

Design Problem

Foster dog families need a **device to track** their dog's **activity levels**, since there is no **reliable** and **affordable** method currently available.

Motivation

- Dogs in shelters often require **attentive care** and are sent to foster families that can tend to their needs before they shift over to permanent homes.
- These dogs are frequently in rehabilitee programs. **Full rehabilitation** requires daily management of specific activity and movement levels.
- There is no solution currently available that meets our client's maximum price point of **\$50.00** with no **monthly subscription fee**.

Kalman Filter

We used a Kalman Filter to provide a more accurate and reliable estimate of the dog's distance traveled. The filter achieves this through combining GPS and accelerometer data (*Fig. 1*) and assigning a specific weight to each input based on its predetermined uncertainties. Uncertainty of the GPS data is obtained from published manufacturer technical specifications. Accelerometer data uncertainty is negligible.

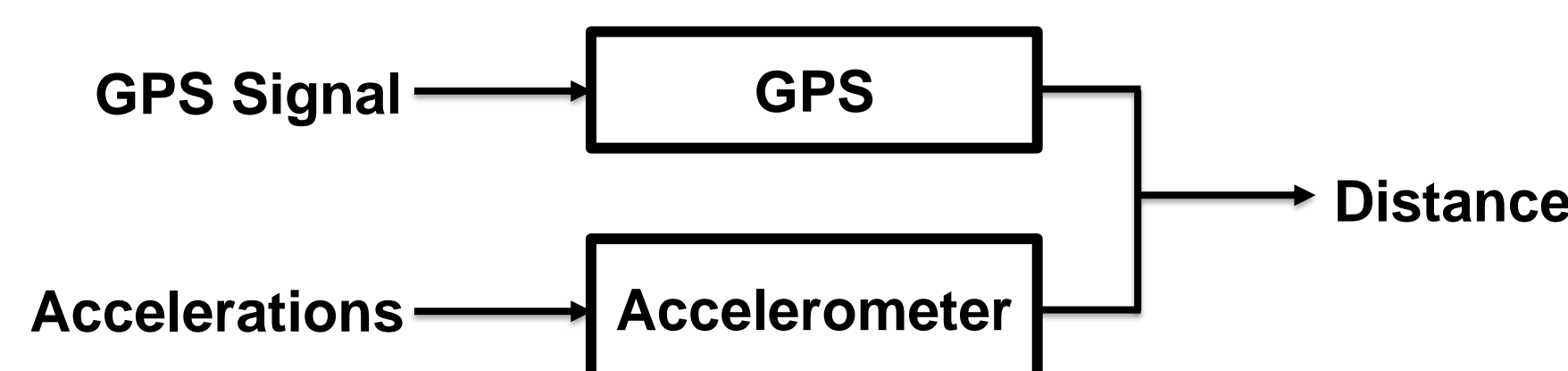


Figure 1 – Kalman Filter

Hardware

The ground station receives a radio signal sent through and received by a HC12 transceiver (*Fig. 2 - 1*) and (*Fig. 4 - 3*). This signal is processed by an ESP32 (*Fig. 2 - 2*) microcontroller. Through its integrated Wi-Fi capabilities, the ESP32 uploads the data to a Firebase database.

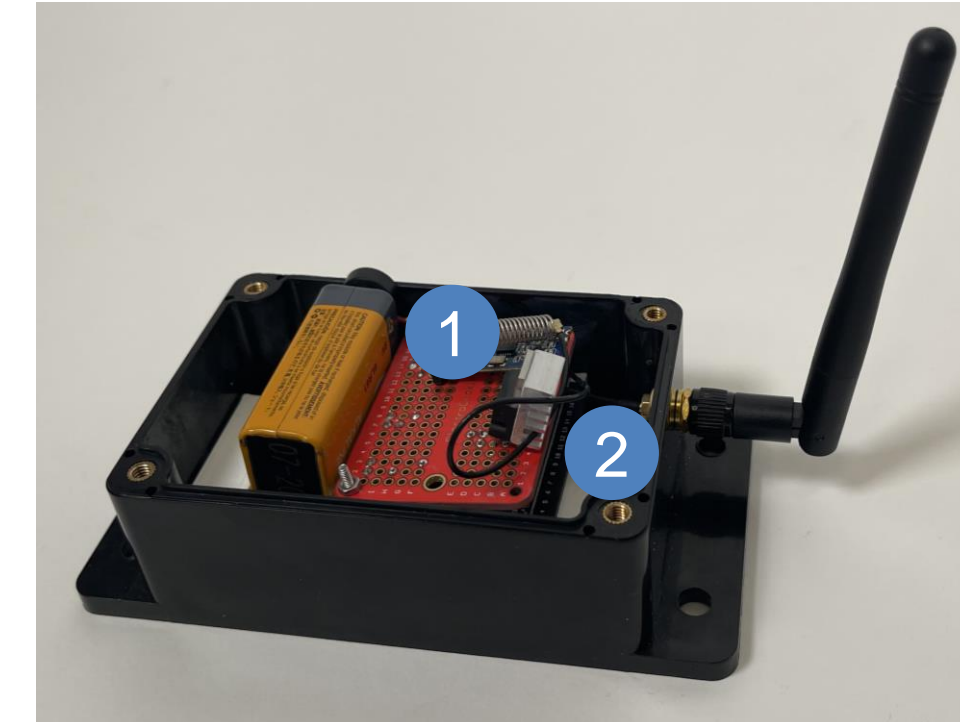


Figure 2 – Ground Station

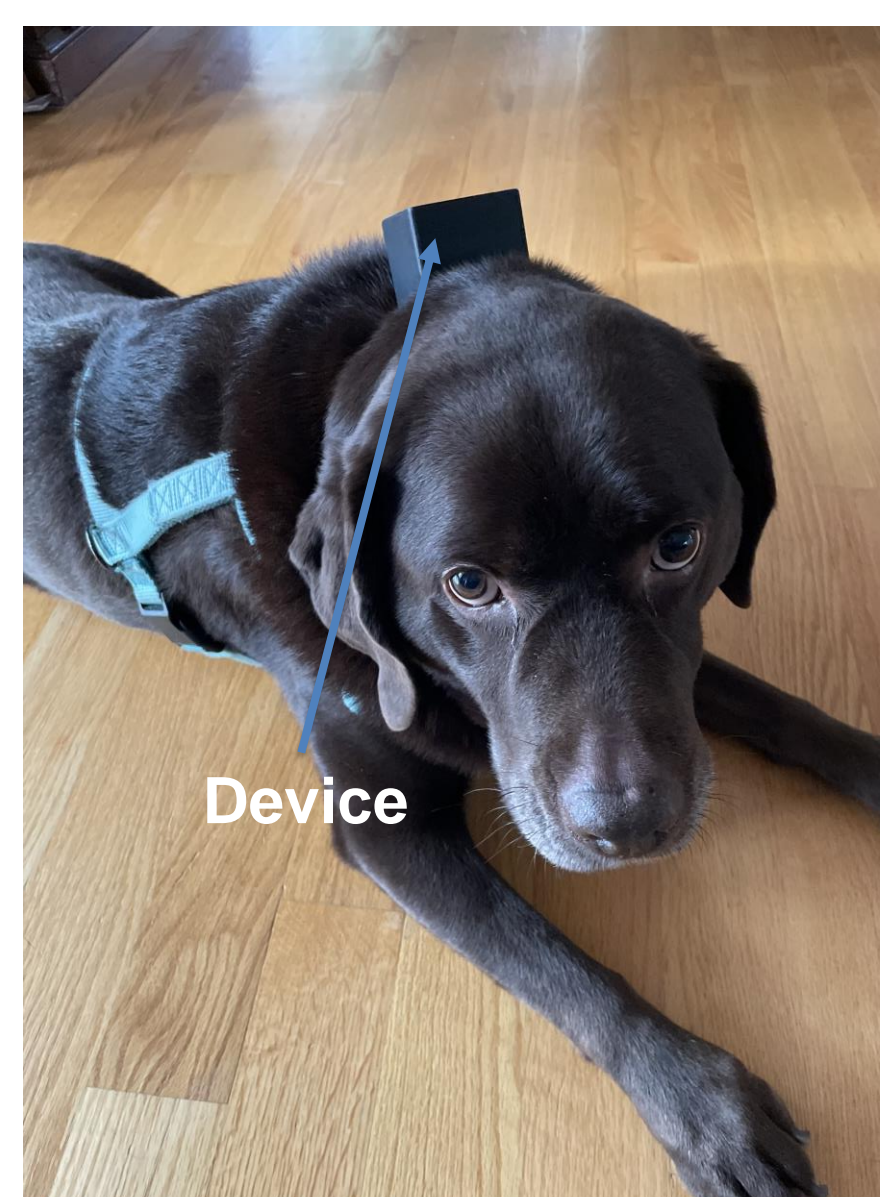


Figure 3 - Device Installed on Collar

The device integrates GPS (*Fig. 4 - 1*) for precise dog position tracking and distance calculation, while the accelerometer (*Fig. 4 - 2*) conserves battery life and estimates activity when a GPS signal is unavailable. Water resistance is achieved through indents and a rubber seal in the casing (*Fig. 5 - 4*). The yellow strap aids battery removal (*Fig. 6 - 5*).

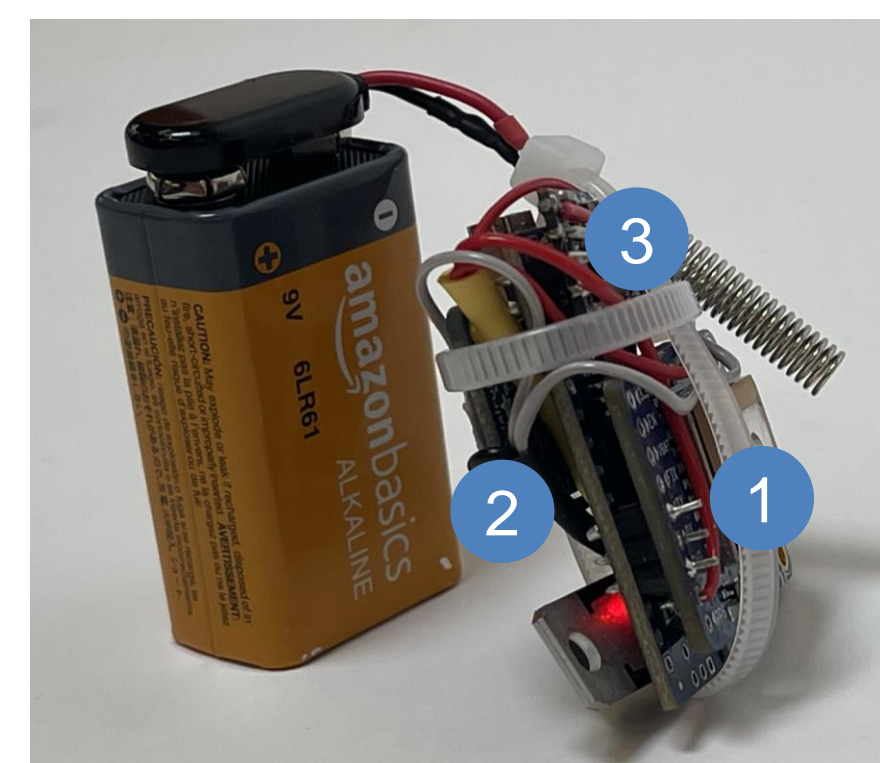


Figure 4 – Internal Electronics



Figs. 5 & 6 – Casing, waterproofing, electronics



Software

Data from the GPS and accelerometer is processed through a Kalman Filter which determines the dog's distance traveled (*Fig. 7*). The data processed by the filter is sent to a cloud-hosted Firebase Realtime Database. The dog's distance is available to the user via a Web Application (*Fig. 8*). Users can adjust their dogs' target activity levels and reference the past two days' statistics.

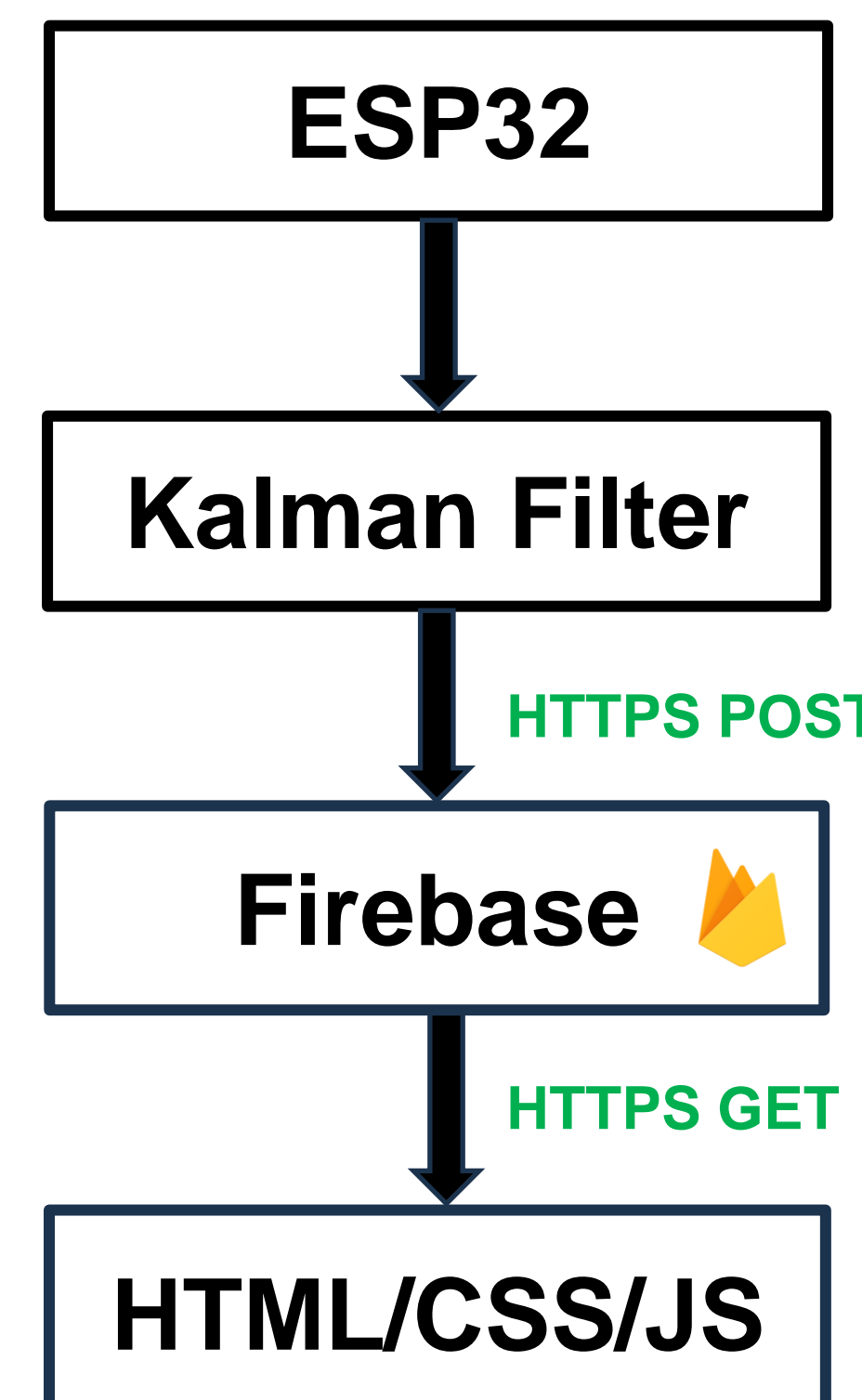


Figure 7 – Hardware to Software

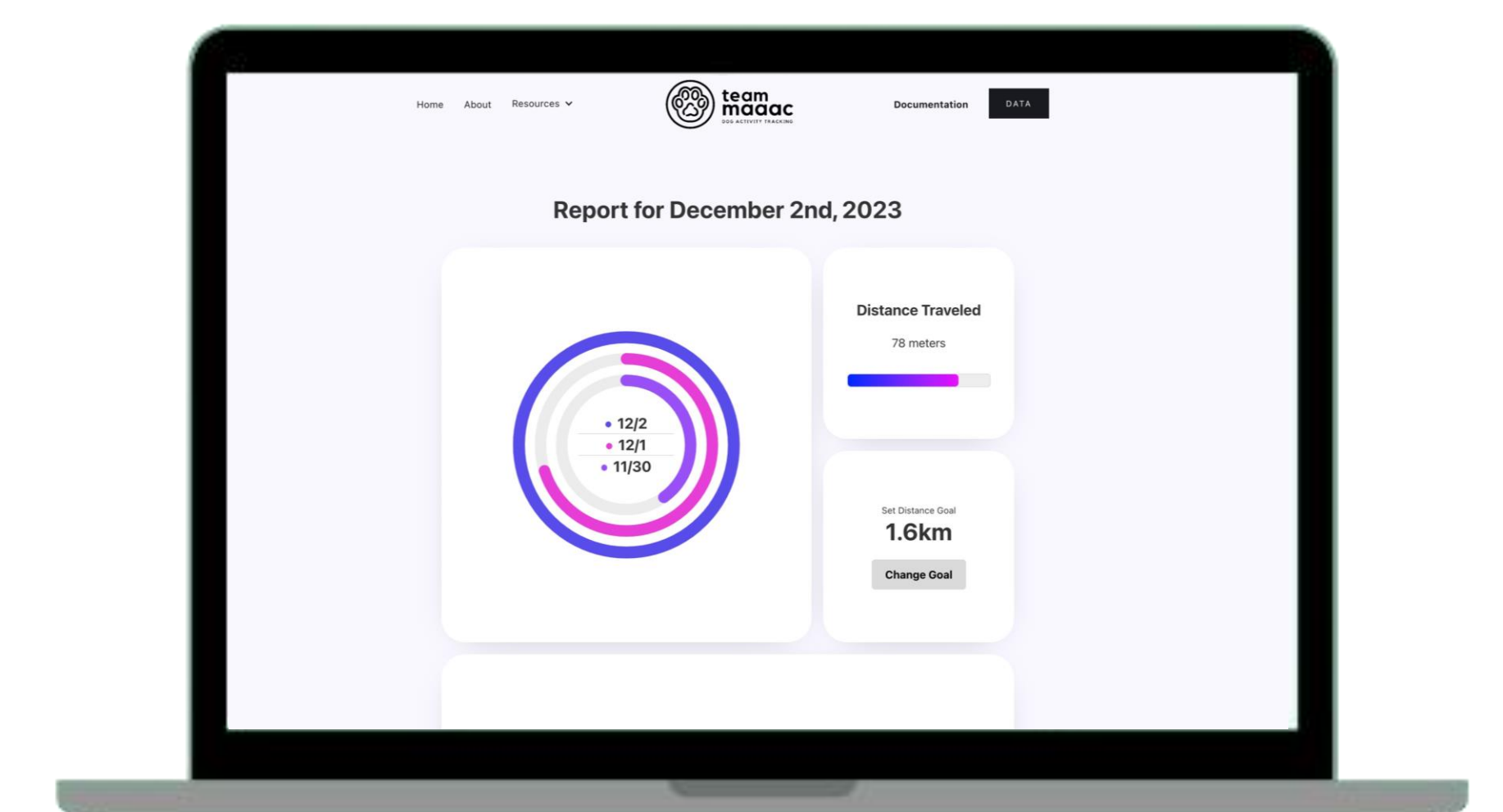


Figure 8 – Web UI

Conclusion

We designed a device that tracks the distance traveled by a dog in **real time**, which enables foster families to **monitor and subsequently adjust** their dogs' activity levels. The device has **passed** design criteria tests in **cost, durability, accuracy, weight, and safety**. Battery life and User-Friendly UI are yet to be tested. We acknowledge that improvements need to be made:

- Minimize the device size to increase comfort.
- Substitute to a rechargeable battery.
- Distribute the device to a group of foster families for further testing.

Acknowledgements

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Design Criteria and Testing

Objectives	Target	Test	Results
Cost	Price point of less than \$50; no monthly charging fee	Adding up price for individual parts	Pass Cost \$42.72
Durable	Device is water/impact resistant	Submerge device 15 cm; drop device 3 m	Pass
Accuracy	< 10% error in distance tracking	Person walks along a 20 m line with the device	Pass +8.7% error
Weight	Weight < 400 g	Weigh device	Pass 123 g
Battery Life	≥ 3 days per battery	Measure battery's life span	TBD
User-Friendly User-Interface	Present data representing dog activity in user-friendly UI	Ask 10 people to fill in a form and rate user friendliness from 1 to 4	TBD
Safety	No sharp edges	Check that all edges are rounded	Pass