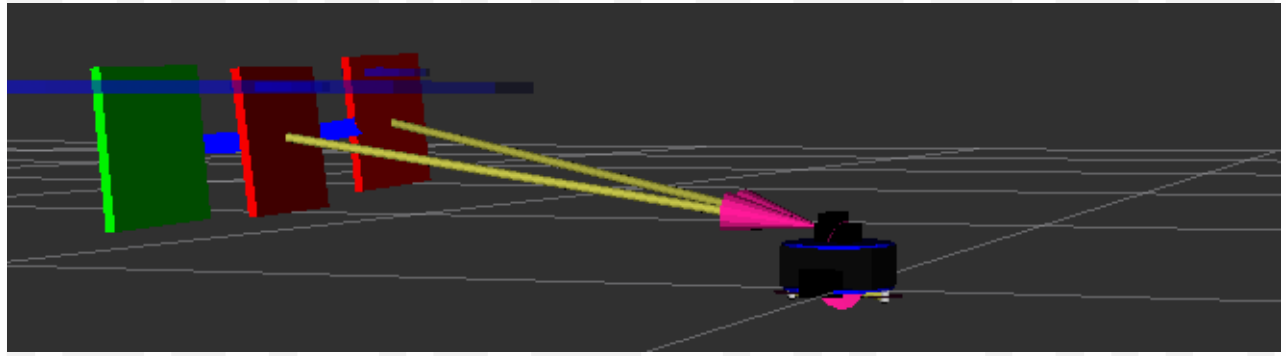
Fiducial SLAM with ROS

Using Fiducial Markers

for Robot Mapping and Localisation

By Shaun Price
https://www.linkedin.com/in/shaunprice/

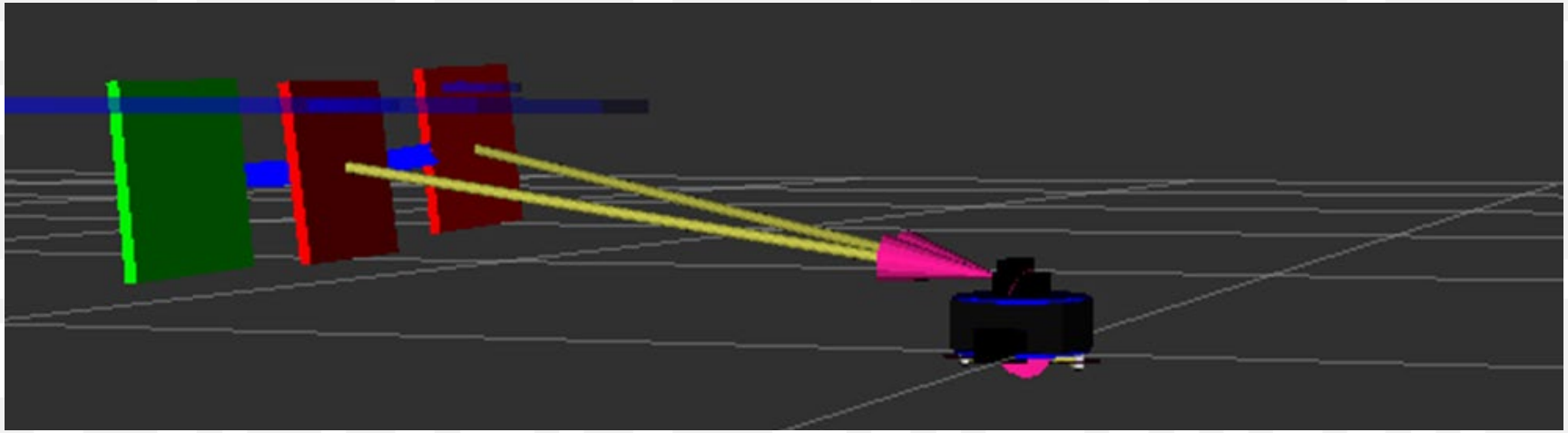


Fiducial Markers?

- A fiducial marker or fiducial is an object placed in the field of view of an image as a point of reference or measure.
- Rulers and other objects of know size are often used in images as fiducials to provide scale to the image.
- The ArUco marker (right) is a type of Fiducial Marker.
- Fiducial markers of known dimension can give scale, orientation and distance to the marker in the scene.
- They can be processed using low power hardware (e.g. Raspberry Pi)

Simultaneous Localisation and Mapping

- SLAM is used to localise a robot in an environment and map the environment at the same time.
- Robot Localisation and Mapping allows us to plan a path for a robot in an environment and navigate through the environment.



ROS Rviz simulation using real-time camera data from a scene containing three fiducial markers.

How do fiducials work?

- Each fiducial is printed and represents a number stored in a dictionary.
- An image is captured of the scene and the markers are detected.
- Each marker is compared to predefined shapes and sizes and it’s orientation and distance are calculated.
- Multiple Fiducial marker distances and orientations can be used to improve the accuracy of the robot localisation.
- Marker locations and orientation are stored in a map file to create a three dimensional map of the environment.

Notes about Fiducial Markers

- Best located on the roof to ensure the robot can see them.
- There needs to be at least two markers detected.
- The camera used needs to be calibrated to compensate for distortion.
- The fiducial needs to be flat for the detector to measure it accurately.
- You need to use only one of each numbered marker. The patterns represent numbers and the markers location is stored in the map.
- Fiducials can be used in Augmented Reality to map the scene to the computer generated graphics in 3D space.
- Fiducials can be used for more than just location and mapping. You could follow a fiducial attached to an object.

Beyond Fiducials

- There are other ways of mapping environments similar to fiducials.
- Single camera feature mapping can provide localization but not scale unless the distance between shots where both shots are at known locations.
- LIDAR scanners can provide both scaled maps and localization but they are typically very expensive.
- Stereo Cameras can provide similar functionality to LIDAR scanners but require features to map in the scene. Sometimes features are provided by an IR LASER projecting shapes on the scene mainly for inside depth use.
- Intel's Realsense D435i Depth camera uses stereo cameras, an IR LASER projector for depth mapping and an IMU (US$199+shipping and taxes from Intel).
- Intel's Realsense T265 Tracking camera uses feature mapping and an IMU to track the unit in the scene (US$199+shipping and taxes from Intel).

References

ROS fiducial package documentation:

http://wiki.ros.org/fiducials

OpenCV ArUco (fiducial) Markers

https://docs.opencv.org/3.1.0/d9/d6d/tutorial_table_of_content_aruco.html

Robot and ROS Build used

https://github.com/ShaunPrice/ROS_for_Waveshare_Alphabot2

Videos

Robot Localization using ArUco

https://www.youtube.com/watch?v=VsIMl8O_F1w

AR big scene using ROS

https://www.youtube.com/watch?v=zL6FuKqAUsA

Mapping with ArUco markers using ROS

https://www.youtube.com/watch?v=1jss-v16y4w