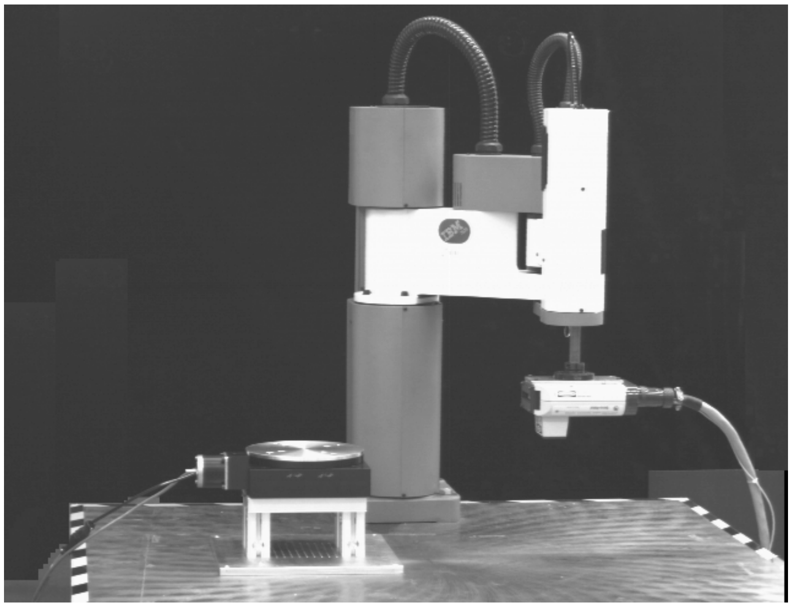
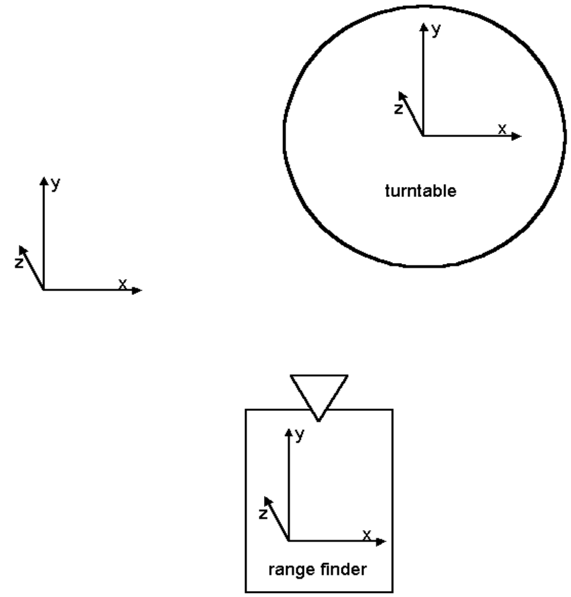
Range Finder Calibration

A. Gueorguiev, P. Allen
Dept. of Computer Science
Columbia University

Calibration: The Problem



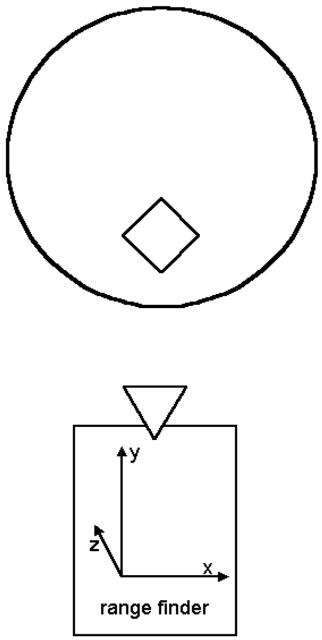


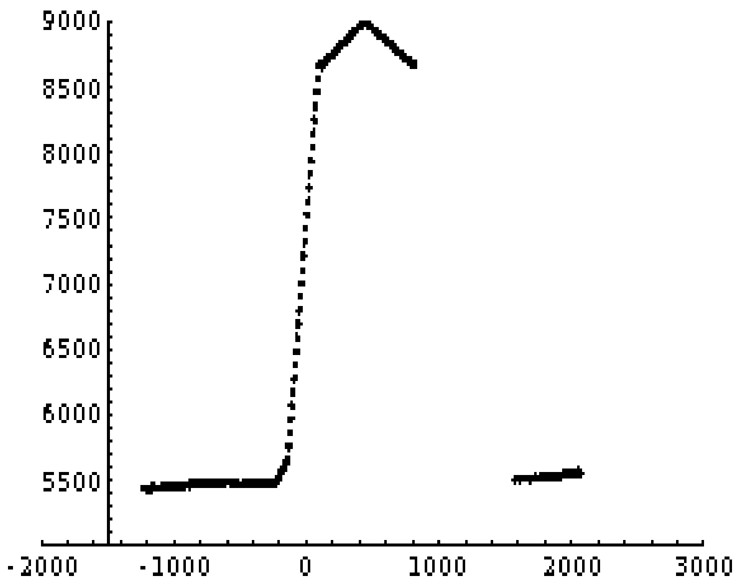
Find $T : \mathit{range\ finder} \rightarrow \mathit{world}$

Assumptions (experimentally verified)

- The range finder’s scanning plane is parallel to the turntable’s surface
- The robot arm holding the range finder is perpendicular to the turntable’s surface

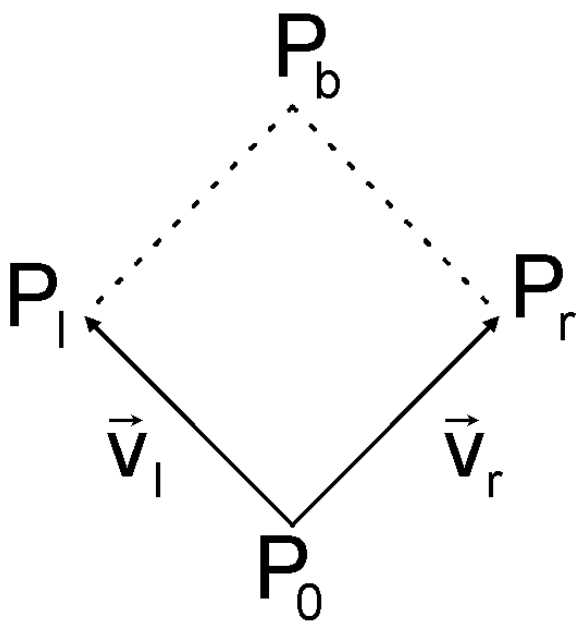
The Range Finder





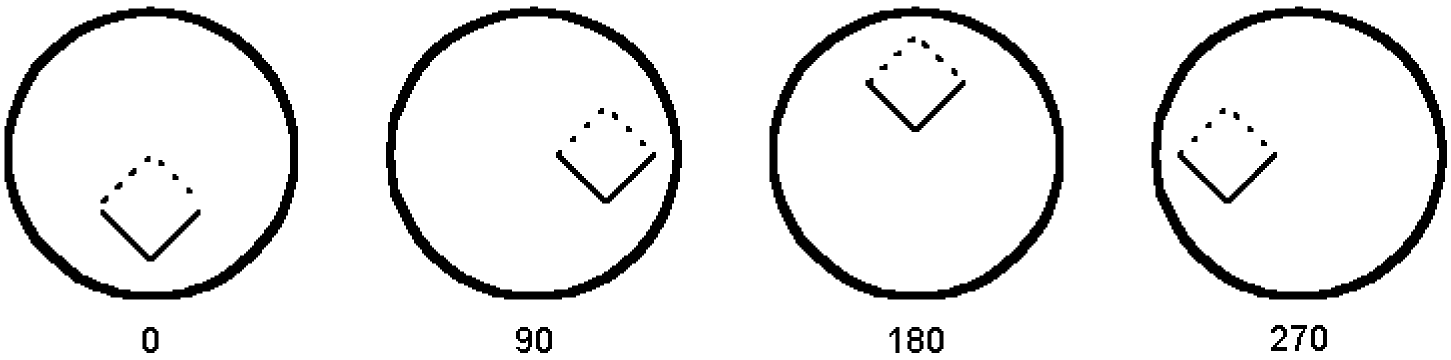
The range finder is planar

What can we recover from a single scan line?



- l_l & l_r
- $\vec{v}_l$ & $\vec{v}_r$
- $P_0 = l_l \cap l_r$
- c - cube size (known)
- $\mathrm{P}_l = P_0 + c\,\vec{v}_l$
- $\mathrm{P}_r = P_0 + c\,\vec{v}_r$
- $\mathrm{P}_b = P_0 + c\left(\vec{v}_l + \vec{v}_r\right)$

The Calibration Process



Ideally:

- $P_l = R\left(x_c, y_c, -90^\circ\right)$
- $P_r = R\left(x_c, y_c, -270^\circ\right)$
- $P_b = R\left(x_c, y_c, -180^\circ\right)$

The Calibration Process II

Minimize:

$$E\left(x_c, y_c\right) = d\left(P_l, R\left(x_c, y_c, -90°\right)\right) + d\left(P_r, R\left(x_c, y_c, -270°\right)\right) + d\left(P_b, R\left(x_c, y_c, -180°\right)\right)$$

$$d(A, B) = \left\| \overrightarrow{AB} \right\|$$

Transformation matrix:

$$T = \begin{bmatrix} 1 & 0 & 0 & -xc \\ 0 & 1 & 0 & -yc \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

Improvements

- Apply a better line fitting method - iterative approach
- Take more scans and construct a minimization function that involves more sample points