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Tasks

1) **Talker listener:**
   The source and readme can be found here:
   https://github.com/princebansal/ros-bootcamp/tree/master/talker-listener
2) **RRBot Control**
   The source and readme can be found here:
   https://github.com/princebansal/ros-bootcamp/tree/master/rrbot-control

Questionnaire

1. What are WhyCon markers and how do they work?

WhyCon is a version of a vision-based localization system that can be used with low-cost web cameras, and achieves millimeter precision with very high performance. The system is capable of efficient real-time detection and precise position estimation of several circular markers in a video stream. It can be used both off-line, as a source of ground-truth for robotics experiments, or on-line as a component of robotic systems that require real-time, precise position estimation. *WhyCon* is meant as an alternative to widely used and expensive localization systems. It is fully open-source. *WhyCon-orig* is WhyCon's original, minimalistic version that was supposed to be ROS and openCV independent.

The base of the localization system is an efficient circular target (ring or roundel) detector. This efficiency allows for detection of hundreds of targets above camera frame-rate. The targets can be easily printed on a B&W printer. A single target allows for obtaining 5DoF (3D position + 2 angles). When constrained on planar (ground) motions, the precision can be further improved.

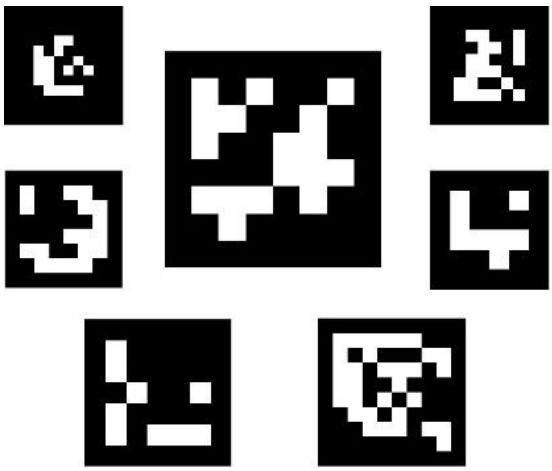
WhyCon is comprised of a very-efficient circle detector module, which employs a strategy similar to connected component labelling, although optimized for the particular case of a circular black ring pattern. On top of this, there is a class handling the process of detecting multiple targets on a single image. Finally, from all the detected circles, a series of computations are performed which recover the 3D position of each circle.

References:
1) https://github.com/lrse/whycon
2) https://core.ac.uk/download/pdf/42583963.pdf

2. What are AruCo markers and how do they work?

Pose estimation is of great importance in many computer vision applications: robot navigation, augmented reality, and many more. This process is based on finding correspondences between points in the real environment and their 2d image projection. This is usually a difficult step, and thus it is common to use synthetic or fiducial markers to make it easier.

ArUco markers are binary square fiducial markers that can be used for camera pose estimation. Their main benefit is that their detection is robust, fast and simple.



The aruco module includes the detection of these types of markers and the tools to employ them for pose estimation and camera calibration.

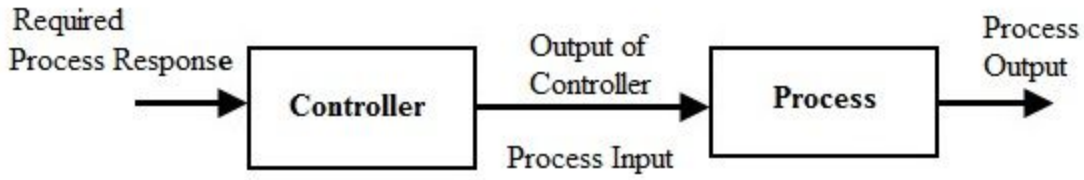
References:

1) *https://docs.opencv.org/master/d5/dae/tutorial_aruco_detection.html*
2) *https://docs.opencv.org/master/d9/d6d/tutorial_table_of_content_aruco.html*
3) *https://www.youtube.com/watch?v=_gvvK6h-wxg*

3. Difference between open-loop and closed loop controllers?

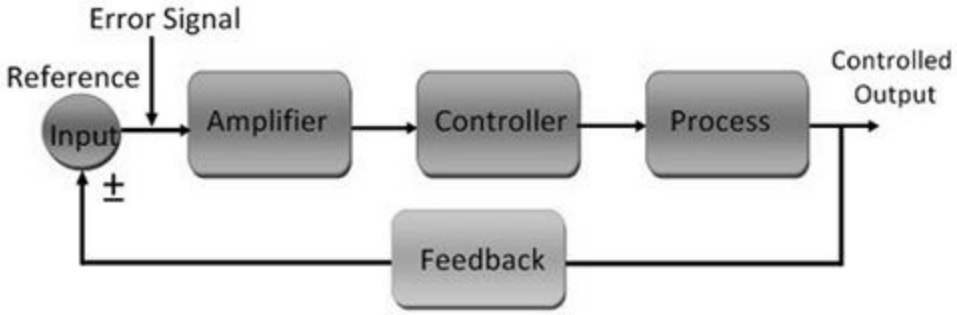
What is an Open Loop Control System?

In this kind of control system, the output doesn't change the action of the control system otherwise; the working of the system which depends on time is also called the open-loop control system. It doesn't have any feedback. It is very simple, needs low maintenance, quick operation, and cost-effective. The accuracy of this system is low and less dependable. The example of the open-loop type is shown below. The main advantages of the open-loop control system are easy, needs less protection; operation of this system is fast & inexpensive and the disadvantages are, it is reliable and has less accuracy.



What is a Closed-Loop Control System?

The closed-loop control system can be defined as the output of the system that depends on the input of the system. This control system has one or more feedback loops among its input & output. This system provides the required output by evaluating its input. This kind of system produces the error signal and it is the main disparity between the output and input of the system.



The main advantages of the closed-loop control system are accurate, expensive, reliable, and requires high maintenance.

References:

a. *https://www.elprocus.com/difference-between-open-loop-closed-loop-control-system/#:~:text=The%20main%20difference%20between%20open,depends%20on%20the%20controlled%20act.*

4. What are PID controllers?

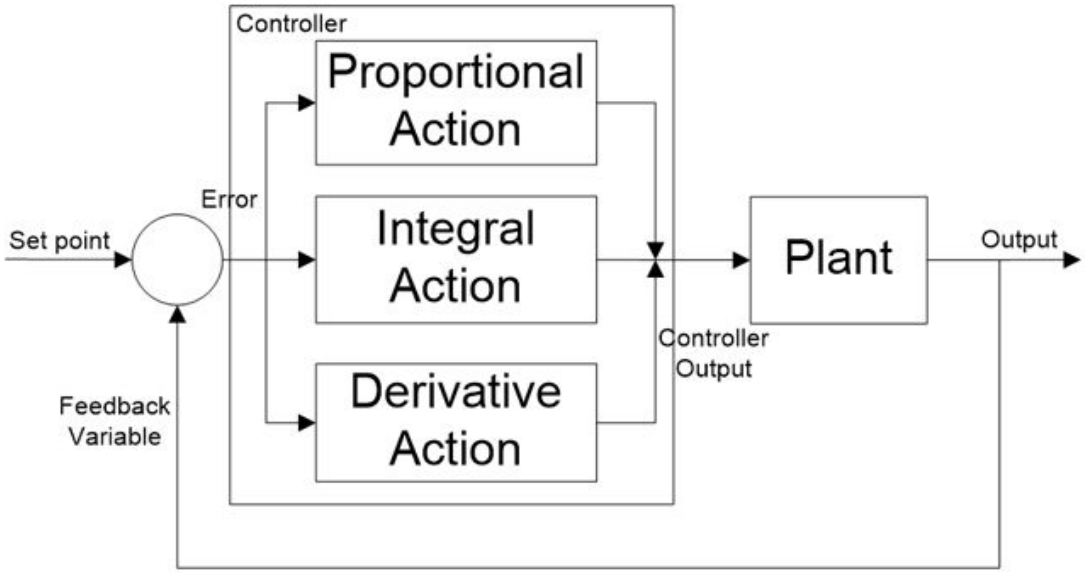
A PID controller is an instrument used in industrial control applications to regulate temperature, flow, pressure, speed and other process variables. PID (proportional integral derivative) controllers use a control loop feedback mechanism to control process variables and are the most accurate and stable controller.

References:

1) https://www.omega.co.uk/prodinfo/pid-controllers.html

2) https://youtu.be/1ImhKwpSmuc

5. Flow chart to explain the working of a PID algorithm



References:

1) https://circuitdigest.com/article/what-is-pid-controller-working-structure-applications

6. Optimum way to tune a PID controller

https://www.youtube.com/watch?v=sFOEsA0Irjs