The Application of kinect sensors for SLAM and DATMO

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Abstract

Simultaneous Localisation and Mapping (SLAM) allows a mobile robot to be completely autonomous in an unknown environment and perform its tasks. The robot is able to create a map of its environment and at the same time locate itself. Real world environments however, are characterised by moving objects such as people, cars, robots and mobile furniture. In order for the robot to interact safely with these moving objects the robot would have to perform Detection and Tracking of Moving Objects (DATMO). Moving object detection and tracking would avoid errors in maps, resulting in a reliable map that would enable the robot to localise itself in the environment and execute its tasks.

Research conducted for SLAM and DATMO involves sensors such as 2D and 3D laser range finders, cameras, and radar. Kinect sensors are inexpensive structured 3D light sensors that have been utilised individually for object recognition, human robot interaction, human gesture recognition, navigation and obstacle avoidance, and SLAM in static environments.

This work involves the development of algorithms for the implementation of multiple Kinect sensors for SLAM and DATMO. The algorithms will allow the mobile robot to navigate in a dynamic environment and simultaneously create a map of the environment. Moving and non-moving objects will be detected and represented accordingly in the map. Moving objects will be tracked to ascertain their future positions and improve map accuracy, thereby allowing the robot to complete its tasks in a dynamic environment. The algorithms will be optimised, tested and validated on a mobile robot integrated in a dynamic environment.

Keywords: SLAM, DATMO, Kinect, dynamic environment.

1. Introduction

The SLAM problem has been researched widely in stationary environments. Applications have evolved from different environments such as indoor to outdoor, airborne, underwater and underground. [3] However, most of these applications are carried out in stationary environments that do not take dynamic objects into account.

If dynamic objects are referenced as static, they can lead to data association errors that decrease map accuracy. SLAM In Dynamic Environments (SLAMIDE), has been researched recently, but open questions still exist. These questions are how to distinguish between stationary and dynamic objects, how to represent these objects in maps, and how to track dynamic objects and predict their future positions. [1-4]

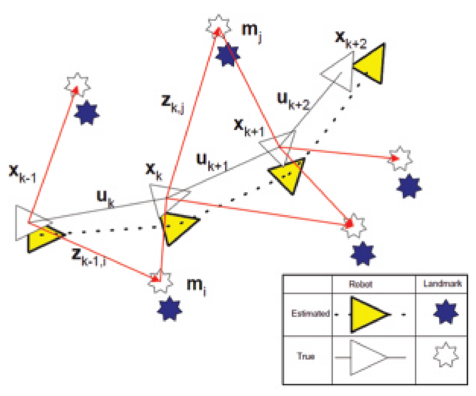


Figure 1: The SLAM problem. The robot simultaneously estimates its location and landmark locations to build a map. [5]

2. SLAM and DATMO

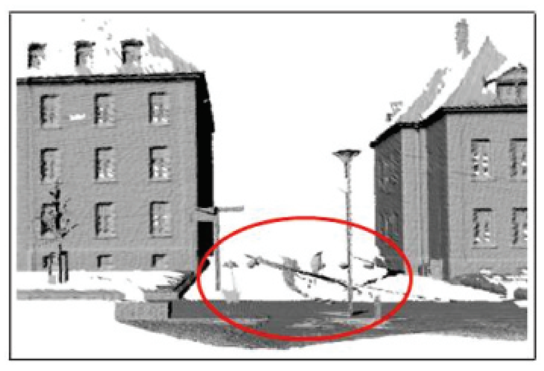
SLAM allows an autonomous robot to process observations from perception sensors to construct a map of the static environment. The map allows the robot to simultaneously localise itself and perform tasks, (refer to Figure 1). SLAM can therefore be regarded as being concerned only with the stationary objects in the environment.

DATMO enables the robot to detect and track dynamic objects so that their positions and respective trajectories can be determined through the use of data association and tracking methods. DATMO can therefore be regarded as being concerned only with the dynamic objects in the environment.

The integration of SLAM and DATMO allows for mutual benefits. Spurious measurements of dynamic objects can be excluded from the mapping process and by tracking dynamic objects their future positions can be predicted, allowing for better map quality, (refer to Figure 3).

SLAM and DATMO are important requirements for fully autonomous entities such as cars and robots. Autonomous cars may serve the physically disabled, perform long transportation tasks, and prevent collisions that are caused by human negligence or distraction. Autonomous robots (e.g. automated guided vehicles) have already been serving the manufacturing industries in mostly stationary environments. If these robots are integrated in dynamic manufacturing environments; offices, hospitals, laboratories, car parks, they will need adequate and affordable perception sensors to detect random moving objects like people, equipment, other robots, etc., (refer to Figure 2). [2, 6]

Figure 2: Outdoor environment with people walking through as the robot performs mapping. [7]



(a)

(b)

Figure 3: (a) 3D map of outdoor environment. People are indicated by curves in red oval. (b) Same environment as in (a) with people filtered out. [7]

3. The Microsoft Kinect

The Microsoft Kinect sensor was designed by PrimeSense to serve as a controllerless user interface for the Microsoft Xbox 360, (refer to Figure 4). It comprises [T1]

- A 640x480 RGB CMOS image sensor
- A 320x240 monochrome CMOS image sensor, and
- A class 1 infrared laser projector [8]

The Kinect transmits an infrared structured light pattern and performs stereo triangulation to produce depth images. [8, 9]

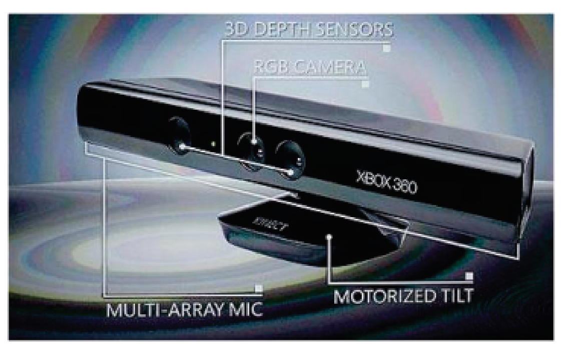


Figure 4: The Microsoft Kinect sensor, with RGB camera and 3D depth sensors. [10]

4. Proposed research

The project entails the development of algorithms for the application of multiple Kinect sensors for SLAM and DATMO. These algorithms will allow the mobile robot to navigate in a dynamic environment and simultaneously construct a map of the environment utilising multiple Kinect sensors.

Moving and stationary objects will be differentiated between and represented appropriately in a map. The map will enable the robot to localise itself and execute tasks. Data association and tracking methods will be researched and applied to allow tracking of dynamic objects so that their future positions can be predicted in order to increase map accuracy.

The SLAM and DATMO algorithms will be tested, optimised and validated to ensure reliable performance in dynamic environments.

5. Objectives

The objectives of this research project are to:

1. Research and develop algorithms for SLAM and DATMO;
2. Research the properties of dynamic and static objects for SLAM and DATMO;
3. Integrate dynamic and static objects in maps;
4. Track moving objects in the environment;
5. Optimise algorithms for applications in dynamic environment; and
6. Validate experimental results with research objectives and specifications.

6. Conclusion

In order to eliminate the error of referencing moving objects in maps, stationary and moving objects need to be differentiated. This will improve localisation and reduce spurious measurements in maps. The robust tracking of dynamic objects will guarantee reliable maps and improve map accuracy.
Should the implementation of multiple Kinect sensors for SLAM and DATMO produce favourable results, it would contribute to a myriad of potential applications for fully autonomous entities in dynamic environments. [6, 11]

7. References

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