# Indoor Assistive Navigation System

*Implementing self-guiding system on robot*

ATR Fall 2018 - Daeun Yim, Shulin Li, Yaqin Wang

# Agenda

- Introduction
- Literature Reviews
- Approach
- Plan
- Equipment List
- Q&A

# Introduction
## Topic

The goal of this project is to design an indoor navigation system on a vacuum robot to guide the user back to their designated destination. The system will use algorithm to calculate the best route from the location of the user to their destination. Multiple sensors will be used to guide robot.

# Introduction
## Motivation

A recent visit in Houston at Brookdale Senior Living

# Introduction
## Objective

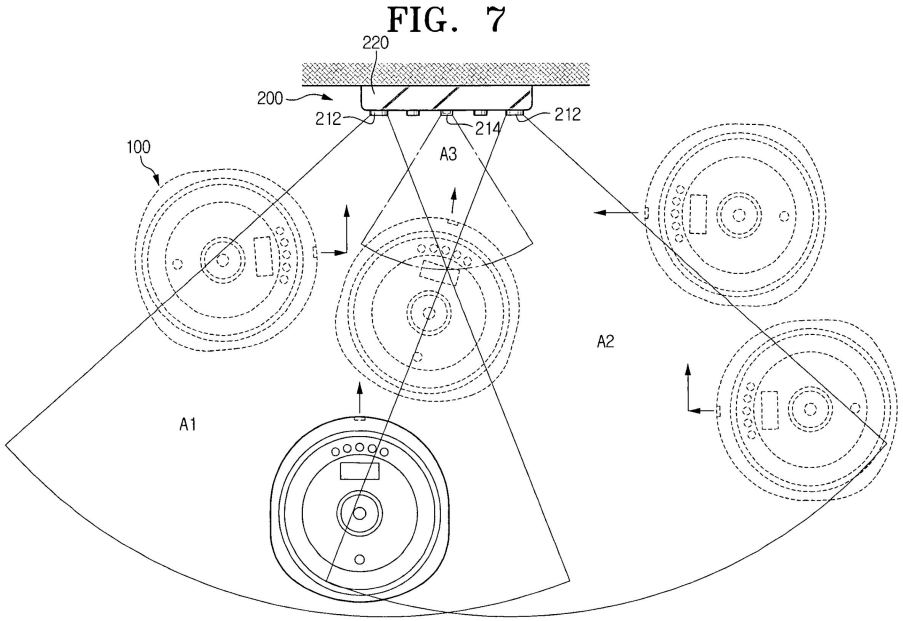
Senior population with Dementia, Alzheimer's, and other disabilities

# How does Vacuum Robot Direct?

- Front Collision Sensors
  - Triggered by the bumper
- Infrared Sensors
  - At sides
    - Emitter - Launch the infrared beam light with an angel with a diode
    - Receiver - Receive the light bouncing off walls
  - At underneath
    - Detect stairs
  - At front
    - Look for the infrared signal emitted by the charger
    - Once found, Roomba follows the signal and docks to the home base

# Literature Reviews

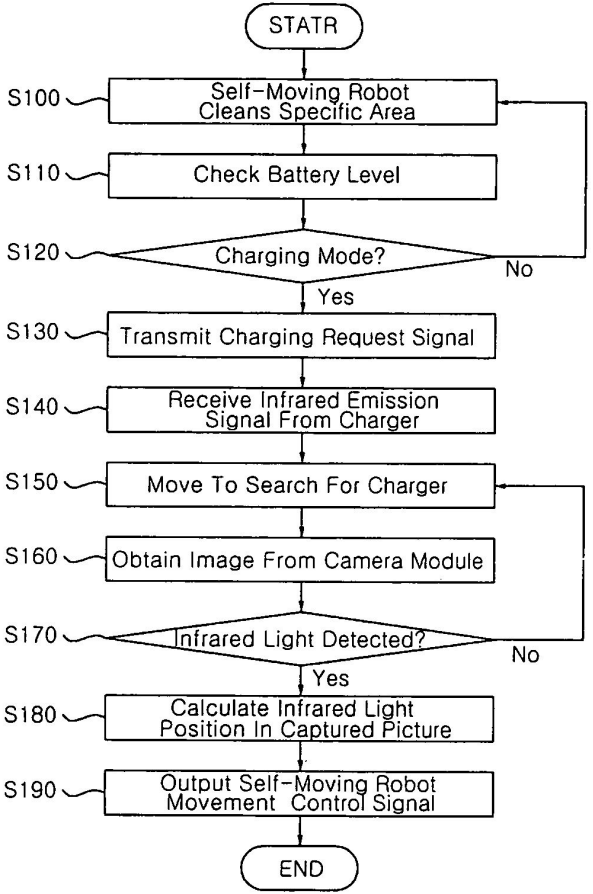
- **Robot Cleaner System and a Method for Returning to External Recharging Apparatus**
  - Three infrared transmitters set up on the charger
  - Each transmitter emits different signals in strength, code and wave



# Literature Reviews

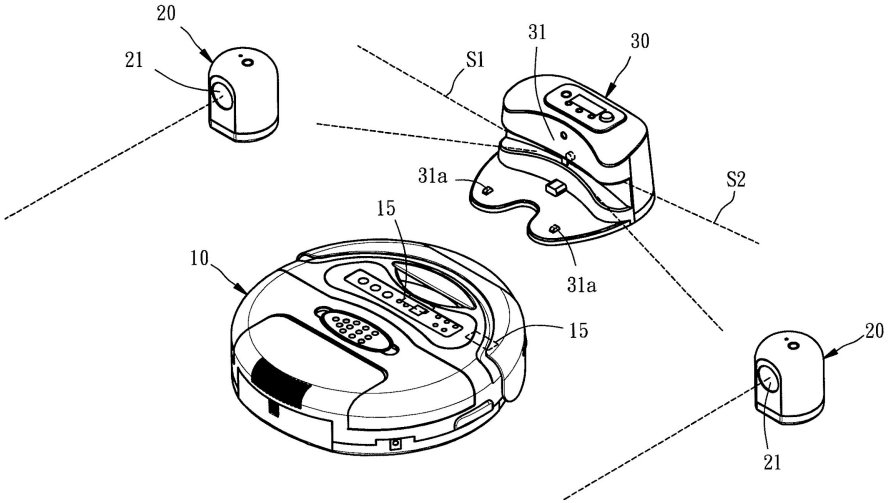
- **System and Method for Automatically Returning Self-moving Robot to Charger**
  - Infrared light transceivers
  - Image processor & camera module responding the infrared signals
  - Position calcular determines the charger location based on the infrared info in the pictures
- Concern
  - Algorithm for searching the light?

FIG.2



# Literature Reviews

- **Battery Charger for Mobile Robotic Vacuum Cleaner**
  - Infrared signal might be obstructed due to the abnormal receiving angel and shielding object
  - Use ultrasound wave instead
  - 3 receivers on the cleaner, but 1 works as well
  - 2 virtual wall generator has transmitters providing range of movement



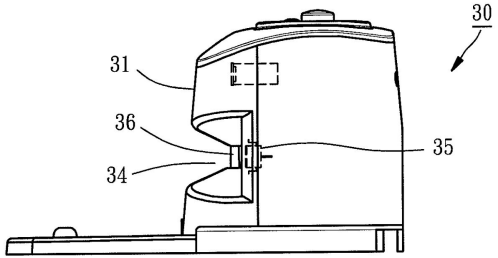




FIG. 5

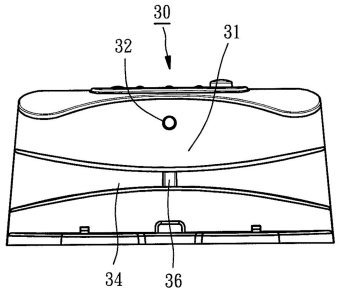



FIG. 4

# Literature Reviews

- A Topological Area Coverage Algorithm for Indoor Vacuuming Robot
  - The natural landmarks are added as nodes in a partial map as they are discovered.
  - Use of simulation to test the result.

- Towards Implementing Efficient Autonomous Vacuum Cleaning Systems
  - The research investigates the factors that affect the reliability of the existing vacuum cleaning systems.
  - They implement an integrated vacuum cleaning system with a fuzzy inference system which enhances the system performance and accuracy.

# Literature Reviews

- RFID in Robot-Assisted Indoor Navigation for the Visually Impaired
  - Use RFID sensor but provide conditions that indoor navigations should meet
  - Explains how robot change direction based on sensor signal

- Sensor-based Navigation of a Mobile Robot in an Indoor Environment
  - Reactive navigation algorithm according to sensor data
  - Obstacle avoidance with sensing

# Approach

## Technologies

1. Infrared transmitters
2. Roomba / irobot
3. Floor plan

## Assumption

1. Initial experiment: calling the robot to see if it comes back to prove if the theory works in the first place
2. Guiding robot speeds and floor does not matter in the ideal situation
3. Figure out the best route to guide users back, with a simple floor demo (next slides)

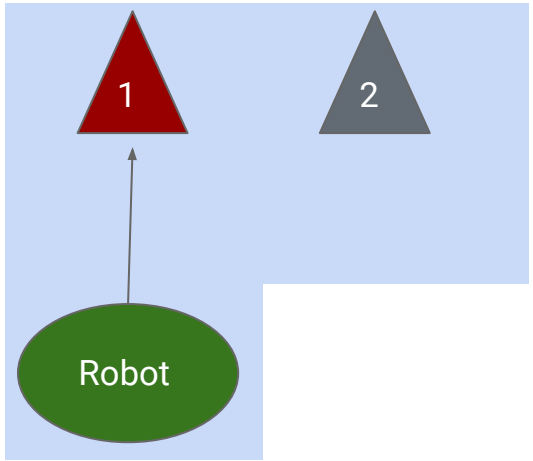
# Plan

- Implementation Stages
- Schedule

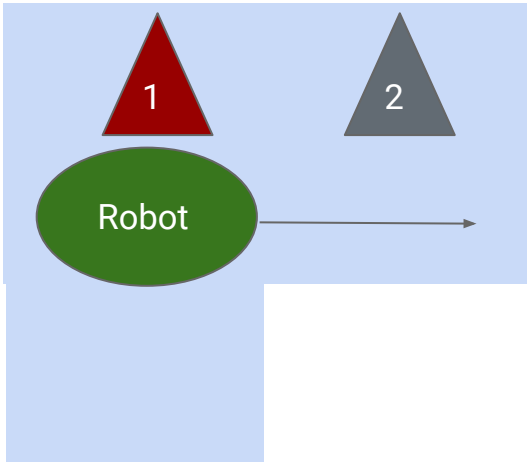
# Plan
## Stages

Stage 1. Transmitter Control Experiment

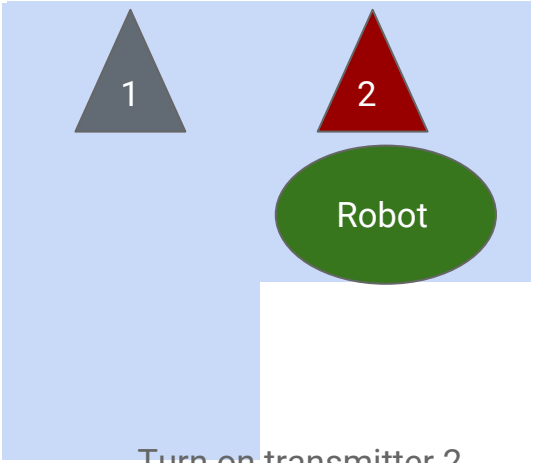
- Experiment if switching transmitter can actually manipulate robot's movement




Turn on transmitter 1




Roomba directs to transmitter 1

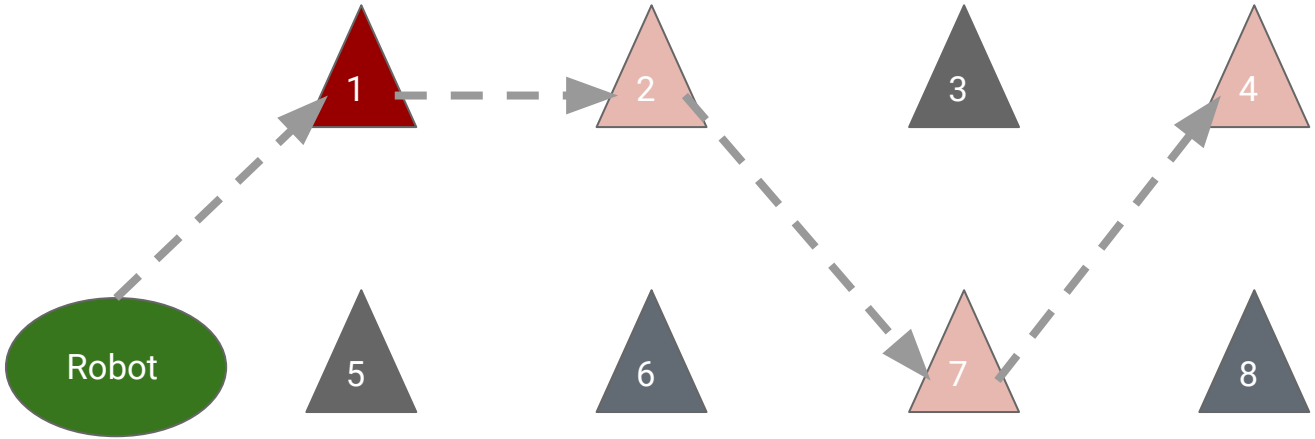



Turn on transmitter 2
Roomba directs to transmitter 2

# Plan
## Stages

Stage 2. Transmitter Controlling System

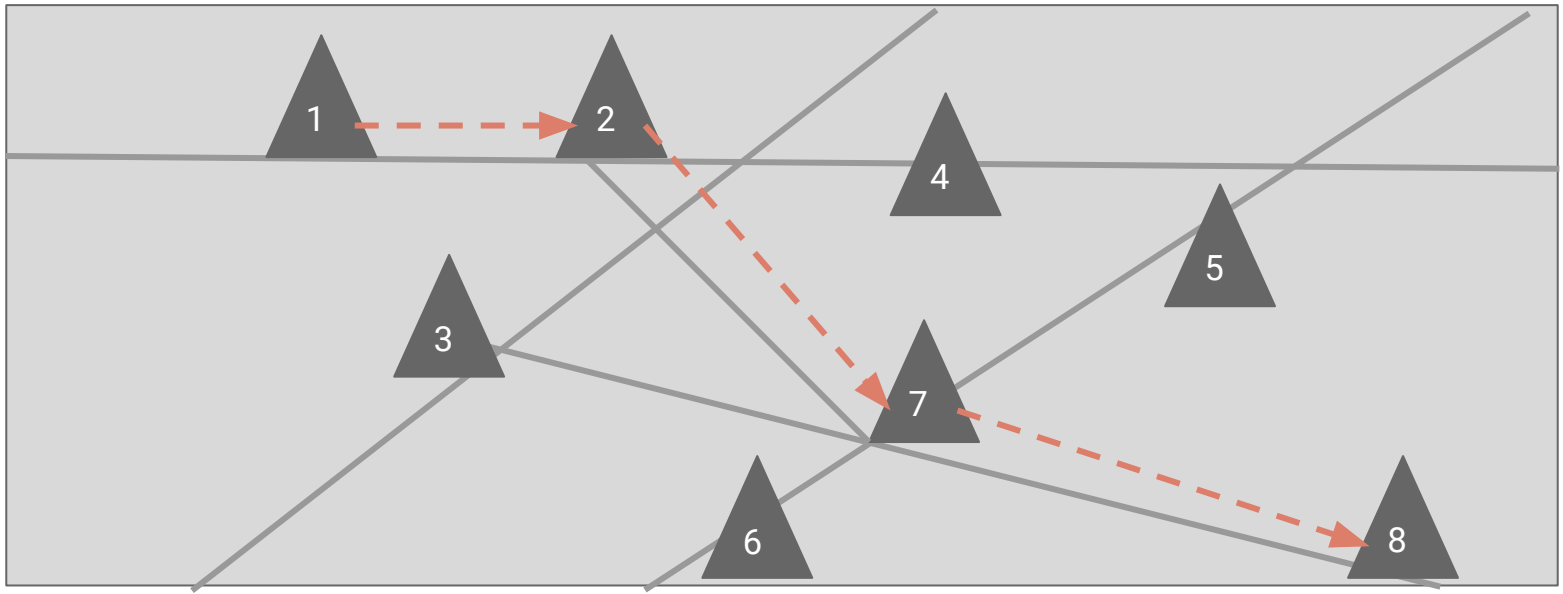
- Experiment with 6 or more transmitters to enable Roomba to actually move according to path



# Plan
## Stages

Stage 3. Transmitter Locating Algorithm + Path Finding Algorithm

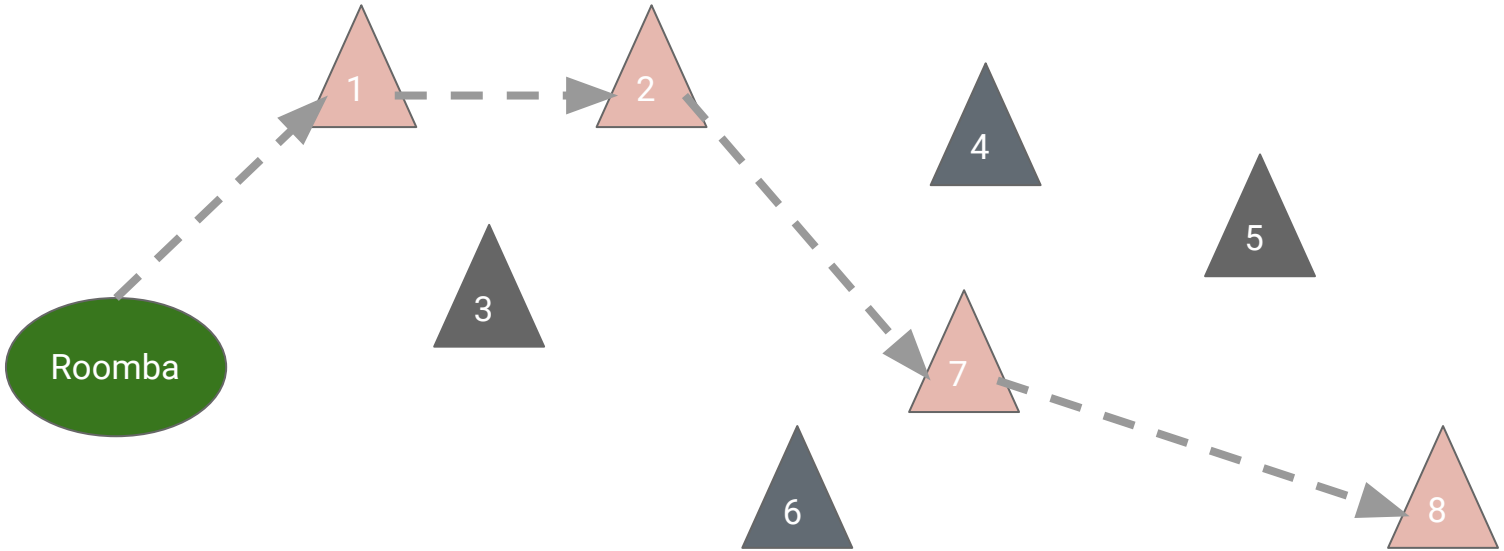
- Implement path finding algorithm, transmitter locating algorithm



# Plan
## Stages

Stage 4. Integrate Implemented Algorithms with Transmitter Controlling System

- Integrate with transmitter controlling system



# Plan
## Stages

### Stage 5. Extra Implementation

- Implement extra features that we assumed to be already implemented
- Web application that enables robot administration for managers

# Plan
## Schedule

| Stages | Stage 1 | Stage 2 | Stage 3 | Stage 4 |
|---|---|---|---|---|
| Time Required | 2 weeks | 2 weeks | 2 weeks | 3 weeks |
| Dates | 9/24 ~ 10/7 | 10/8 ~ 10/21 | 10/22 ~ 11/4 | 11/5 ~ 11/25 |

# Equipment

# Equipment List

Robot


IR transmitters (3+) and receiver

Raspberry pies (4+)

# Citation


- Ching-Kuo Wang, Han-Pang Huang, and Cheng-Han Shieh. 2009. Dynamic analysis of the hybrid recharging system with super-capacitors on the armed cleaner robot. 2009 IEEE/ASME International Conference on Advanced Intelligent Mechatronics (February 2009).
- Gary Li. 2014. Battery Charger for Mobile Robotic Vacuum Cleaner. (March 2014). Retrieved from Google patent.
- Hyoung-deuk Im. 2007. System and Method for Automatically Returning Self-moving Robot to Charger. (June 2007). Retrieved from Google patent.
- H. Maaref and C. Barret. 2002. Sensor-based navigation of a mobile robot in an indoor environment. Robotics and Autonomous Systems 38, 1 (2002), 1–18.
- H. Zhang, W. Wan., & W. Zha.. (2007). A Topological Area Coverage Algorithm for Indoor Vacuuming Robot. 2007 IEEE International Conference on Automation and Logistics (2007).
- V. Kulyukin, C. Gharpure, J. Nicholson, and S. Pavithran. RFID in robot-assisted indoor navigation for the visually impaired. 2004 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS) (IEEE Cat. No.04CH37566).
- W.H.C. Wickramaarachchi, M.A.P. Chamikara, and R.A.C.H. Ratnayake. 2017. Towards implementing efficient autonomous vacuum cleaning systems. 2017 IEEE International Conference on Industrial and Information Systems (ICIIS) (2017).

# Questions ?