P4 Assignment

Team Name:
AniSight

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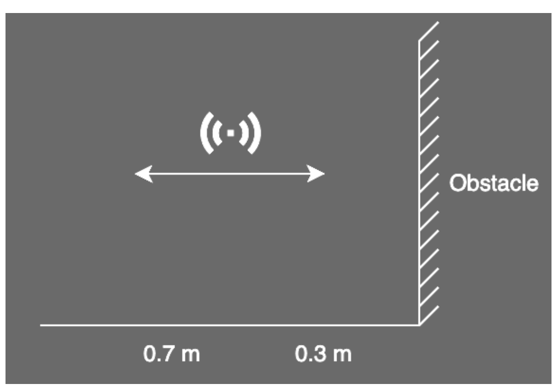
Final Prototype:

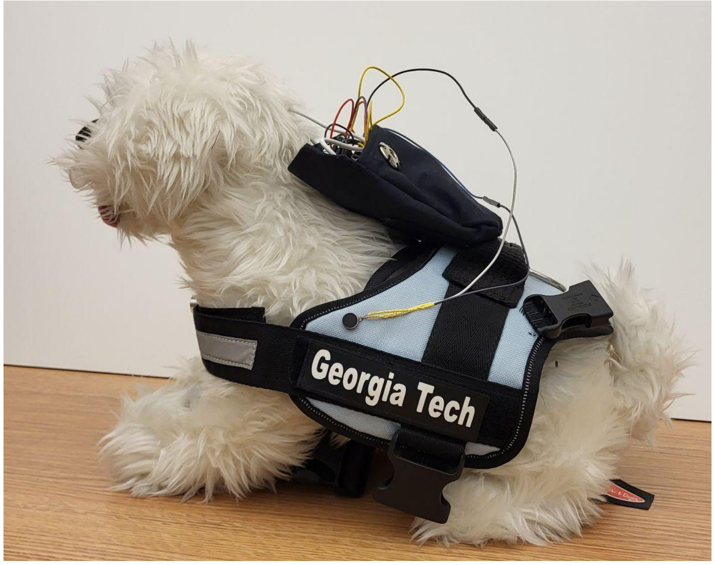
Description:

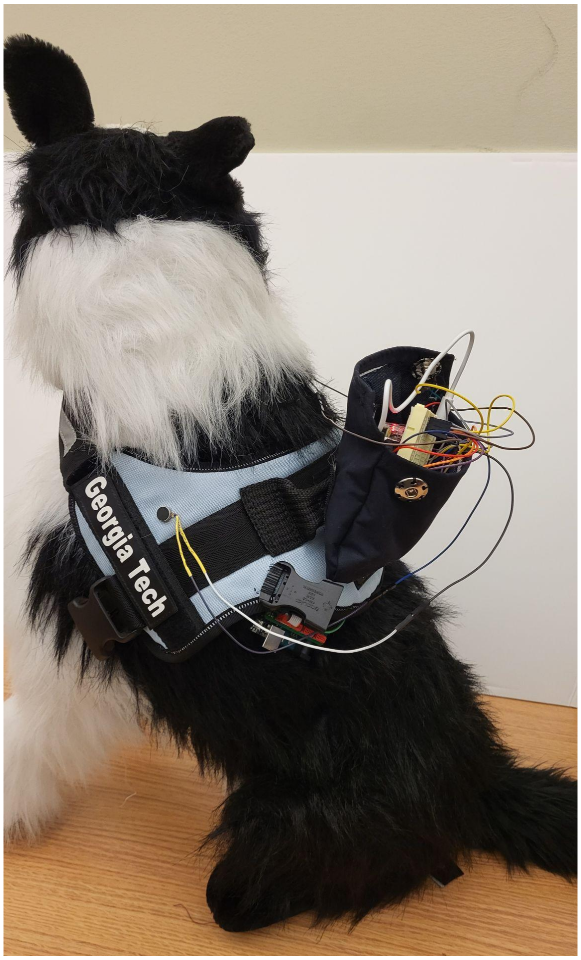
The prototype consists of a Raspberry Pi board, one ultrasonic sensor, a pair of vibrating motors, and a portable battery charger connected to the board. The ultrasonic sensor is attached to the front portion of the dog's collar. The jumper wires wrap around the collar and connect the ultrasonic sensor to the whole setup which is placed at the back portion of the dog in a secured pouch. The two vibrating motors branch towards the two sides of the dog. The Raspberry Pi is programmed to receive data dynamically from the ultrasonic sensor and vibrate the motors. The device is programmed such that the motors vibrate when the animal is within 0.3 to 0.7 meters of the obstacle. This range was chosen on the basis that 0.3 meters are close enough for an animal to halt and avoid colliding with a wall or obstacle. If the range was set at around 0.1 meters and the animal was strolling along the wall, there would be continuous vibration. As a result, 0.3 meters felt like a good fit because the animal is neither too close nor too far away from a wall or obstruction. This prototype's entire setup is fastened to a dog's vest.

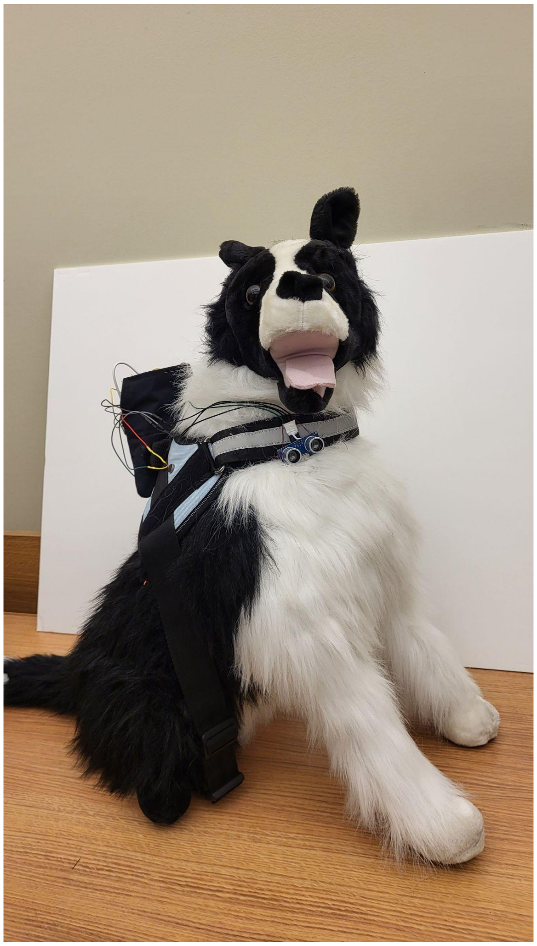


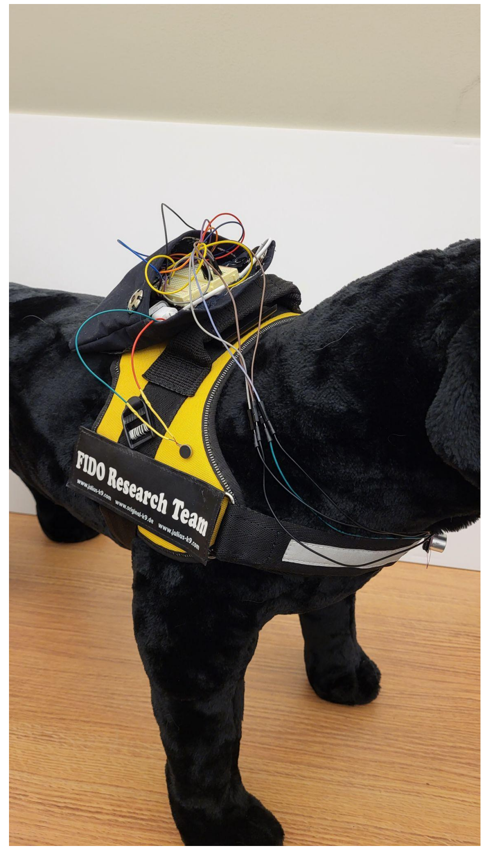
Hardware components used: Raspberry Pi 3B+, HC-SR04 Ultrasonic Module, Dog collar / Vest / Harness, Breadboard, 1.2K and 2.2K ohm resistor, Micro SD Card, Connecting Wires, Vibration Motor, Portable battery.

Pictures:





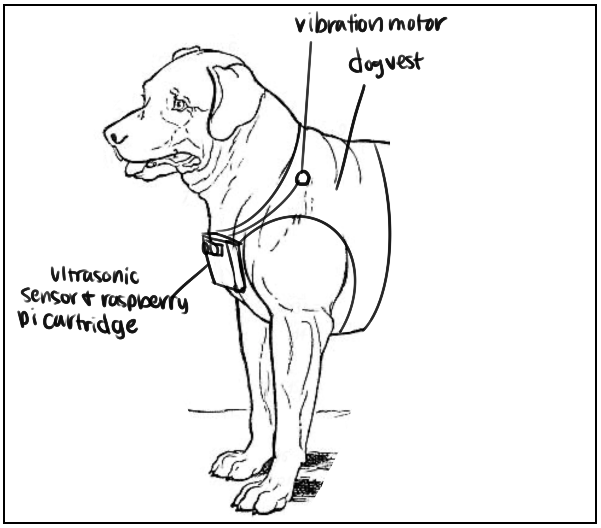




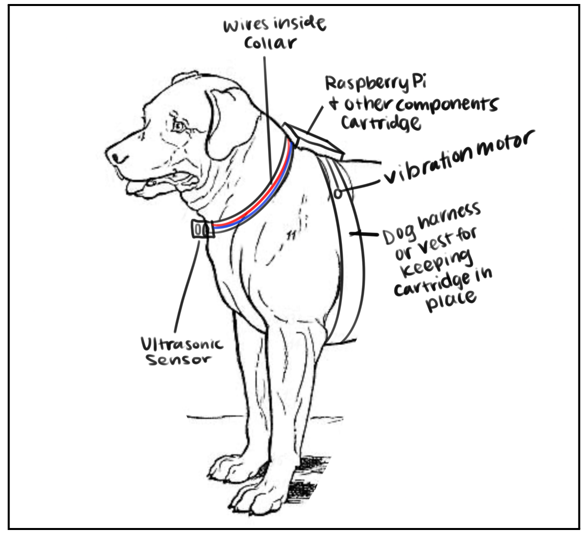
Videos:
https://gtvault-my.sharepoint.com/:f:/g/personal/salawandi6_gatech_edu/EqFOCtmaeN5JltKtQlUlrJYBbNsDn2fd4VLV3Yht7BPkXw?e=6CBGa7

Discussion and conclusion:

We started our project by researching the existing gadgets and solutions available that help in navigation for blind animals like dogs. We discovered a solution in the form of a plastic tube attached to the dog's vest that protrudes out and ahead of the dog's muzzle, preventing it from colliding with the obstruction. The problem we discovered was that it was readily deformed with repeated collisions, and the size of this set-up is not generalizable to all canines and must be custom-built. To address this, we devised an electronic system that employs the power of sensors to notify the animal and serve as an assistive technology system. We had some critical design decisions to make after setting up the appropriate hardware to suit this use case. We came up with two different hardware placement designs:



Design 1



Design 2

Based on the many lessons learned from testing it on the life-size dog structures, we chose to go with Design 2 for our final prototype. The block carrying the Raspberry Pi board and the associated breadboard is heavy and would not allow the dog to roam freely. Furthermore, every time the dog placed its nose close to the ground to sniff or relax, this block of hardware would touch the ground. The Design 2 configuration is likewise ideal for all sizes of dogs and has had no impact on the dog's daily activities.
We limited the length at which the ultrasonic sensor vibrates to 0.1 meters away from the obstacle during the first round of testing. As a result, even when the dog is safe and only moving along a wall, there will be constant vibrations. To avoid this, we programmed the Raspberry Pi to vibrate the motors only when the dog was within 0.3 to 0.7 meters of the obstacle. This gave the dog enough time to stop moving and avoid colliding with the obstacle. We could not test this system on the intended user - the dog as we did not receive permission to do so from IACUC yet.

In conclusion, we believe our final prototype can significantly aid navigation for blind dogs. This is based on the system's manual testing as well as a mock trial on a stuffed lif-size dog structure. Based on the simulations we ran with the stuffed dog structure, the device appears to be ready for its intended use case. We will be able to collect more data about the system's efficiency if we can test it on a real dog.

Reflection:

What we learned from this project:

We primarily learned about the problems that blind animals encounter with navigating known and unknown environments. We researched the products and devices

available in the market and decided to create a product that picks the best aspects from each product to aid animals. Our team was new to hardware projects and we learned to use Raspberry Pi boards, sensors, and motors. Understanding the hardware connections to satisfy our requirements was quite challenging. We learned about designing and prototyping wearable technology systems for animals involving the interfacing of sensors and motors with a microprocessor like Raspberry Pi. We gained hands-on experience in building a system that solves a use case.
From the trials we did with the stuffed dog in setting up the hardware on the vest and testing the hardware system, we learned that our system is crucially dependent on the portable battery and the jumper wires to be in exact places and hence, requires an enclosed pouch for its placement. The hardware also weighs enough for the dog to feel it and cannot be used to hang to a collar. We also realize that training a dog to understand the functionality of this device will require time. Ensuring that the battery is always charged is one of the cons of this setup.

What we would change if starting over:

If we had to start over, we would look for a blind dog from the beginning of the project. We focused first on learning the hardware and then on understanding the connections. We had planned to blindfold a dog to test our wearable device, but we made no effort to locate a blind dog. We would start by conducting ethnographic studies with the dog and shape our motivation and usability targets better. We also wished we had a bling dog to test our prototype during the final leg of the project work when we had finished working on all components and got the device running. Second, we were unsure how much of our proposed use case we would be able to meet, and while we were able to meet all of the proposed ideas from the proposal, we wished we could contact a veterinarian who has experience treating blind animals for additional input. We believe that these inputs would help to shape the design directions and make our product more generalizable to a wider range of animals and to all dogs in general.

Future work:

The current prototype can detect obstacles that are a few meters ahead of the dog, but this range is limited due to inaccuracy with larger distances. In the future, we hope to expand the distance using LIDAR sensors that can reach up to 12m. Of course, it is in the best interest to also limit this distance so that the dog is not getting vibration feedback from virtually everything around the dog. However, if the dog is running at full sprint, it would be ideal to find the obstacles while the dog is far away enough to be able to stop itself from crashing into an object. Additionally, we plan to train real dogs to use this device using positive reinforcement techniques. We would like to test what vibration frequency of the motors is suitable for what kind of dogs based on the fur thickness and sensitivity. Based on such data collected, we want to increase the efficiency of the system and user experience. As an extended plan for the project, we aim to develop a mobile application, that alerts the dog handler/human owner if the dog has hit obstacles many times in a short period of time or when we sense there is something unusual going on. This application can also send human-user reminders to charge the battery of the device. It would also be ideal to set the ultrasonic sensor's range through the mobile app. Each dog's snout size and physical body can change what the ideal range is for them, so having a customizable range may be beneficial.