Sparse time-of-flight pods for low-cost occupancy sensing

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LESA
Lighting Enabled Systems & Applications

Overview

Project Description: The project is to set up a privacy preserving in-door positioning system by distributed time-of-flight(ToF) sensor network for precision occupancy and location detection.

Problem Addressed: Smart lightening system is used widely not only improving the efficient use of energy, but also react to the human's need with lightening control. However, traditional camera sensors system interferes with people's privacy. Therefore, we seek technologies that strike a balance between accurately detecting human movement, and preserving the privacy of a room's occupants. There are some specific problems we need to confront:
1. How to set up a efficient communication system between distributed sensors?
2. What algorithm to use in seeking for precise prediction?
3. How to distribute limited number of sensors to cover as much area as possible?

Project Goals: Build a smart room system to track occupants movement inside the room using single-ray time-of-flight sensor. The ultimate goal is to precisely determain the occupancy and track people's movement with optimal number of sensors applied.

IP relevant to this work is available for licensing.
(delete this text unless applicable, if deleting please resize Acknowledgements box to eliminate blank space)

Application Areas

HEALTHCARE

The system can be applied to check the status of patients with their privacy protected.

COMMUNICATIONS

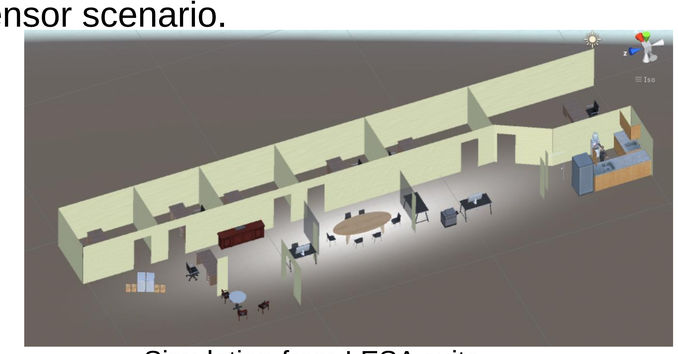
COGNITION

PLANT SCIENCE

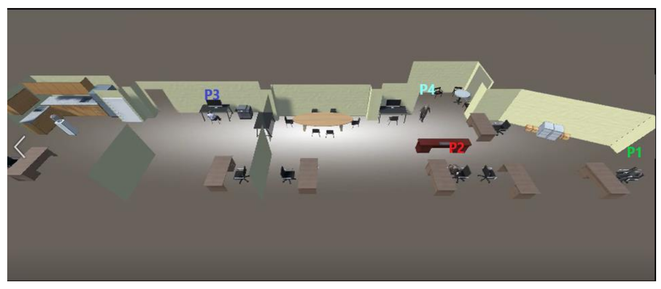
EFFICIENT BUILDINGS

Research Highlights

Unity simulation:
Simulate real LESA suite according real room and test the tracking algorithm based on the real sensor scenario.



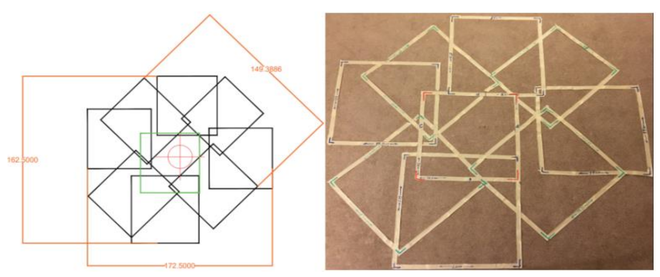
Simulation from LESA suite



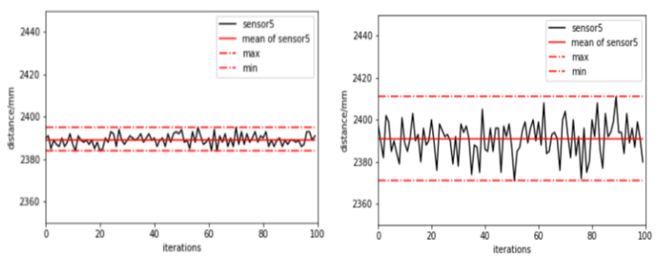
Simulation of occupants movement inside the room

Tracking algorithm of occupants movement

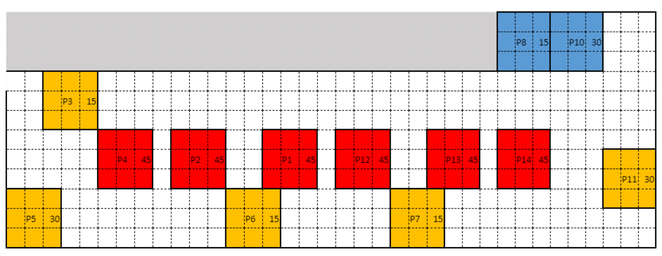
Real test:



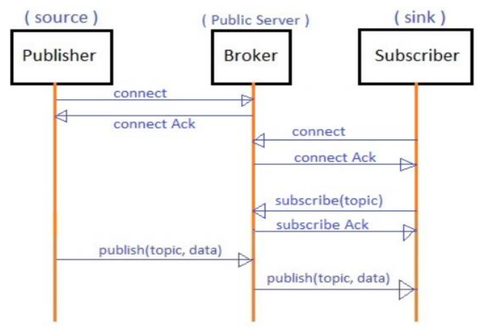
Area covered by the 15 degree pod



Noise of the ToF sensor without/with sun light



LESA suite model

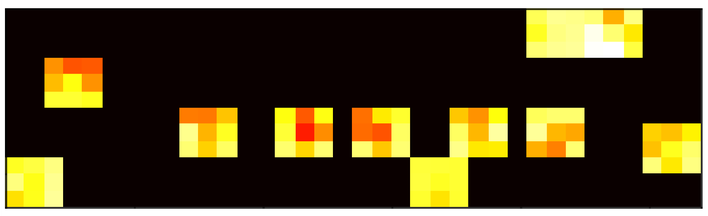


communication using MQTT protocol

Recent Research Results

	Occupancy rate	Person detected	Number of sensors		
			15 degree	30 degree	45 degree
Base Test	105/765	42.65%	6	7	0
Test 4	96/765	42.36%	6	6	0
Test 10	108/765	68.72%	6	6	1
Test 14	107/765	82.74%	6	5	2
Test 16	102/765	90.24%	6	3	4

Person detected rate changes according to the change of sensor placement and selection



Real data collected correspond to the LESA suite model

Next Steps

- **Near Term Milestones**
  - Embed the tracking algorithm in the real system and feed it with real sensors reading
  - Collect and label data for learning
  - Develop the learning algorithm to track the direction of the movement of the person to predict the future position
  - Modelize the noise caused by sun light and make compensation.
- **Long Term Milestones**
  - Optimize the number of sensors applied
  - Further improve the accuracy of detection and prediction

Sponsored Research Areas

INCLUDE THE FOLLOWING ITEMS IN THIS SECTION:
Bulleted list of possible sponsored research areas identified by your research group – this list would serve as talking points with industry members as possible ways to collaborate with them

Acknowledgements

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