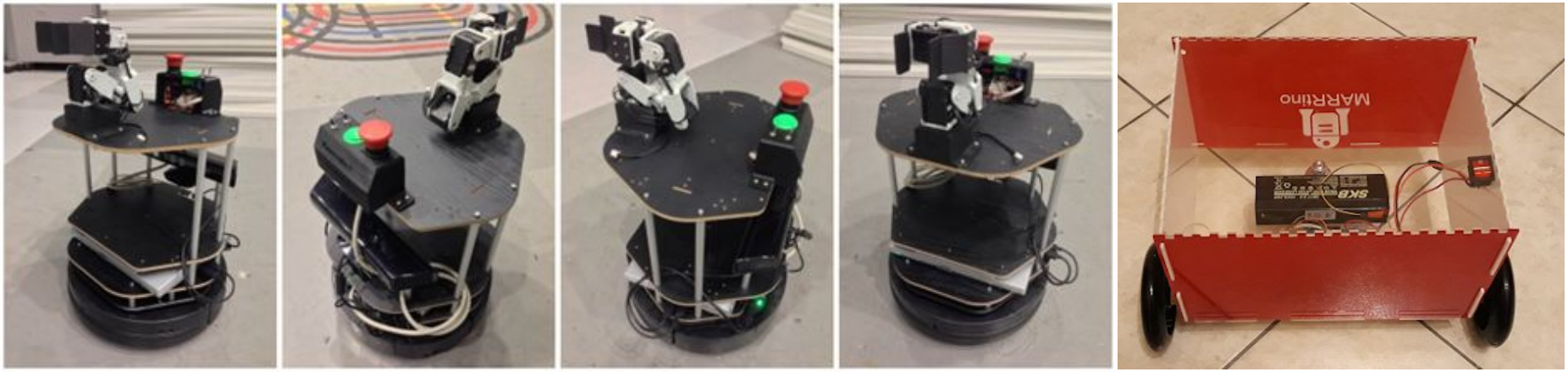

RoboCup@Home Education
ONLINE CHALLENGE 2020
Online Classroom Open Platform

04 Robot Visual Perception (1/2) : RGB-D Sensing

Jeffrey Tan, Jupiter Robot | 2020.05.07

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Online Challenge 2020: Online Classroom OP

04 Robot Visual Perception (1/2) : RGB-D Sensing

Speakers: Jeffrey Tan, Jupiter Robot

Time: **May 07, 2020 (Thu) 10:00 - 11:00 am (GMT+8)**

04 Robot Visual Perception (2/2) : Image Processing

Speakers: Jeffrey Tan, Jupiter Robot

Time: **May 07, 2020 (Thu) 11:00 - 12:00 noon (GMT+8)**

Zoom: https://cernet.zoom.com.cn/j/64488547874 | PW: robocup

Facebook Live: https://www.facebook.com/robocupathomeedu/live/

Web:
https://www.robocupathomeedu.org/challenges/robocuphome-education-online-challenge-2020

Online Classroom:
https://www.robocupathomeedu.org/learn/online-classroom/online-challenge-2020

** Privacy reminder: Video will be recorded and published online.

Previous Assignment / Prerequisites

1. Combine speech synthesis and speech recognition to develop robot speech question and answer system
   a. Design and develop several question (speech recognition) and answer (speech synthesis) pairs for robot self introduction.
   b. Display the results on the terminals too.
2. Upload to GitHub
   a. Create own repository and upload the source code, system design and question and answer pairs, and speech interaction video (with terminal results) to GitHub.

Visual Perception Development System

Hardware

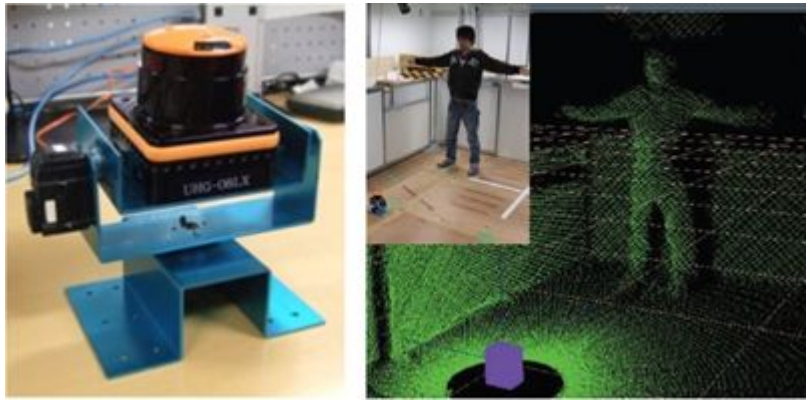
- Webcam
- RGB-D sensor (optional)
- Laptop computer

Software

- Ubuntu
- ROS
- Related component software

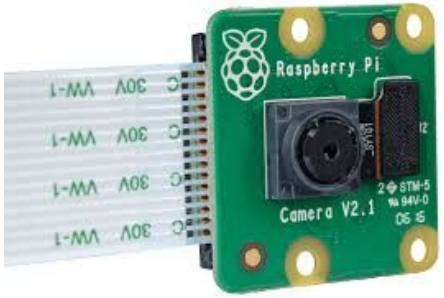
Robot Vision Sensors

- Optical and camera based systems
- Laser range finder, ultrasonic distance sensor, 3 dimensional range image camera using modulated infrared light, etc.

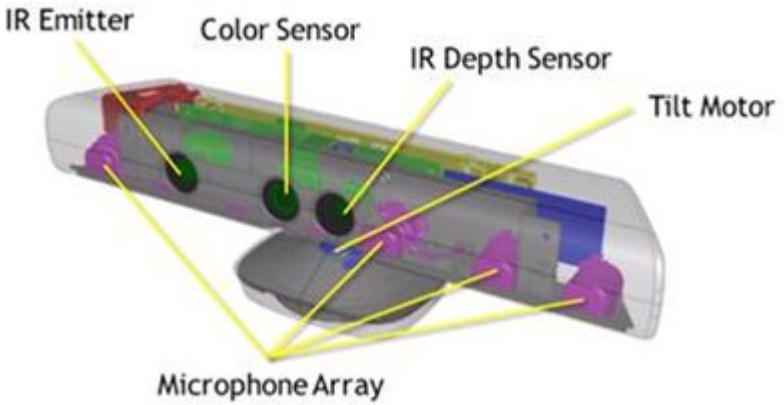


3D laser range finder

2D laser range finder



Color camera

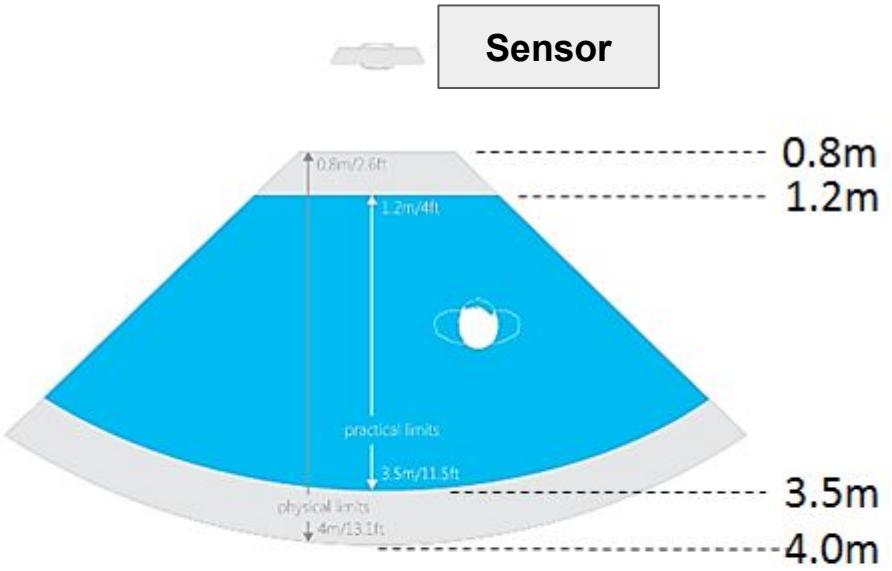


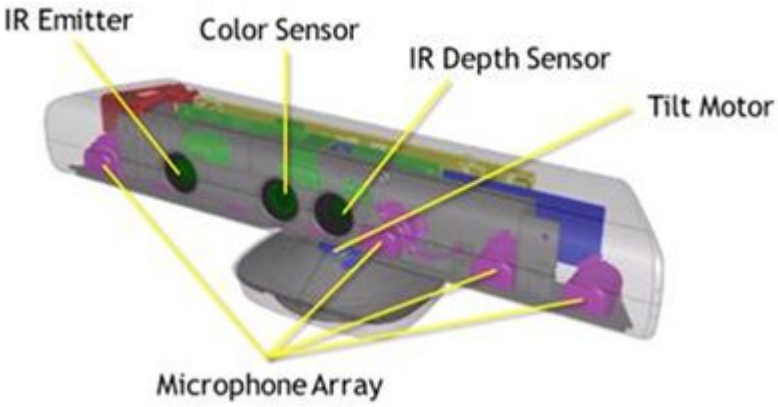
[https://msdn.microsoft.com/en-us/library/jj131033.aspx]

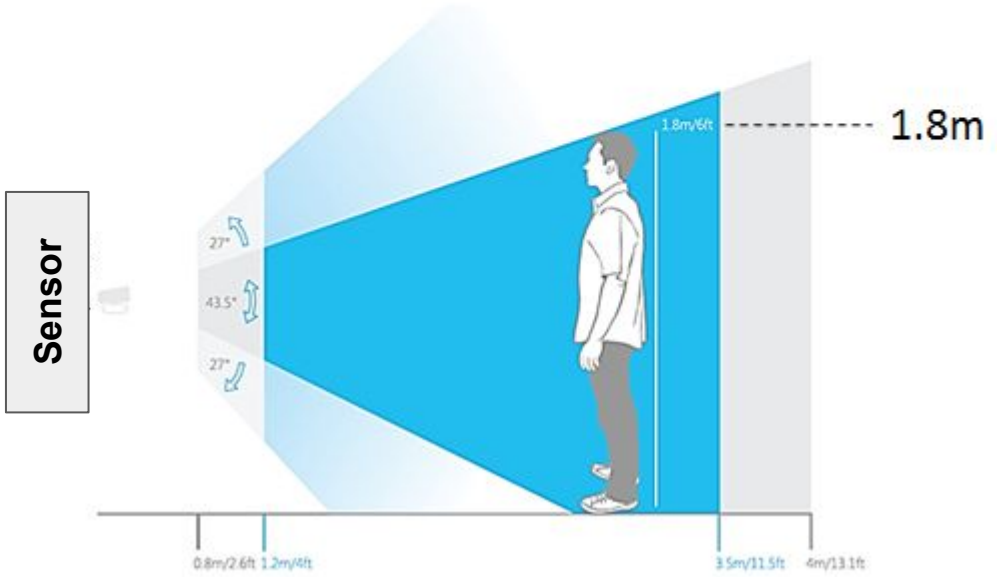
RGB-D Sensor

3D MS Kinect sensor

- RGB Color VGA Video camera
- Depth sensor
  - Infrared projector
  - Monochrome CMOS sensor
- Resolution 640 x 480 pixel
- 30 FPS



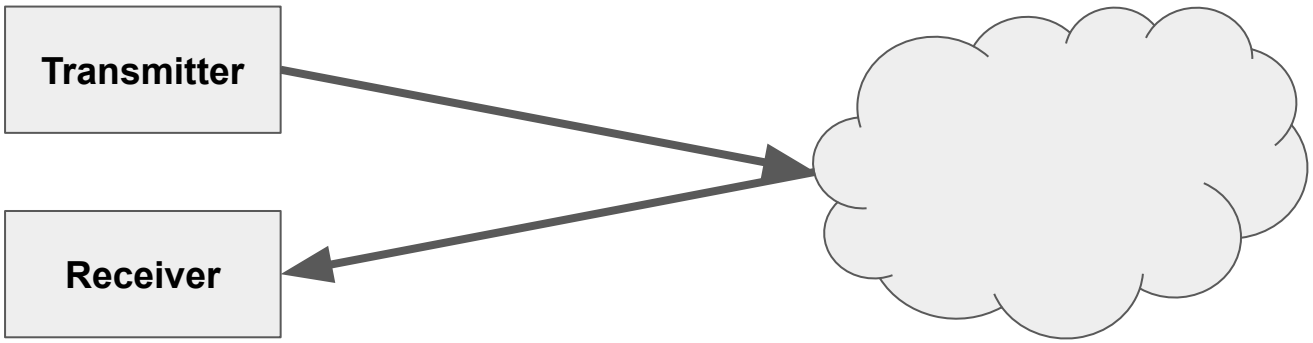




Distance Sensing

The distance to the object is measured using the time (Time of Flight, TOF) of the laser beam emitted from the transmitter hits the object and returns to the receiver.

$$l = v\Delta t / 2$$



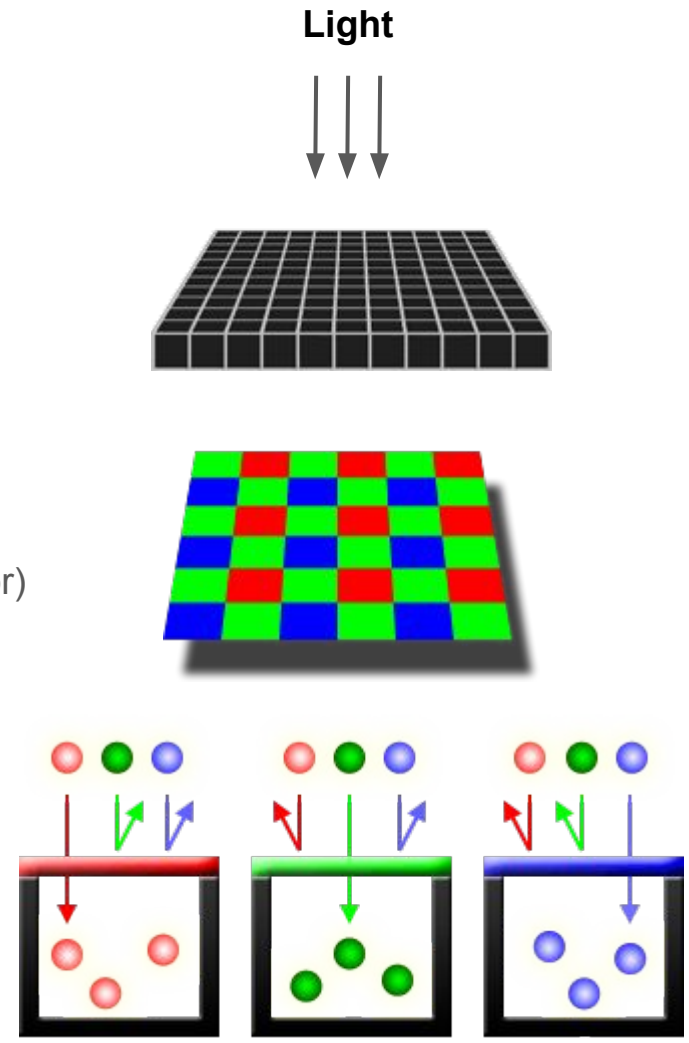
Color Sensing

How camera sensor works

- Imaging element

  Light intensity → Electric signal

  - CCD(Charge Coupled Device)
  - CMOS(Complementary Metal Oxide Semiconductor)
- Photodiode
- Color filter: R(red), G(green), B(blue)
- Pixel
  - Pixel value: 256 levels (0 – 255)



[https://www.cambridgeincolour.com/tutorials/camera-sensors.htm]

Digital Image Processing

To process digital images through an algorithm

- Classification
- Feature extraction
- Multi-scale signal analysis
- Pattern recognition
- Projection

[https://en.wikipedia.org/wiki/Digital_image_processing]

Visual Perception Challenges

Scenario: RoboCup@Home

(a) Typical arena

(b) Typical objects

Visual Perception Challenges

Tasks

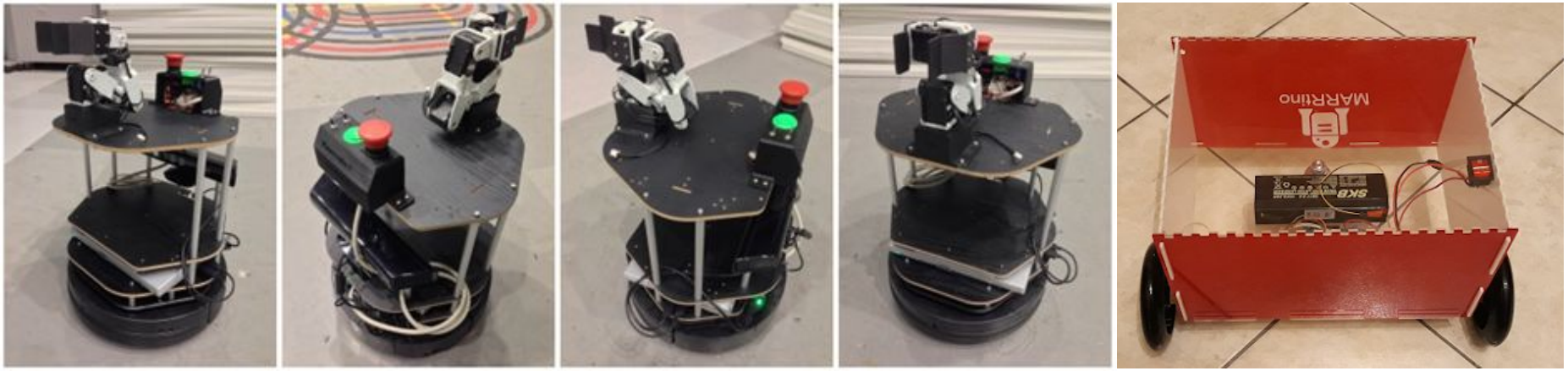
- Speech and Person Recognition
- Storing Groceries

Robot Vision with ROS

- OpenNI2 - http://structure.io/openni
- OpenKinect - https://github.com/OpenKinect
- PCL - http://pointclouds.org/
- OpenCV - http://opencv.org/
- ROS opencv_apps - http://wiki.ros.org/opencv_apps
- Installation:
  - Astra Setup - http://wiki.ros.org/astra_camera
  - USB Camera - $ sudo apt-get install ros-kinetic-usb-cam
  - ROS opencv_apps
    - $ cd ~/catkin_ws/src
    - $ git clone https://github.com/ros-perception/opencv_apps
    - $ cd ~/catkin_ws
    - $ catkin_make
- Multiple Astra sensors
  - Check Astra device id: $ rosrun astra_camera astra_list_devices
  - Update device id into rc-home-edu-learn-ros/rchomeedu_vision/launch/multi_astra.launch
    - device_1_id – Base sensor for navigation
    - device_2_id – Top sensor for visual perception

Robot Vision with ROS

- Bring up
  - [Astra] $ roslaunch astra_launch astra.launch
  - [Kinect] $ roslaunch freenect_launch freenect-registered-xyzrgb.launch
  - [USB Camera] $ roslaunch usb_cam usb_cam-test.launch
  - [Multiple Astra] $ roslaunch rchomeedu_vision multi_astra.launch
- Display RGB and Depth images
  - $ rosrun image_view image_view image:=/camera/rgb/image_raw
  - $ rosrun image_view image_view image:=/camera/depth_registered/image_raw
  - [USB Camera] $ rosrun image_view image_view image:=/usb_cam/image_raw
  - [Multiple Astra] $ rosrun image_view image_view image:=/camera_top/rgb/image_raw



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Web: https://www.robocupathomeedu.org/challenges/robocuphome-education-online-challenge-2020
Online Classroom: https://www.robocupathomeedu.org/learn/online-classroom/online-challenge-2020
Online Entry Form: https://forms.gle/UBREeC1xTCVQ9wr78
Online Entry Form (backup): https://www.wjx.cn/jq/72082120.aspx
Contact: oc@robocupathomeedu.org

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