

# How to get a robot position from video image

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## 1 Intro

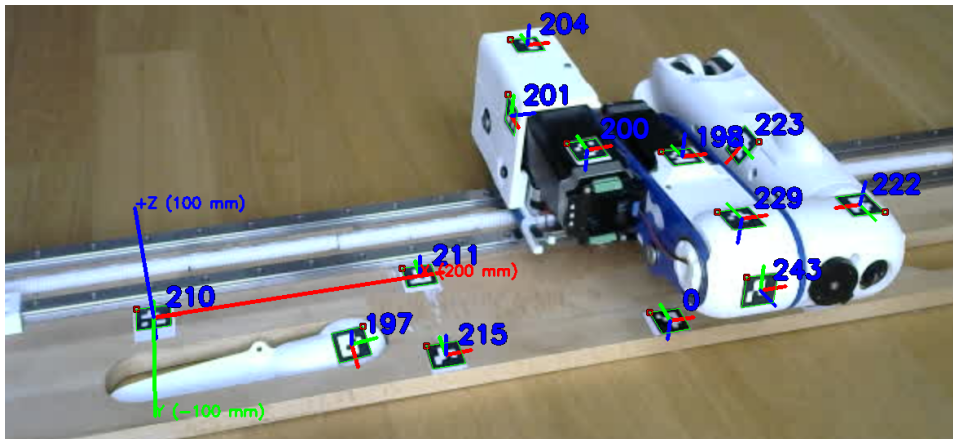
My Robot-Arm does not have homing switches. I want to use WebCams and Aruco-Markers to get the position of each joint. This way I can get the position as well as double-check the position while working under load.

I work with Arucos. With my low resolution WebCam I can get reliable positions (when using two cams). But the angle resolution is not usable. So I have to calculate the angle of each element from the relative positions of the markers.

## 2 Angles

### 2.1 Biceps y

To find the angle of the biceps (upper arm) there are different options, depending on the angle-of-view and which ArUcos are visible.

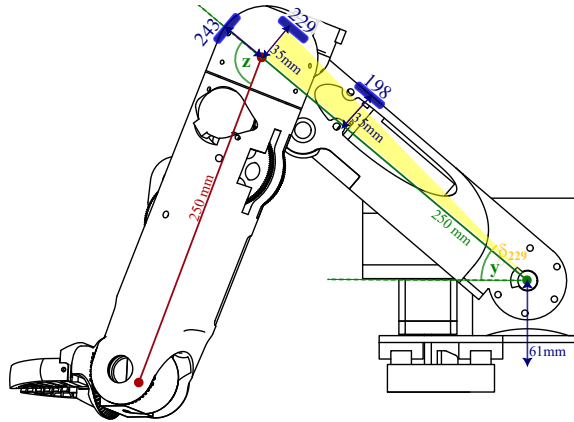


The calculation is based on two approaches: Position of the Markers 243 etc on the one hand, and relative position 198  $\leftrightarrow$  229 on the other hand.

Several ways to calculate  $y$ :

- $229 \leftrightarrow 198 \tan(y) = \frac{\Delta z}{\Delta y}$
- From  $y_{\text{Axis}}$  and the positions of 243, 229, 198 (each position on its own) we can calculate  $\tan(y + \delta)$  with a known  $\delta$  from the geometry.

Thus we get  $y$



Each available (if marker is visible) approach to calculate  $y$  is done, and the mean is calculated. We can check if they deviate too much, and give warnings.

## 2.2 Ellbow – Rotation

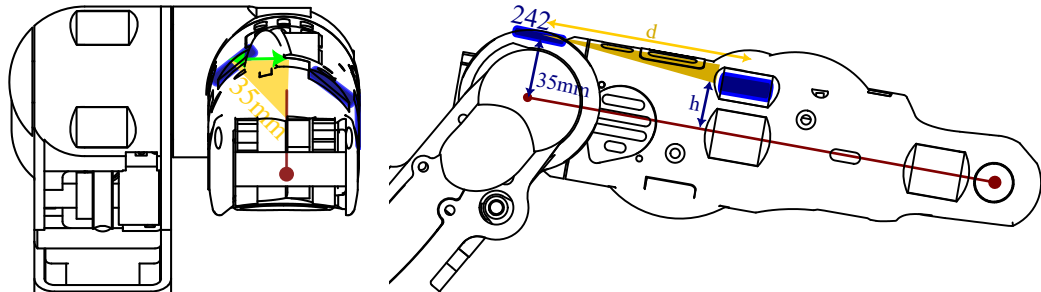
At the ellbow there is a motor that turns the forearm arround. Depending on which Arucus are visible, the position  $a$  of the motor can be calculated:

- $x$  of 223 or ... (only the  $x$  Position, in the graphics in green). It is independent of all other angles.

the  $y$  and  $z$  position of 223 etc can't be used, as it depends on the angle of the forearm and the angle of the biceps. Thus is it less reliable. (Although it would be a nice thing to use as a double-check). With the  $x_{223}$  compared to the  $x_{242}$  i can calculate the ellbow turning  $a$  value:

$$\sin(a + \alpha) = \frac{\Delta x}{35 \text{ mm}} = \frac{x_{223} - x_{242}}{35 \text{ mm}}$$

as I know the angle  $\alpha$  (yellow triangle) from the printed geometry of the arm. The  $x_{242}$  is calculated from all visible markers of the sled and biceps, as their markers are fixed in  $x$  position. This  $\alpha$  is calculated for all markers of the forearm.



As the rotation  $a$  may change for different markers, the median is taken.

## 2.3 Forearm

With the