Garmin Free Dive Tone Testing Device

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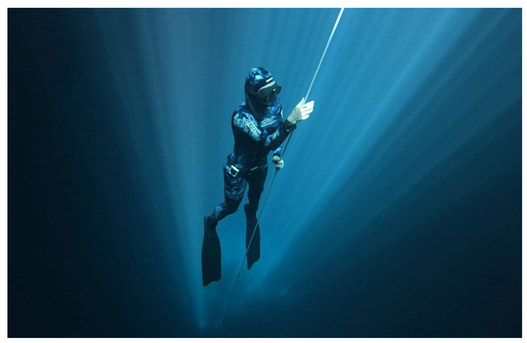
Motivation

- Freedivers swim hundreds of feet without any breathing aids
- Divers use watches to monitor physiological parameters
- Garmin wants to find the tones that are easiest to hear underwater
- Current testing system is inefficient



Our Project

Our team is tasked with designing a wrist-mountable device for Garmin that projects sounds generated in real time and enables divers to provide immediate feedback to engineers above the water to reduce overall testing time.

Final Design

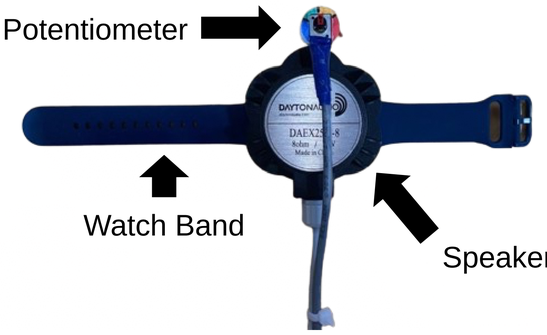


Fig. 1: Final Wrist-Mounted System

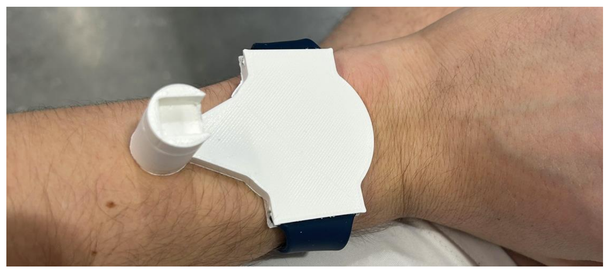


Fig. 2: Wrist-Mounted Housing Close-up

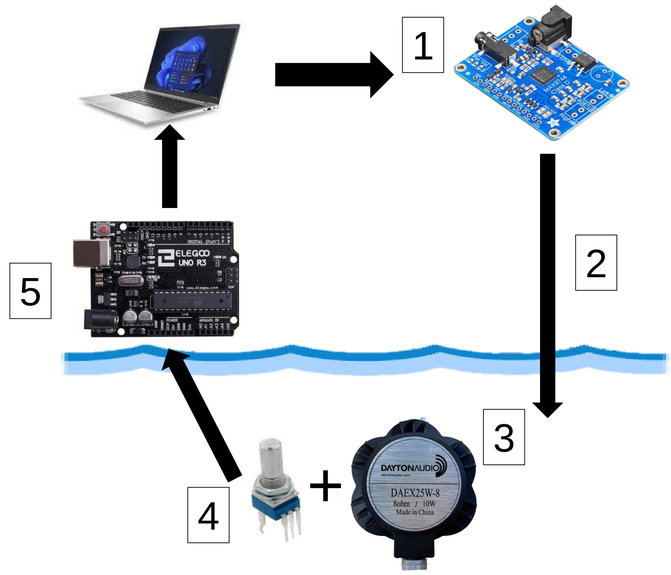


Fig. 3: Flowchart

1. Engineer sends tones from computer to an amplifier via Python script
2. Amplified tones go to the speaker underwater
3. Diver hears the tones and rates them 1-4 with potentiometer during dial tone
4. Potentiometer reading goes to Arduino
5. Python script converts potentiometer reading to feedback level and writes to output file

Programming

- Sound engineer inputs file path of .wav files
- Speaker plays sounds conducted through Python script
- Potentiometer reading translated into four levels of feedback
- Data is written to output text file for data analysis

Design Criteria and Testing

	Target	Testing Method	Results
Effective Feedback	Differentiates between feedback with accuracy ≥ 96%	While underwater, randomly generate a number 1-4 and turn potentiometer to corresponding value.	Pass: 100% accuracy over 30 trials
Sound Output	200Hz to 20kHz at around 70 dBSPL with variance of ≤ 3	Measure ambient level from speaker. Measure the sound output of the speaker at the same distance. Find the difference.	Fail: Speaker capped at 19kHz
Ease of Use	4 average on user-defined scale	Use a Likert scale (1-5) evaluating comfort, ability to move, and ease of mounting.	Pass: 4.33 average
Durability	Can withstand depths of 6 meters for up to 6 hours	Place product at a depth of 1 meter for 1 hour. Does the product still work?	Fail: potentiometer had a greater margin of error post-test
Portability	Circumferences ranging from 130mm to 250mm and weight ≤ 200g	Weigh the watch using a scale. Measure minimum and maximum circumference of the band in mm.	Fail: 158.75mm - 222.25mm in circumference; 128g
Transfer Speed	≤ 10 seconds to transfer information to and from laptop	Find the time between the diver sending the feedback and the engineer receiving the data and vice-versa.	Pass: 1.58 second transfer time

Conclusion

Current Design:

- Successfully plays a tone underwater
- Allows diver to quickly give "bad, good, better, best" feedback

Future Work:

- Exploring the use of alternative power (i.e., batteries)
- Testing at a 6-meter depth
- Adjust sizing to fit more comfortably and help portability
- Work with Garmin to upgrade the speaker / sound output

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