Explanation of ArUco Tag detection is **well explained** here:
ArUco Library Documentation

Code used for TARS is based on this GitHub (**following these steps can recreate the code**):
https://github.com/immersive-command-system/Pose-Estimation-Aruco-Marker-Ros

1) **Obtain image from USB Cam**
   Usb_cam (http://wiki.ros.org/usb_cam) package was used to obtain the /image_raw topic from the USB Cam on TARS.

   Added camera image flip to source code based on:
   https://github.com/ros-drivers/usb_cam/pull/116/commits/89dd4ca50aa189df7212b5bb48792f6aaa5d10ed (this is because TARS usb cam module natively flips the image, so need to flip it back) remove this part of the code if needed.

   Note: param highlighted in yellow

```
<launch>
 <node name="usb_cam" pkg="usb_cam" type="usb_cam_node" output="screen" >
   <param name="video_device" value="/dev/video2" />
   <param name="image_width" value="640" />
   <param name="image_height" value="480" />
   <param name="pixel_format" value="mjpeg" />
   <param name="camera_frame_id" value="usb_cam" />
   <param name="io_method" value="mmap"/>
   <param name="image_flip" value="true"/>
   <param name="image_flip_code" value="1"/>
 </node>
 <node name="image_view" pkg="image_view" type="image_view" respawn="false"
output="screen">
   <remap from="image" to="/usb_cam/image_raw"/>
   <param name="autosize" value="true" />
 </node>
</launch>
```

   In the launch file of usb_cam pkg, change the param value of /dev/videox based on your camera's port (eg. video0,video1,video2 etc.) Also, change the pixel format based on your camera's supported format (eg. yuyv, uyvy, mjpeg, grey, rgb24, yuvmono10).

2) Camera calibration to remove distortion

Follow the calibration steps mentioned in
ArUco Detetction TARS Auto Docking

Note: To run calibration script, **execute the following**:
$ rosrun camera_calibration cameracalibrator.py --size 8x6 --square 0.108 image:=/usb_cam/image_raw camera:=/usb_cam

Change –size 8x6 to –size <your grid size>, –square 0.108 to –size <size of 1 grid square in metres>. Ensure the topic names for image and camera match your settings.

3) Aruco_ros Pose Estimation

Install aruco_ros pkg from ArUco Detetction TARS Auto Docking, this pkg publishes the /aruco_single/pose topic (pos x,y,z and quaternion x,y,z,w)

Note: In aruco_ros/src/simple_single.cpp

```
poseMsg.header.frame_id = reference_frame;
          poseMsg.header.stamp = curr_stamp;
          //poseMsg.pose.position.z=(poseMsg.pose.position.z+0.0844)/1.26; //Add
camera offset of z-axis here
          pose_pub.publish(poseMsg);
```

The line highlighted in yellow is the **“manual offset”** used to correct the pose z value based on real-world experiment testing. Change this value to offset your error.

4) My_aruco_tracker pkg

This package combines the usb_cam pkg and aruco_ros pkg to be used together, the write_data python script can be ignored

5) Docking movement pkg

```
<launch>
   <node pkg="docking_movement" type="docking_OOP.py"
name="auto_docking_test_node" output="screen"></node>
   <param name="x_offset" value="0.22" /> <!-- x offset of camera to robot centre
in meter -->
   <param name="y_offset" value="0" /> <!-- y offset of camera to robot centre in
meter -->
   <include
file="/home/nvidia/tars_ws/src/docking_movement/launch/usb_cam_stream_publisher.l
aunch"/>
   <include
file="/home/nvidia/tars_ws/src/docking_movement/launch/aruco_marker_finder.launch
"/>


</launch>
```

This package includes the docking movement for TARS, the launch file launches usb_cam and aruco_ros pkgs with the command:
Roslaunch docking_movement dock.launch (gazebo.launch is used align with gazebo only, difference in tag size)

Run:
1. Usb_cam_stream_publisher.launch (to run usb cam only)
2. Aruco_marker_finder.launch (to detect aruco tag only, must launch usb_cam_stream_publisher first)
3. Aruco_gazebo.launch (for gazebo use)

4. roslaunch docking_movement **dock.launch to run the whole package (usb cam, detect aruco, docking movement in 1 file)**

NOTE IMPORTANT:
Make sure when migrating packages to a new system (ie.PC), migrate the **camera_info folder in /home/.ros as** well