Team A5: FollowMe: Object Recognition in Blind Aid

Oct 01, 2023

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Use Case/Application

Use case: Object recognition system that detects obstacles and navigates routes for blind people. Blind will use cane in addition to it. Convenient.

Scope: Flat indoor settings without dangerous obstacles such as racing cars/scooters dashing at the blind.

Requirements:

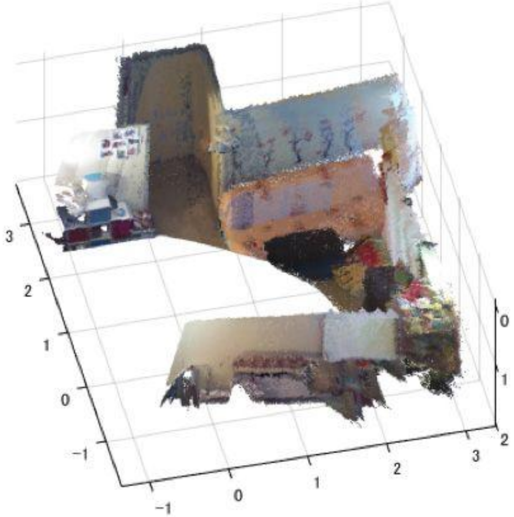
- Moving Obstacles - **5m** - **90-100%** Accuracy
- Static Obstacles - **3m** - **90-100%** Accuracy
- Latency: **500ms**
- Weight: **5lb**
- Battery life: >**1** hour with low battery warning

Design Requirements for Recognition

Sensors: Detection range: 5+(1+0.5)*3≈ **10m**.

Camera: **> 0.8 million pixels; > 10fps**

    a. DL model input channel: >16*16 pixels



Lidar: Depth Accuracy ~ **20 cm;**. > **10 fps**

Processor:

1. Paper: Pascal Titan X-> real-time latency
2. SLAM model: ~ **20 Terra FLOPS**

Use-case Goal: > 90% Accuracy + 500ms Latency

 https://arxiv.org/abs/1808.10654

Design Requirements for Peripherals

Battery: **4000 mAh** power bank

Speaker: <**0.5 lb**; <**$20;** <**1W**; loud: >**60db**

Stand: weight < **2lb**; material

Use-case Goal: Light weight <5lb; power last 1 hour

Solution Approach

Design:

The blind people will carry a frontpack with the stand holding a camera, a lidar, and a speaker. They are connected to computing module. The power bank powers the system.

Recall use case: Recognition system is an auxiliary device to the blind. Blind still uses walking canes. It can ensure the safety and comfort of walking.

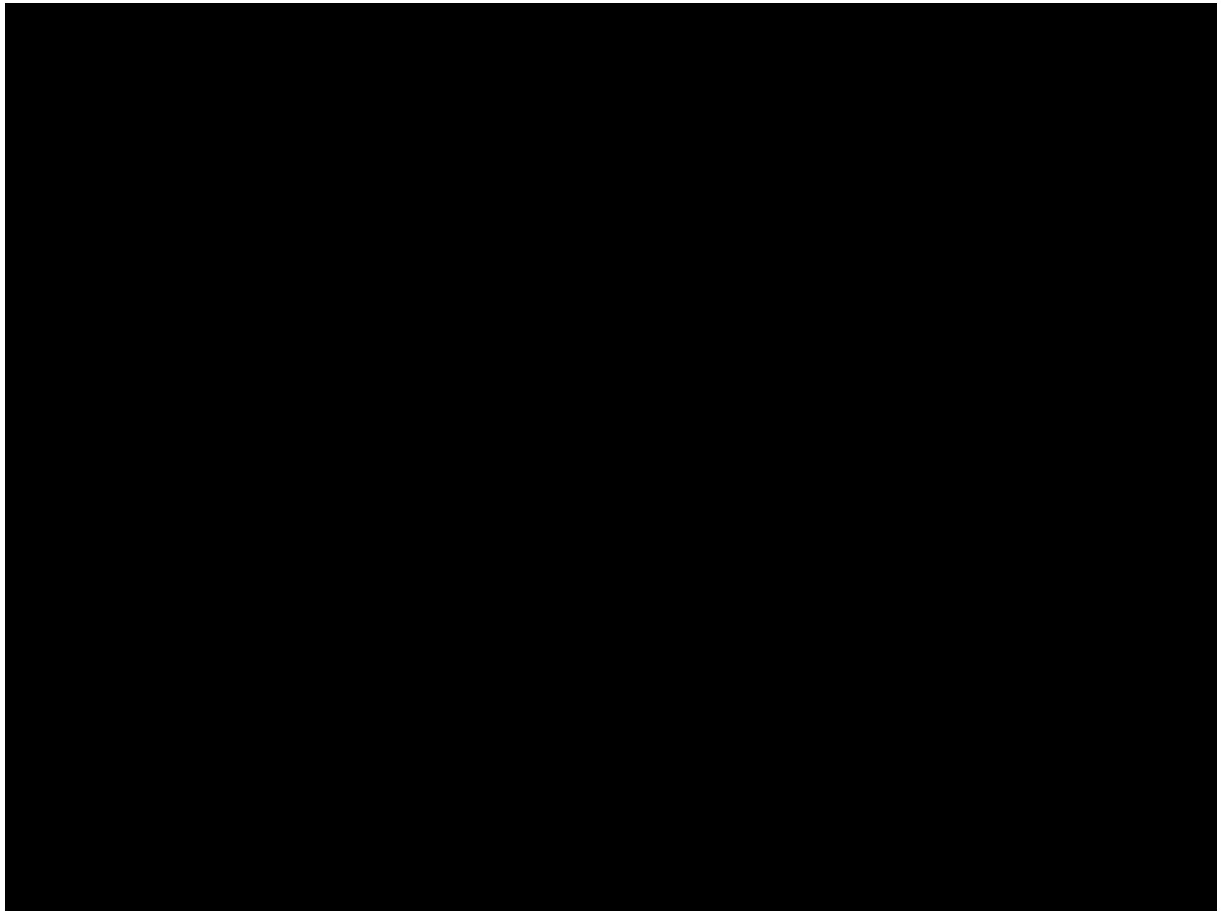
Consideration: Public welfare for blind people.

Solution Approach

Sensors collect data, processor uses SLAM (Simultaneous Localization And Mapping) to create a labelled map.

-> If sees obstacle, speaker: “x Meters ahead, Moving/Stationary Obstacle, Stop/Avoid”.

-> In navigation, speaker: “Keep Straight/Turn left/right after x seconds/Intersection xxx seconds ahead”

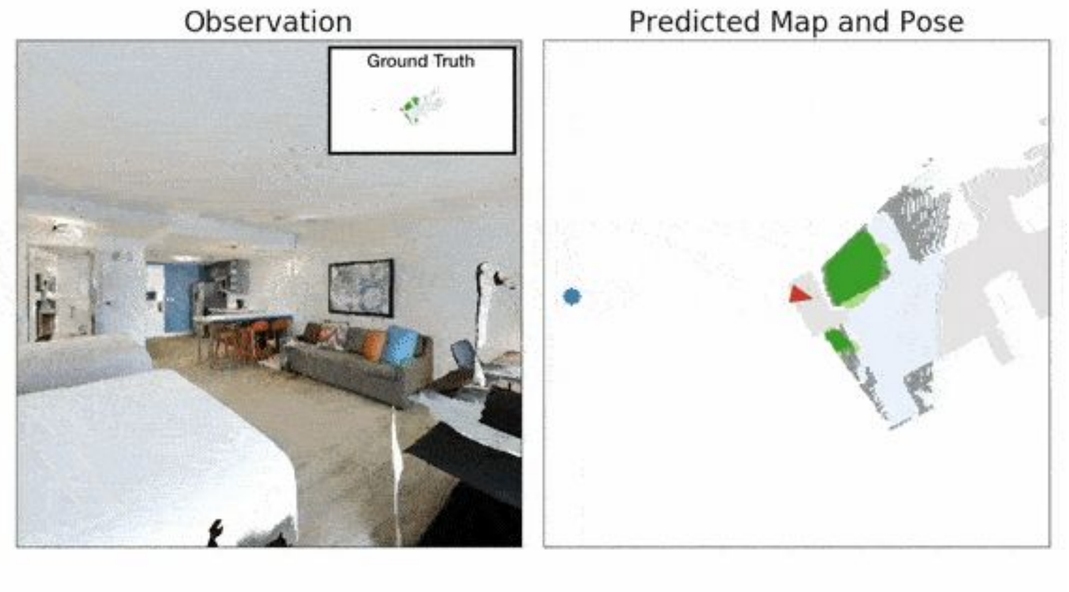


Solution Evolvement & Highlights

Why & How SLAM?

- Why? Reconstruct a labelled 3D map for navigation (roadmap), not just obstacle detection + Higher Accuracy
- How? Data stream -> Goggle of Gibson Environment -> SLAM -> labelled map

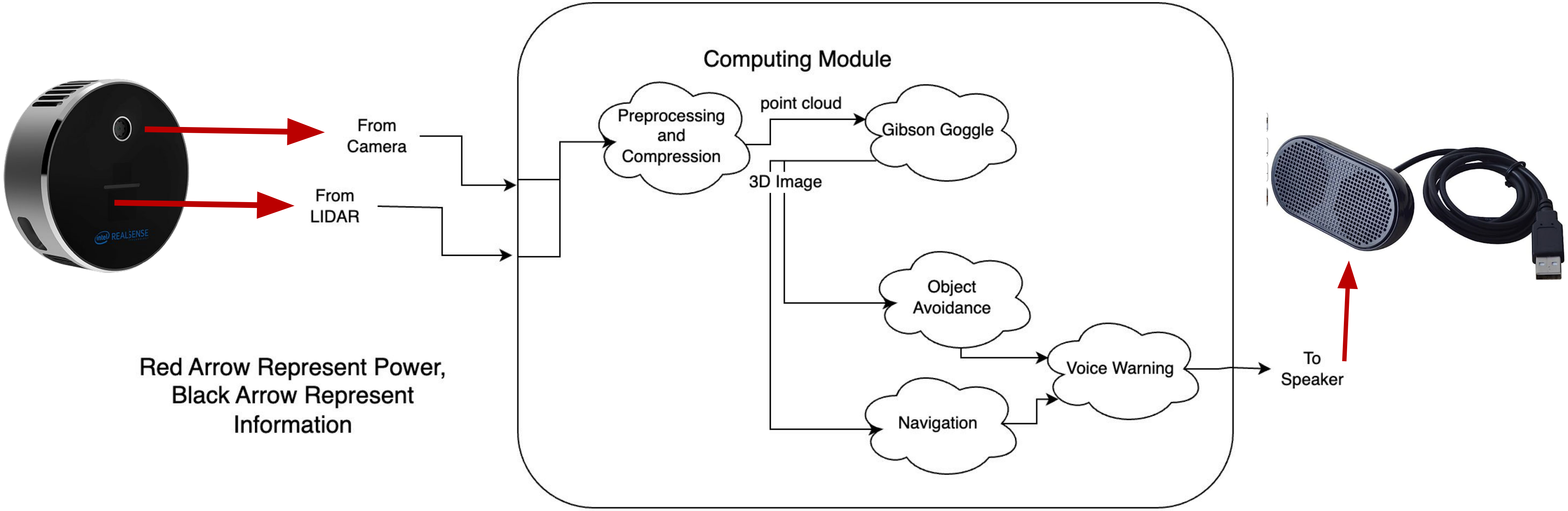
- http://gibsonenv.stanford.edu/method/#goggles
- https://github.com/devendrachaplot/Neural-SLAM



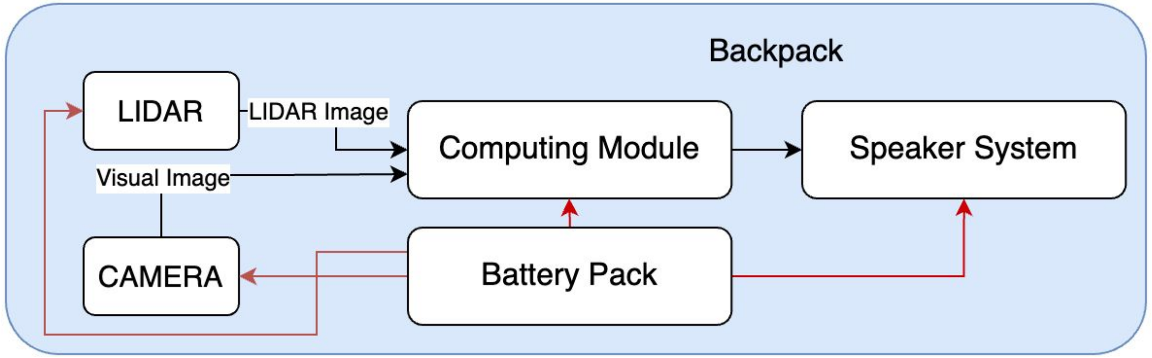
Latency Issue -> Compress 2 times

Backup plan: YOLO for obstacle recognition + roadmap recognition

Software



Hardware

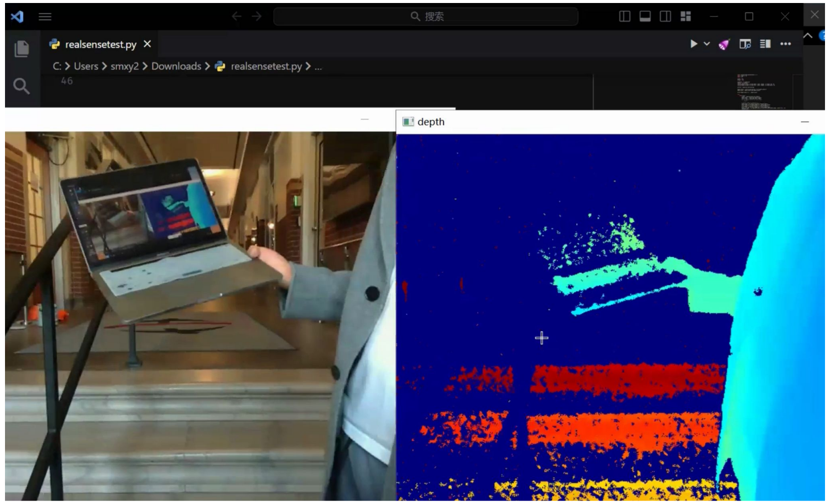


Implementation Plan

Rent: Lidar, Camera, NVIDIA Jetson

Buy: Speaker, Battery, Stand

Assembly: Nvidia Xavier nx with speaker, with battery, mount on stand.

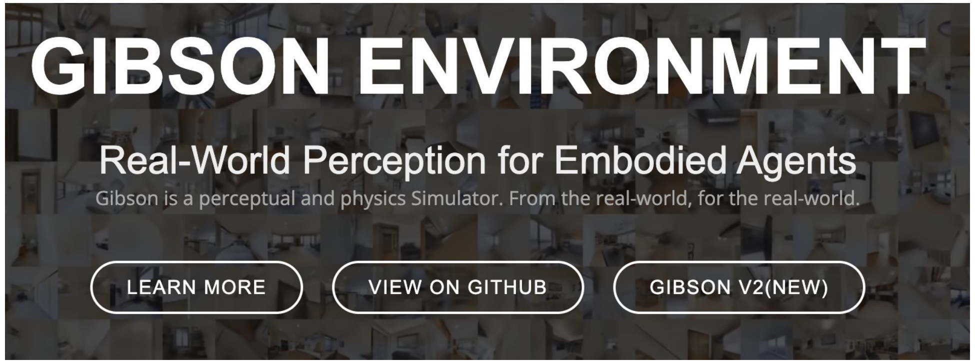


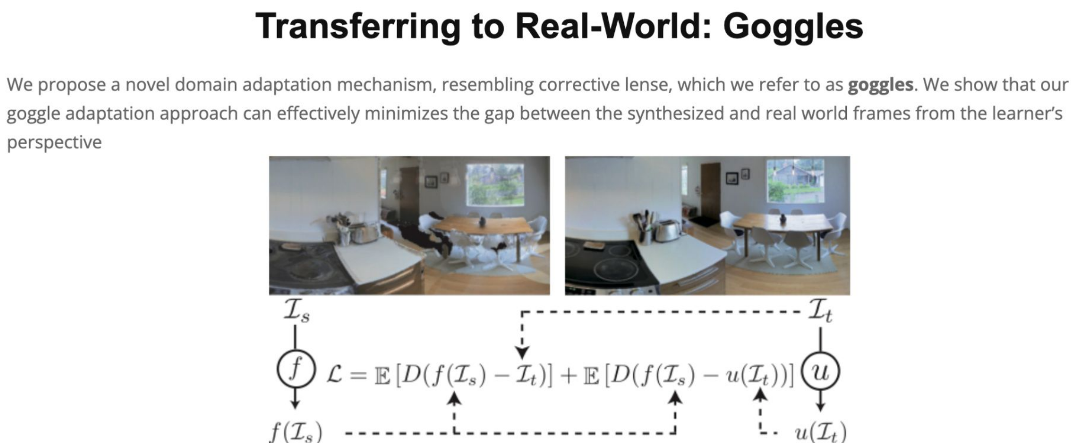
Implementation Plan

Design:

- Algorithm for giving instruction based on 3D SLAM map/YOLO
- Collect own data. Train the model. Modify CV model
- Control code for sensor pipeline

Import: Gibson environment and SLAM model





Testing and Verification Metrics

Test for Distance + Test for Accuracy - Control group

- Moving Obstacles: 5m + >90% Accuracy
- Static Obstacles: 3m + >90% Accuracy

Passing metric:

- Latency: 500ms
- Weight: < 5lb
- Power life: > 1 hour

Risk Mitigation: Replace SLAM w/ YOLO

MileStones / Plans / Job Split

- Holiday impacted weeks
- Start and End within the week
- May take less than 1 week start from middle of the week
- May take > 1 week butwill try to cut down
- Reserved Time for work catchup during holidays
- Milestone Checking Week

Assignee	Task Name	Sep 17 - Sep 24	Oct 2 - Oct 8	Oct 9 - Oct 15	Oct 16 - Oct 22	Oct 23 - Oct 29	Oct 30 - Nov 4	Nov 5 - Nov 11	Nov 12 - Nov 18	Nov 19 -
Jeffery	[Hardware - PreMVP] Implement or Incorporate Lidar SLAM API		Implement based on existing API		Work Finalization					
Jeffery, George	[Hardware - PreMVP] Test and verify distance measuring			MVP Testing	Work Finalization					
Jeffery, George	[Hardware - PreMVP] Test on Speaker			MVP Testing	Work Finalization					
Ging	[Software - PreMVP] Finalize on limitations and requirements		Upon receiving equipment, test camera with model to check alternatives							
Ging	[Software - PreMVP] Implement or Incorporate Visual SLAM API		Implement based on existing API		Work Finalization					
Ging, George	[Software - PreMVP] Test and Verify object recognition correct rate			MVP Testing	Work Finalization					
George	[Software - PreMVP] Analyze respond from both end and Send final decision to speak		Implement Decision-making System		Work Finalization					
						Oct 23 - Oct 29	Oct 30 - Nov 4	Nov 5 - Nov 11	Nov 12 - Nov 18	Nov 19 -
										Thanksgi
All	[Design] Modify Plans and Goals based on Feedback from MVP									
Jeffery	[Hardware - PostMVP] Speaker Mounting On Frontpack									Work Fin
Jeffery	[Hardware - PostMVP] Camera/Lidar Mounting On Frontpack									Work Fin
Ging	[Software - PostMVP] Adjust CV model to handle more dynamic situation									Work Fin
George	[Software - PostMVP] Implement Emergency Protocol									Work Fin
George	[Software - PostMVP] Algorithm Instruction Optimization									Work Fin
Ging, George	[Software - PostMVP] (Extra) Webapp Implementation									
All	[Design] Final Demo Prep									
All	[Design] Website Updates									
All	[Design] Slack Updates									
All	[Design] Team meetings with Professors and TAs									