

**e-Yantra Robotics Competition - 2017**

**Chaser Drone**

**1712**

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**Q1. Whycon detects markers and represents each marker on the image in the following format: '[1,1,1] 1'. What are the four numbers and what do they represent? Describe the whycon format. (10)**

**Answer:**

The 3 numbers in the brackets [ ] represent the linear x, y, z coordinates of the whycon marker's center with respect to Gazebo world's frame of reference. The 4th number represents the marker or target number, where each marker placed in the world is identified by a number.

Whycon Format is

**[ x , y , z ] marker\_no**

where x, y, z are linear positions of the marker

**Q2. For a static camera placed above the map, state the relation between the whycon frame of reference and the camera frame of reference. If the camera orientation were to be changed while keeping its physical location same, state the change in the detected whycon marker format, if any. (20)**

**Answer:**

The region of detection of markers is called operational space. The operational space of the camera with respect to whycon's frame of reference is pyramidal with its tip situated at the camera's aperture and its base placed over the horizontal plane of the marker. The algorithm resolves the whycon markers as ellipses with minor and major axis and the centers of these ellipses are identified, using cameras information. The coordinates of the centers are corrected with respect to the center of the image frame (square or rectangular image) taken by the camera. Therefore, the x and y of the marker coordinates identified by the algorithm are the relative distance of the center of marker with respect to exact center of image (The image center divides the image into four quadrants). The z axis coordinate is the relative distance of the marker from camera's plane obtained by whycon from the camera\_info node. In summary, the pattern’s orientation and position with respect to camera's frame of reference is given by eigen analysis of the characteristic equation obtained from the ellipse representing the marker. If the orientation of camera is changed keeping the physical location same, which we tested in the gazebo world by changing parameters in the task\_1.launch file, the whycon markers coordinates did not seem to change. This is because, the information of camera is passed to the whycon algorithm and thus, when the orientation of the camera is changed, whycon algorithm takes neccessary corrections to calculate the position of markers using that new information. Thus, even when camera orientation is changed, the whycon markers are detected accurately with respect to image axis. However, change in yaw of the marker goes unnoticed.

**Q3. Why do we need to specify the number of whycon targets before running the node? Can the number of targets be changed at runtime? If yes, explain how. If no, justify. (20)**

**Answer:**

Whycon markers placed in a single frame of image are identified one by one by its localisation algorithm. The algorithm can search for as many markers as mentioned as target number in the launch file or passed as argument to its script. If the number of markers is lesser than the number of targets, the algorithm continues searching for another marker and never determines the markers' positions until the number of markers detected is equal to target number. Similarly, if the number of marker is greater than the number of targets, the remaining markers go undetected. For example, if the number of targets is passed as 5 to whycon detection algorithm, the whycon algorithm searches for only 5 targets in the image. Once all the 5 markers are detected by the algorithm, it displays the markers coordinates. As a result, if the number of markers placed is 6 and number of targets is 5, the algorithm searches for only 5 markers, displays the coordinates for first 5 detected markers and the remaining one marker goes undetected. Similarly, if number of markers is 4 for the same target number, the algorithm detects 4 markers but keeps searching for the 5th marker and since it can never find one, it never displays the coordinates for other 4 markers too! It can be inferred that the algorithm searches and detects the markers based on this target number, and thus **for accurate and reliable recognition of the marker by the algorithm, it is essential to specify the number of whycon targets before running the node.**

However, so far **Whycon does not allow dynamic reconfiguration of number of targets and hence it cannot be changed on runtime**. This is because, when the algorithm determines a particular target in the previous frame, in the next frame the detection starts at the same position. If the target number were changed, the algorithm would have started searching the whole frame of the image again (computation time and stability of results is affected). If the target number has to be changed, then the algorithm (or the node) has to be restarted as all the markers must be available and detected until they are lost for the specified number of targets. Therefore, changing target number is not possible on runtime.

Moreover, changing the parameter value on runtime using command '***rosparam set /whycon/targets 4***' is not possible as it only affects the value in the parameter server of the ROS master but does not affect the actual value in the whycon detection node.

It is, however, possible to pass the number of targets as parameter to the whycon launch file while launching the node using the following command line argument:

***roslaunch whycon whycon.launch targets:=x***

where x is the number of targets to be passed.