A Novel Robotic Device for Measuring Hunger in Cichlids

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Robotics and automated sensory systems have become increasingly pertinent to the study of animal behavior.[1]

How can the use of robotics or automated sensors help to quantify hunger in brooding African cichlids?

The African Cichlid, *A. burtoni,* broods its young in its mouth. During this brooding period the female cichlid carrying the brood does not eat.[2] This behavior puzzles researchers and begs the question: Do cichlids feel hunger while brooding?

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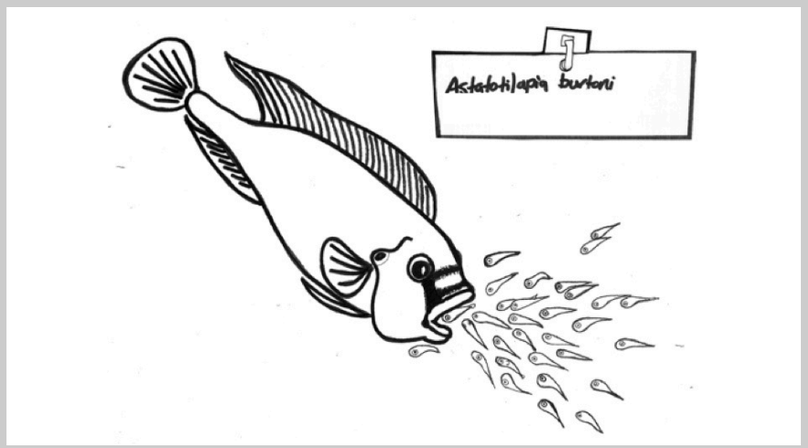

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We looked to robotics and automated sensory systems for an innovative experimental method to address the issue of cichlid hunger during brooding periods.

Experimental Design:

Hypothesis: Hunger in cichlids is correlated to the rate at which the focal fish moves toward a known food source

The fish need to undergo operant conditioning before they can recognize the known food source. This entails training the fish to recognize a light shining from a red LED. When the fish swim within a set distance of the sensor the red LED turns of and the fish is rewarded with food. A white LED then flashes as a secondary reinforcer for the conditioned behavior.[3]

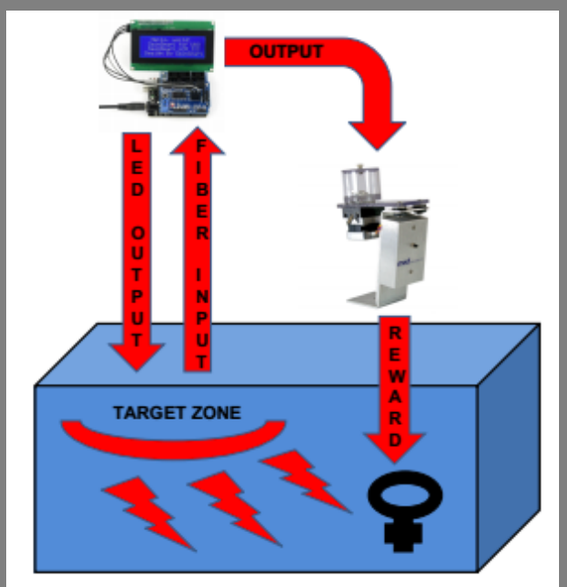


Figure 1 (left). Cartoon schematic of automated sensory system. In order to measure the rate of Cichlid movement toward the known food source, a sensor connected to an LED tracks the distance of the fish from the food source through differences in voltage.

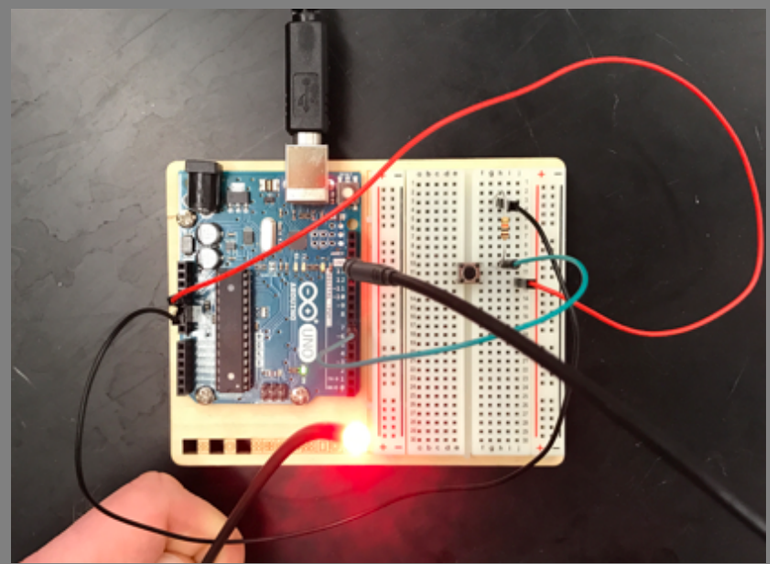


Figure 2 (above). Arduino circuit with heat-shrinked LED to optical fiber. The Arduino platform allows us to connect the LED to the sensor, and then to the feeder. This fully automates the process of conditioning and data collection.

Methods and Results

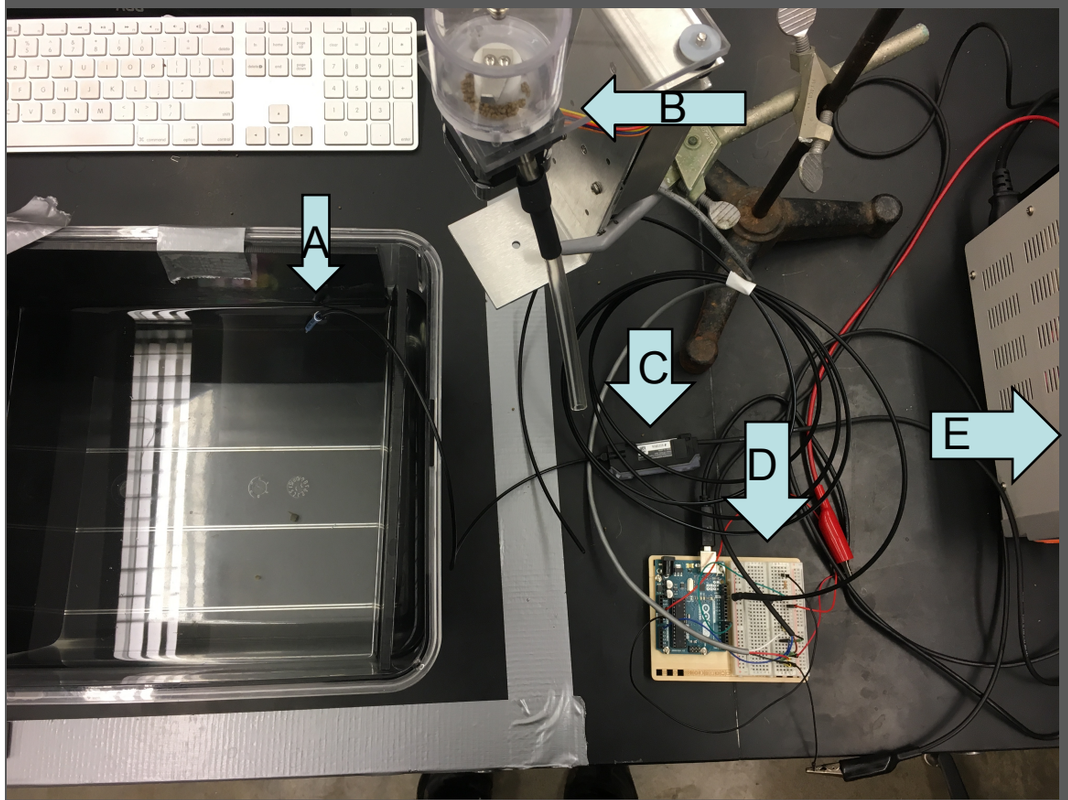


Figure 3 (above). Experimental tank setup. a) In tank infrared sensor
b) Feeder
c) Sensor amplifier
d) Arduino micro-controller
e) Power supply

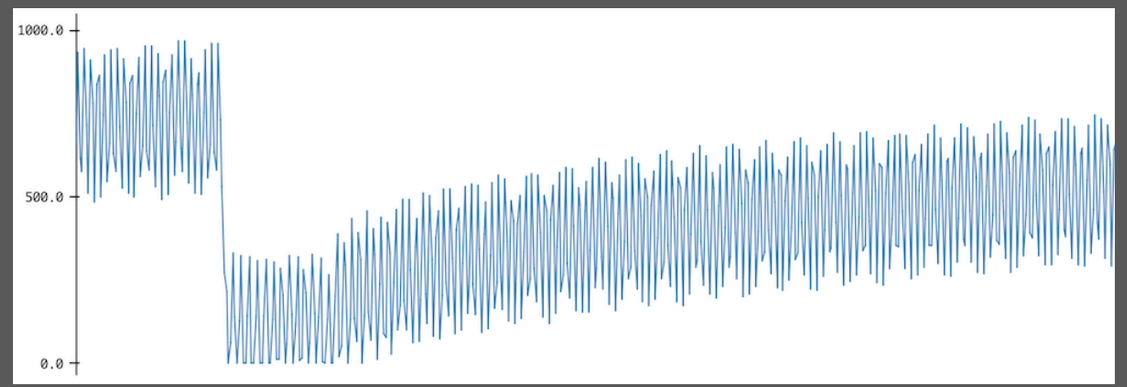
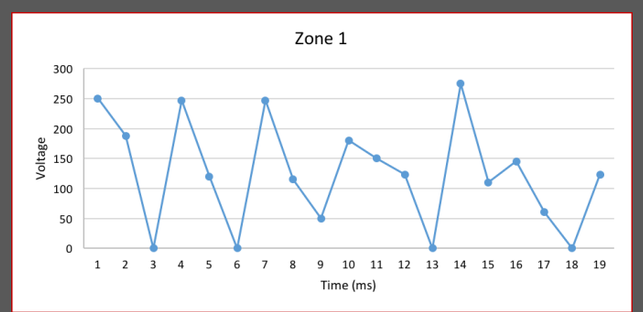
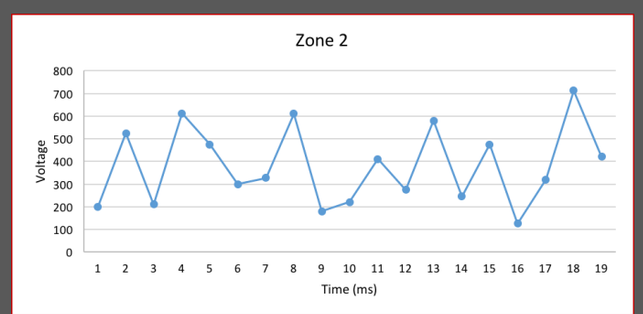


Figure 4 (above). Arduino IDE serial monitor real-time plot. As fish approached sensor, voltage drops to zero and then rises as fish exits the target zone.





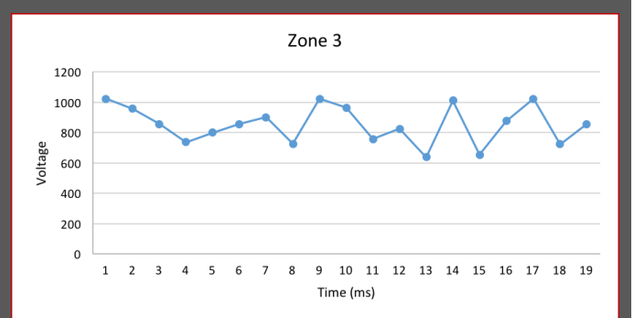
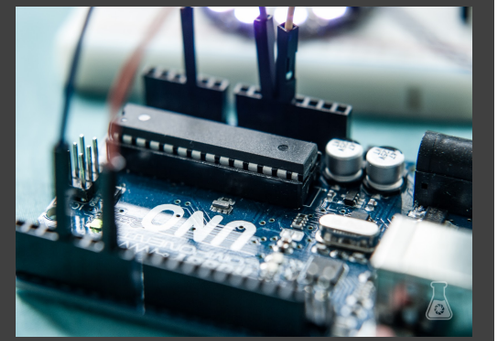


Figure 5 (right). Voltage differences by zone. The further the fish is from the sensor (Zone 3), the higher the voltage valued recorded. At a close proximity (Zone 1), voltage drops to zero and triggers the automatic feeder. Zone areas were measured on the experimental tank in centimeters.

Discussion:

The use of robotics and automated systems will become increasingly prevalent in the study of animal behavior and biology as a whole. In order to further study the intricate processes of behaviors such as mouthbrooding in cichlids, the use of precise behavioral study methods will be imperative. The appetitive behavior associated with mouthbrooding must be studied without feeding the fish. The use of this Arduino circuit will allow for the latency of swim time to the target zone, measured by the infrared sensor, while brooding. This will provide a measure of hunger in the fish.



Future Directions:

Our sensor's ability to detect the distance of a fish from the known food source using voltage differences, and the automation of the feeder that is wired to this sensor, allows for a more seamless data collection method than have not been previously applied to research on cichlids. Automation frees up the observer and reduces the amount of human interference in a behavioral study. Essentially, robotic sensing and reward systems create a greater possibility for the integration of research methods into the environment of the focal animal/animals. Operant conditioning trials should be the next step in this process.

References:

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