Scientific Experimentation and Evaluation

Assignment 5

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CONTENTS

1 Abstract

The upcoming tasks automate the observation and estimation of a differential drive robot, which is run repeatedly in a forward, and by following right and left arcs. The start and end poses of this repeated experiments are measured and collected in order to derive a motion model of the differential drive robot.
One of the aims of the upcoming experiments will be to compare and verify the results of previous experiments that were made by manual observation and measurement of the robot pose. By manual observations and measurements repeatability of the experiment is hard to be ensured; and therefore it is more convenient to have an automated observation and estimation set-up.

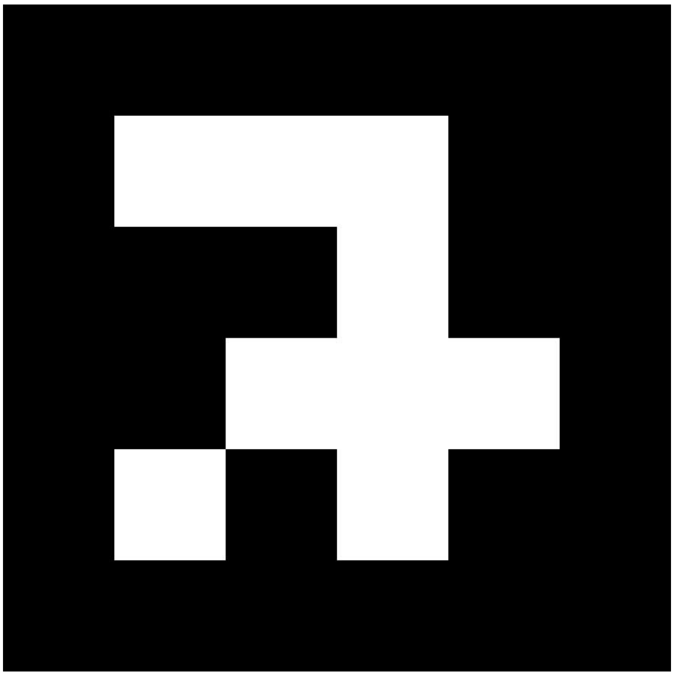
2 Experimental set-up

2.1 AICISS system

The experimental set-up to be used was developed as part of the AICISS project, which aimed at developing an robust service Robot platform to be used in crowded environments, where the conventional means of localization (such as laser scanners) can not be relied on. Am important part of this project was to have an observable robot environment, so as to observe and record the Robot behaviour over long periods of time.
For our experiment we are using the robot tracking set-up of the AICISS project.

The robot is localized and tracked by attaching to it *ArUco markers*.
An ArUco marker is a synthetic square marker composed by a wide black border and a inner binary matrix which determines its identifier (id). The black border facilitates its fast detection in the image and the binary codification allows its identification and the application of error detection and correction techniques. The marker size determines the size of the internal matrix. For instance a marker size of 4x4 is composed by 16 bits[1]. Figure 1 shows an ArUco marker.

Figure 1: *ArUco Marker*



Having a model of the of the marker position on the robot, the tracking system first detects the marker in the camera images, and then the pose estimation is achieved by estimating a transform (rotation + translation) between the detected marker in the image and the marker model.

For better accuracy and precision, a bundle of markers is attached to the robot as shown in Figure 2.
This leads to multiple solutions for the pose estimation since each marker return a pose estimation. The optimization of the pose estimation is done using a 2D-2D closed closed form least square method proposed in [2]. This technique optimizes the estimation of the rotation and the translation between the observed marker poses (x_n) and the known model marker poses (y_n), which is expressed by the equation:

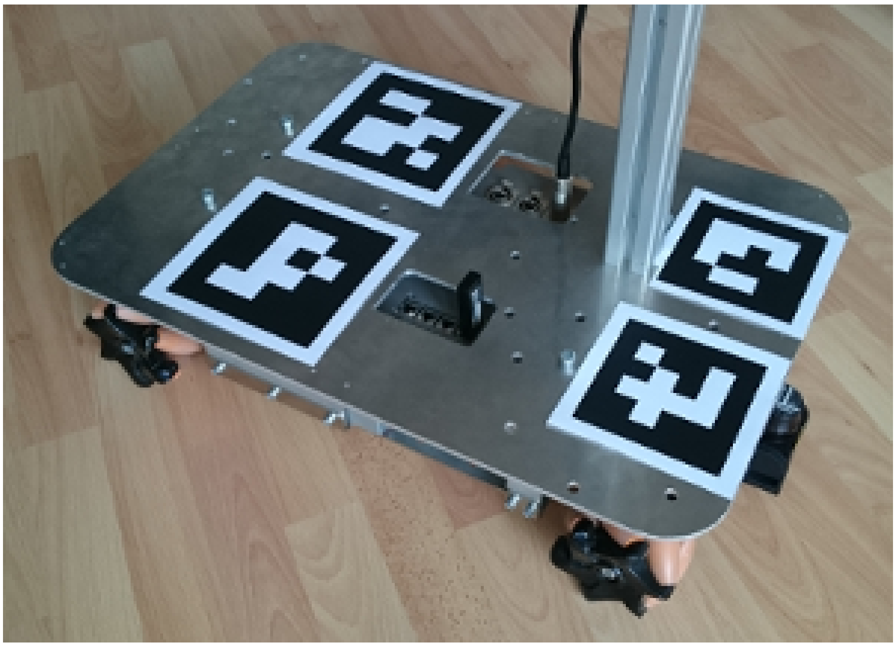
$$y_n = Rx_n + t$$

Where

- x and y are 2-D poses of the marker's corners.
- R is the rotation matrix between the observed marked position and the modelled marked position

- t is the translation between the observed marked position and the modelled marked position

Figure 2: *ArUco Marker Bundle*



3 References

[1] http://docs.opencv.org/3.1.0/d5/dae/tutorial_aruco_detection.html#gsc.tab=0

[2] Pose Estimation from Corresponding Point Data. Robert M. Haralick et all.