SEARCH: Smart Electronic Assistance and Retrieval Companion for Home

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PROBLEM STATEMENT

Dementia, ADHD, and various other cognitive impairments often cause **forgetfulness** in the elderly population, especially in **short-term memory function** and further cause a greater number of **misplaced items**.

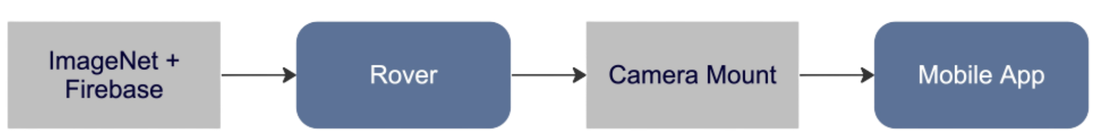
ENGINEERING GOAL

The goal of our project is to develop a system or device that can **address the problem of misplaced items** in the elderly population and consequently increase independence in their day-to-day lives.

REQUIREMENTS

#	Level	Requirement Type	Requirement Statement	*Prototype #1 (Low Camera Mount)*	*Prototype #2 (Higher Camera Mount)*	***Prototype #3 (Final)***
1	1	Functional	The device shall identify the locations of items within an area with at least 50% accuracy.	No	Yes	Yes
2	1	Functional	The device shall reduce the frequency of searching for lost items by at least 50%.	No	No	Yes
3	1	Functional	The device shall respond to client requests for misplaced items within 10 seconds.	Yes	Yes	Yes
4	1	Safety	The device shall not cause injury to the client(s).	Yes	Yes	Yes

METHODS



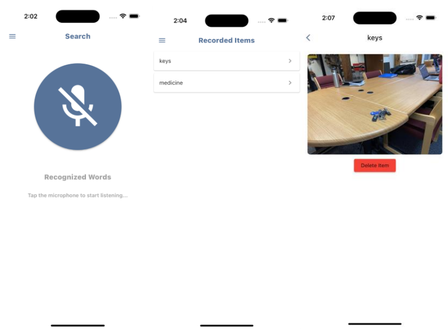


Figure 1: Mobile application screenshots. *Note. Mobile designs for speech recognition and interaction with Firebase.*

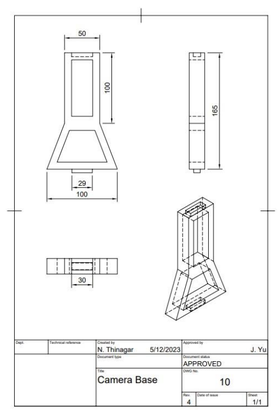
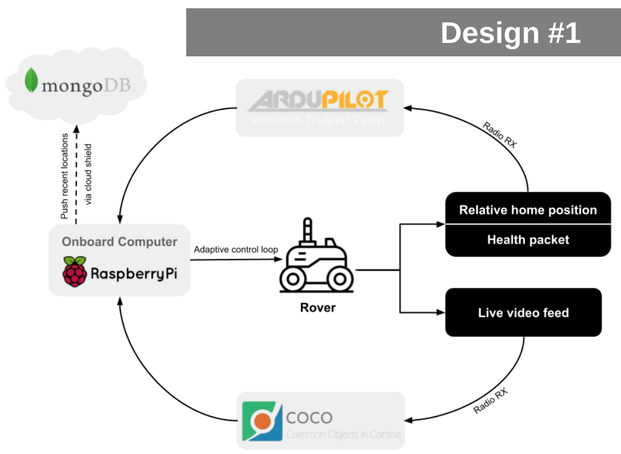


Figure 2: 3D printed camera mount design. *Note. Allows the rover camera to reach a height of greater than one meter.*

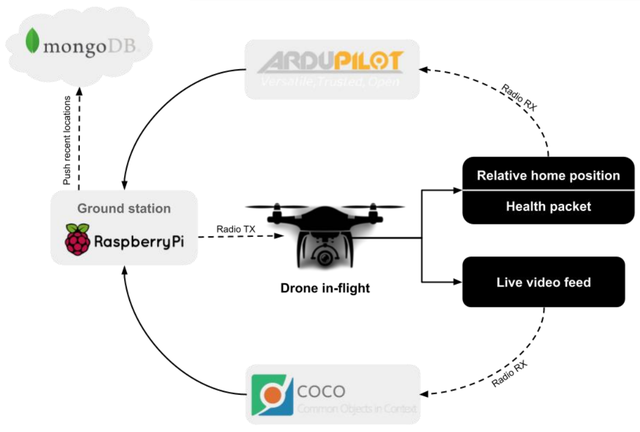
PROJECT DESIGNS

Design #1



- **Raspberry Pi-based rover** with ArduPilot autopilot system for navigating a home environment
- **COCO object detection classes** (50 classes of common objects) for computer vision
- **MongoDB** cloud storage system.

Design #2



- **Pascal VOC object detection** classes for detecting misplaced items
- **ROS2** robotic operating system rather than ArduPilot for more dynamic robotic control

Design #3

- **Drone-based device** with onboard cameras and advanced image recognition algorithms
- Same algorithms as Design #2
- **MySQL** database for cloud functionalities

Design #4

- **CDR Design (Current Design)**
- Uses multiple technologies from Design #1 and Design #2
- Plan to utilize several novel navigation algorithms in conjunction with our real-time object detection and obstacle avoidance methods

DESIGN STUDIES

Figure 3: Diagram of design study #1. *Note. The water bottle is being detected.*

Study #1: ImageNet – We tested the efficacy of our object recognition model based on ImageNet with over 1000 object options. The water bottle had a confidence of 57.68% in a close, clear range.

Study #2: Mobile App – We tested the mobile app and measured the response times of various functions.

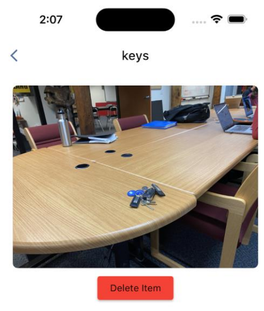


Figure 4: Diagram from design study #2.

Table 1: Response time in different mobile application functionalities.

Test	Result	Response Time (in seconds)
Speech recognition	Functional	3.0 < t < 4.0
Item query	Functional	0.0 < t < 1.0
Item log menu	Functional	0.0 < t < 1.0
Image output	Functional	2.0 < t < 3.0
Delete items	Functional	0.0 < t < 1.0

Study #3: Rover Stability – We tested the rover's ability to withstand forces from various directions and its stability at various moving speeds.

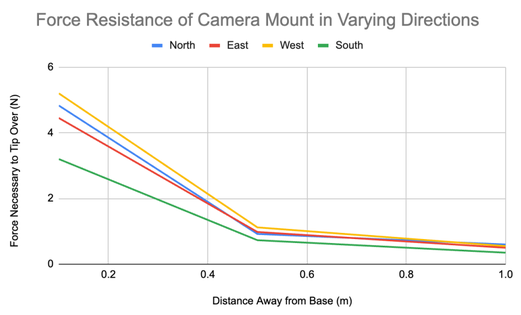


Figure 5: Experiment image of design study #3.

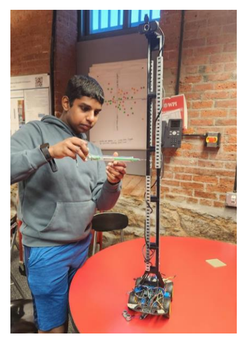


Figure 6: Experiment image of design study #3.

CONCLUSION

- Creation of rover-software system that can communicate to find commonly misplaced objects
- Integration with ImageNet image classification to enable the rover to identify 1000+ objects
- Easily-accessible, fast mobile application with voice control
- Robust low-cost prototype hardware with easily interchangeable parts

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github.com/Joe-and-Sons-Inc