Measuring ARToolKit Accuracy in Long Distance Tracking Experiments

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Introduction

This poster presents the results of some experiments we have been performing which are designed to measure the accuracy of the ARToolKit tracking software. ARToolKit is commonly used for 3D tracking, but only at arm's reach distances - the distance between the user and the target is often quite small (less than one metre), and so many errors are not noticeable except at larger distances. This poster presents some experiments we have performed to measure accuracy at distances between 1 and 3 metres, and we found that the accuracy seems to depend on the angle that the target is at, with either the corner or the side facing the camera.

Experiment

We fixed a fiducial marker on the floor of a large empty room, and drew four circles centred on the target at a distance of 1, 1.5, 2, and 2.5 metres, shown in figure 1. A camera on a tripod was placed at angles along the circle every 15 degrees, and measurements were taken from ARToolKit and compared against the known position of the tripod. The maximum errors for each case is shown in figure 2.

Results and Analysis

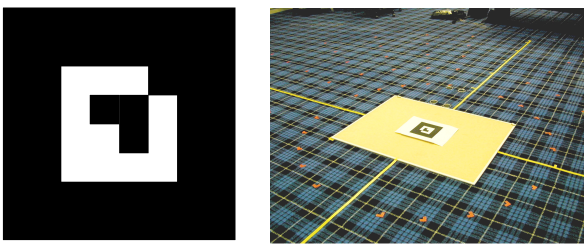
For the accuracy of the measurements, we noticed that the Y position is always more accurate than the X position, as shown in figure 3. We believe it might be that the X axis created on the floor at the start of the experiment may have had a larger error than the Y axis.

For each of the points processed, it appears that the radial distance estimated by ARToolKit is always a larger value than the real measurement, and figure 4 shows the estimated and measured circles with this demonstrated.

In figure 3, we can clearly see that the error increases with distance, from 9% to 18% for Y and from 6% to 12% for X. It might be possible to correct for this error by adding a filter which would estimate the distance to the target based on the values from ARToolkit. As a first step for this calibration, a linear function could be tried to see if it helps improve the accuracy. To extend this filter to other cameras or settings, it would then be enough to measure the error at 1m and 2.5m and then interpolate the values in between.

Finally, another result from the experiment is that the accuracy of the X and Y values fluctuates with the angle that the camera is at to the target, as shown in figure 5. The results show that the X values are more accurate around 90° and 270°, while the Y values are more accurate around 0° and 180°, which is the opposite of the X values. This may come from the pattern design, but for now we are not sure of the cause of this phenomenon.

Figure 1- Example target, and photograph of experimental setup



Environment

We used a Pyro 1394 Firewire camera for this experiment, mounted onto a tripod, with plumb line hanging for position calculations. The camera resolution was 640x480, and the calibration file for ARToolKit (with extra corrections) was:

$$camera = \begin{bmatrix} 750.51 & 0.0 & 320 & 0.0 \\ 0.0 & 722.98 & 240 & 0.0 \\ 0.0 & 0.0 & 1.0 & 0.0 \\ 0.0 & 0.0 & 0 & 1.0 \end{bmatrix}$$

$$size = (640{,}480) \quad centre = (320{,}240)$$

$$focal = 60.9000 \quad sizefactor = 1.036854$$

Figure 2 - Maximum error values for the four distances

Distance (m)	1 m	1.5 m	2 m	2.5 m
Error (mm)	□ 14 mm	□ 18 mm	□ 22 mm	□ 27 mm

Figure 3 – X and Y mean error values for the four radii

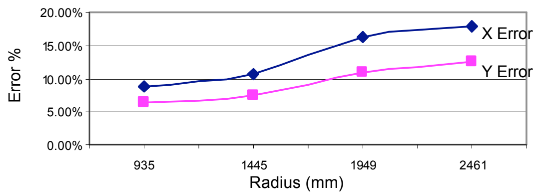


Figure 4 - ARToolkit radius estimates are always larger than actual physical measurements

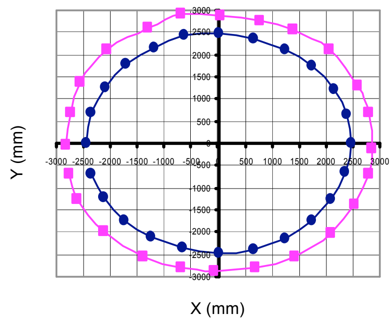
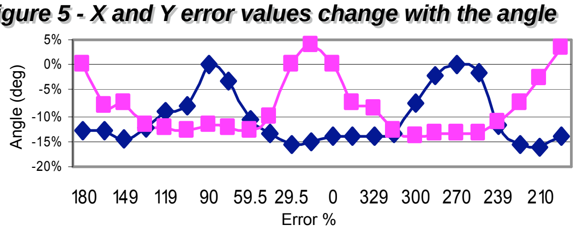


Figure 5 - X and Y error values change with the angle



More Information at http://wearables.unisa.edu.au

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