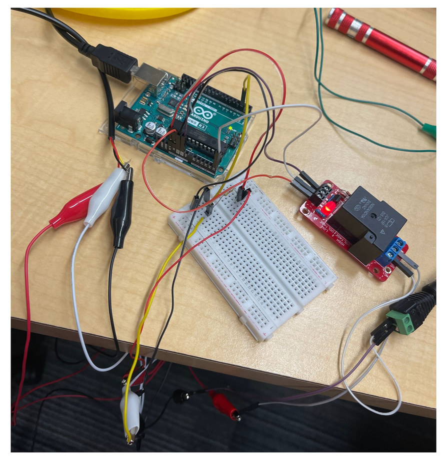

Figure 4: Final Temperature Circuit

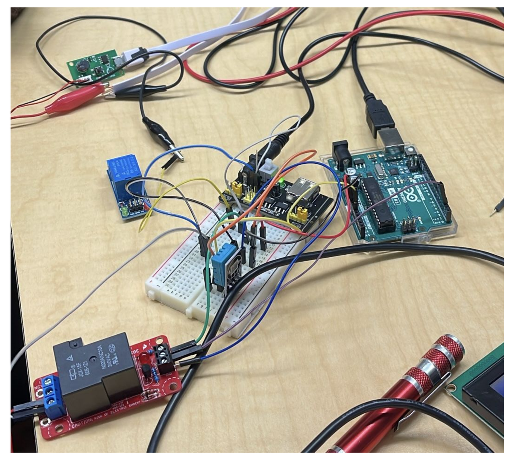

Figure 5: Final Humidity Circuit

Testing

- Temperature testing was done through 4 cycles
  - A cycle is defined as one oscillation in the temperature data.
  - A member of the team held the heating element in their hand to ensure it was getting warmer.
  - To ensure that the temperature went down, the sensor was placed on the heater and team members ensured that the element was getting cooler.

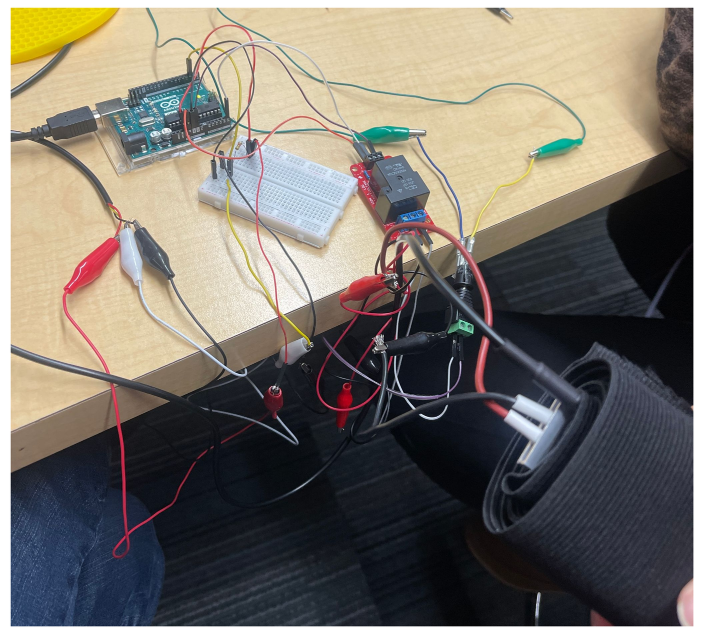

Figure 6: Testing of Temperature System

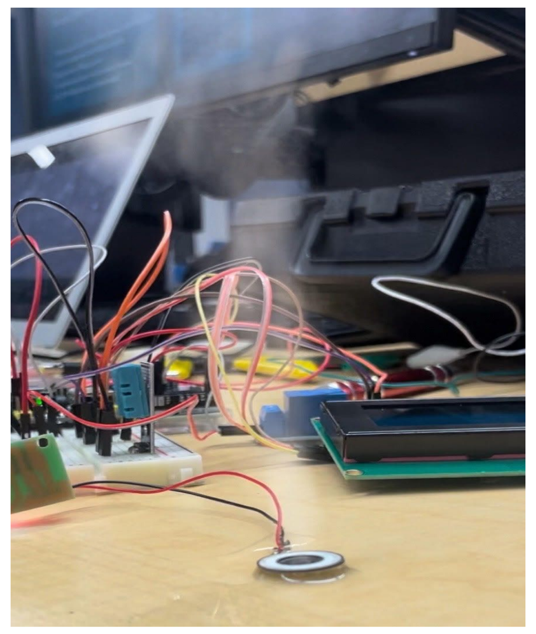

Figure 7: Testing of Humidity System

- Humidity testing was done through 5 cycles
  - A cycle is defined as one oscillation in the humidity data
  - The circuit was placed inside of a cardboard box
  - The team ensured that the atomizer went off when the sensor was reading below 60% humidity
  - The team also checked to make sure that the atomizer was not going off when the humidity was at or above 70%

Results

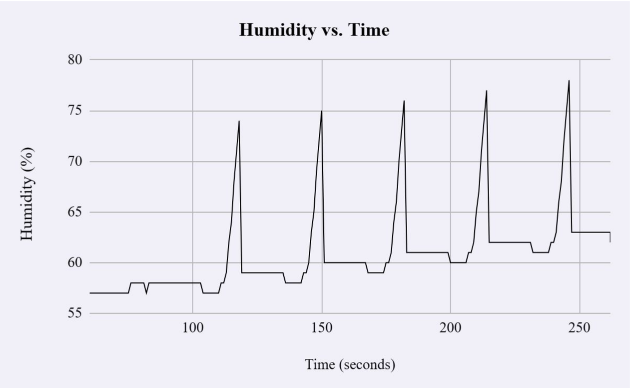

Figure 8: Graph of Humidity vs Time The humidifier turns on and off when necessary but maintains a minimum around 60% humidity

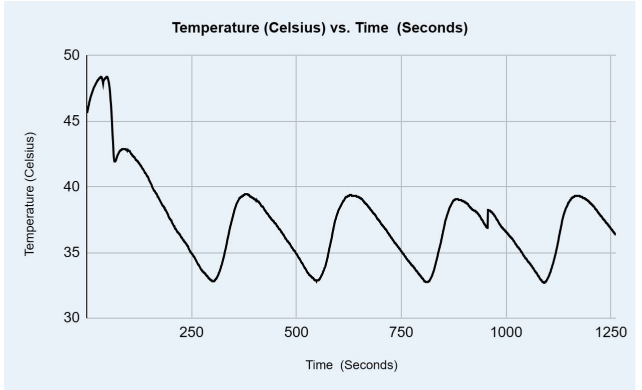

Figure 9: Graph of Temperature vs Time Following calibration, the temperature is maintained between 32-40℃ (89-104℉)

Discussion

- The humidity range should remain between 60% to 70%
  - Our sensor was able to judge the the humidity accurately and turned the atomizer on to increase the humidity when necessary
  - However, the humidity has increased too high at times so the feedback mechanism might have to utilize predictions
- The temperature range should remain between 93-97°F
  - The temperature changed slower than the humidity and was more stable
  - The feedback system was still too slow, and allowed the temperature to go above and below ideal limits

Future Work

- Improve regulation of temperature and humidity through feedback system (PID)
- Implement changeable temperature and humidity using a dial
- Create the external shell via 3D printing or T-Slot 80/20.
- Test the whole system over multiple hour period rather than the individual components
- Test the shell for modularity and or durability

Acknowledgements

- Dr. Stelford
- Dr. Block
- Cindy Armour
- UW-Madison BME Department

References

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[3] J. Terrien, "Behavioral thermoregulation in mammals: A Review," Frontiers in Bioscience, vol. 16, no. 1, p. 1428, Jan. 2011. doi:10.2741/3797

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[5] "TLC brooders/Intensive Care Units," /Hospital Cage, https://www.brinsea.com/p-682-tlc-50-zoologica-ii-parrot-brooderintensive-care-unitrecovery-incubator.aspx (accessed Sep. 21, 2023).

[6] "TLC brooders/Intensive Care Units," Home, https://www.brinsea.com/p-615-tlc-30-eco-parrot-brooderintensive-care-unitrecovery-incubator.aspx (accessed Sep. 21, 2023).