e-Yantra Robotics Competition - 2018
Pollinator Bee

<1027>

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Q1. Figure 1 is a graph of a PID Controller. **(7.5)**

a. **What do the red line and the green line at 0 signify in the graph?**
b. **What effects do the Kp, Ki and Kd values have on the wave shown in the graph?**

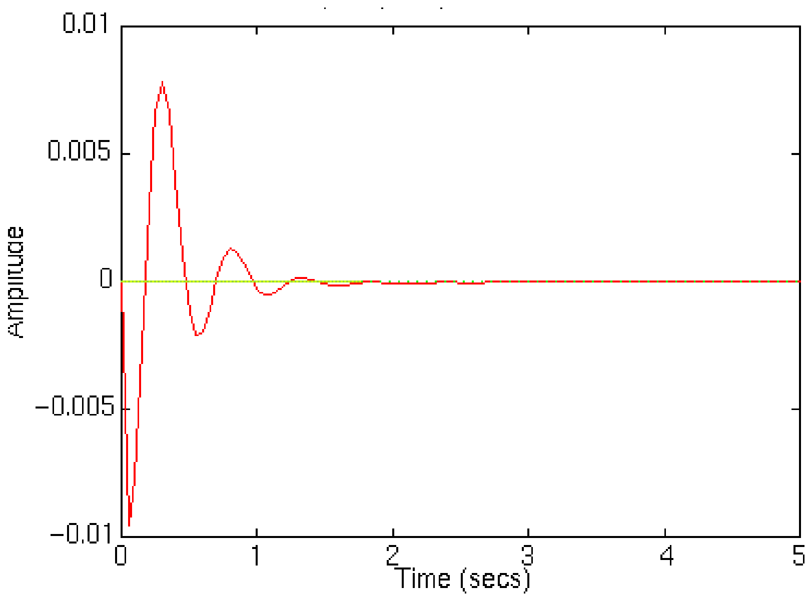


Figure 1: Graph of a PID Controller

a. The green line in the graph is the zero error line and the red line in the graph is showing the current altitude error after applying PID to the corresponding model , this error is the difference between set altitude and current altitude. And the red line at zero is overshooting.
b.

- Effect of Kp= It is the one which is producing the overshoot at the start also causing the rise time to be less.
- Effect of Ki= Ki helps in bringing the steady state error value to zero. Also it is decreasing the rise time
- Effect of Kd= Kd is multiplied with the rate of change of error or derivative , it helps in reducing the oscillations. As seen in the above graph after the overshoot the oscillations are decreased by Kd constant.

Figure 2 is a graph of a PID Controller. Notice how the red line sets itself immediately to the desired set point. For a PID controller with a response as shown in Figure 1, what changes should be made to the Kp, Ki and Kd values in order to achieve the graph in Figure 2? Explain your answer in detail. (7.5)

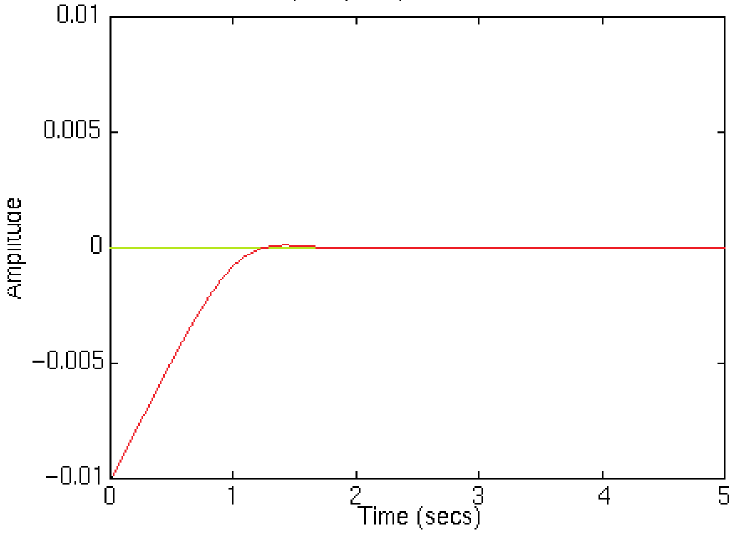


Figure 2: Graph of a PID Controller

Answer: ____________________

- In the graph shown in Figure 1, it is observed that rise time is very less and it is overshooting hence in the second figure it more so that Kp value is decreased a lot.

- we should decrease the Kp value slowly till the time overshoot is minimum, we should decrease it slowly because too much decrease in the value of Kp will also cause overshoot.

- After the Kp value is decreased, The oscillation in the fig 2 is reduced with repect to fig 1, to achieve this Kd value is increased because Kd helps in decreasing the oscillations. After the change of value of Kp and Kd , if there is steady state error , then ki is increased because Ki helps in bringing the steady state error to zero. If there are no oscillations or steady state error Kd and Ki are not changed.

Q2. Given a static set point in a 3D space defined by (x,y,z) coordinates, answer the following questions: (i) how would you move the drone from its current position to this set point and (ii) how would you ensure that the drone is on the set point and it is ready to go to the next way point?
Explain the pseudocode you would implement in detail. (15)

Answer: ____________________

i) With respect to the simulation,first through a program we initialise the necessary conditions required for the drone to get armed ,take off,disarm etc . The drone is then controlled by PID controller. A PID controller continuously calculates an error value which will be the difference between a desired set-point and measured current coordinates. By measuring the the position and substracting from the given set point ,PID algorithm calculates how much value to supply or reduce from the initial one so that the drone hovers over the given set point.

ii)we can ensure that the drone is at the set point in many ways.We can ensure it by analysing the graph where if error is zero then it will be at the set point.Through /whycon/poses which publishes the the coordinates of the whycon marker placed on the drone or through whycon image out where we can visually see the coordinate and the drone.

pseudocode:
set_point=co-ordinates of the set point
current_position=co-ordinates of the current position
previous_error=0
integral=0
loop:
error=set_point-current_position
integral=integral+error
derivative=error-previous_error
output=Kp * error + Ki*integral + Kd*derivative
previous_error=error
loop repeat

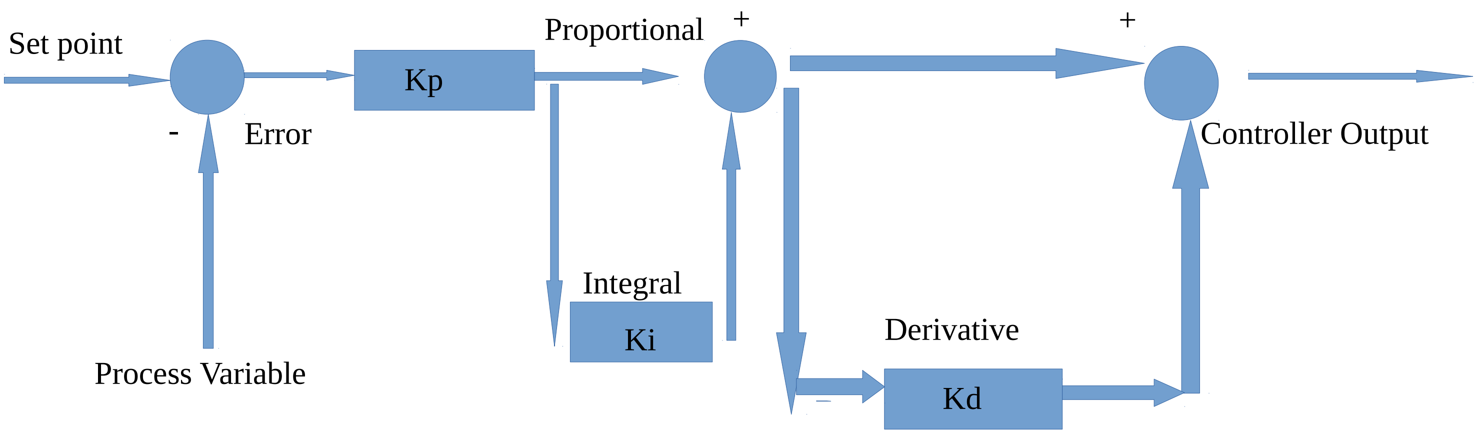
- In the above Pseudocode first set _point and current_position are initialised first. Then error calculates the difference in measured current coordinate and the set point.
- The current position is supplied by the whycon/poses.
- Then PID algorithm takes this error and with the assigned Kp, Ki, and Kd values it gives out a correction value(output in the code).
- This correction value is then either subtracted or added to the initial value and this process repeats.
- Here the initial value maybe throttle, pitch, roll or yaw.

Q3. In order to achieve the task in Problem Statement 1.1, did your team implement a cascaded PID loop or a parallel PID loop for maintaining the roll, pitch and yaw of the drone? Explain the reason of your choice with advantages and disadvantages over the other option. Use a block diagram to explain your answer in detail. (20)

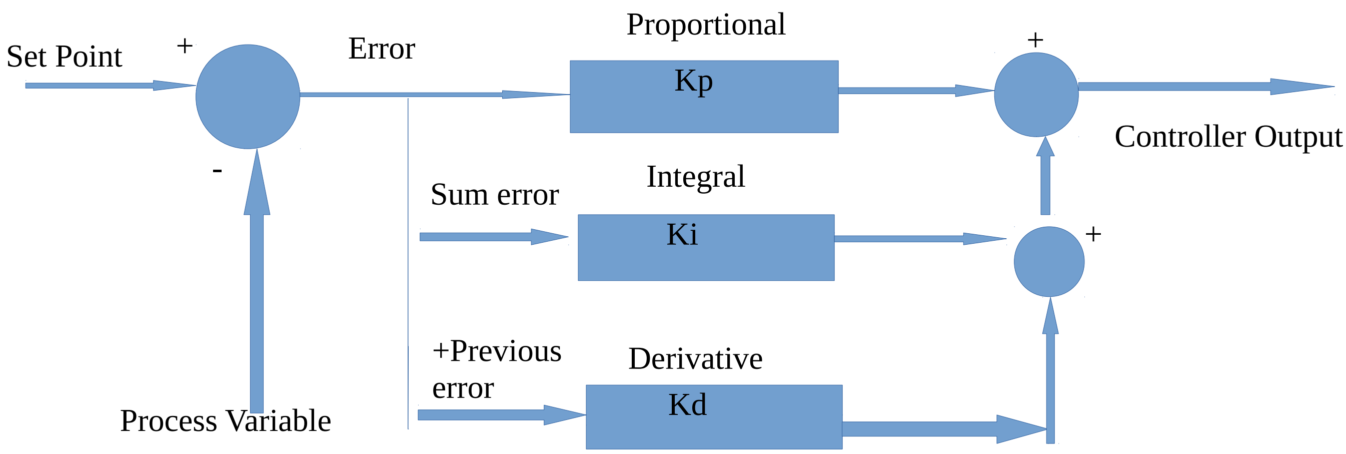
Answer: ____________________

- We implemented parallel PID.

- Cascaded loop block diagram:



Parallel loop block diagram:



The reason is in the parallel PID loop the proportional ,integral and derivative actions are working separately with each other and combine effect of these three actions are act in the system,this makes the code simpler where each actions are computed independent of other and after that all the three are added up to give an output , block diagram of parallel pid loop is shown above(Parallel loop block diagram).

Advantages and disadvantages:

- In the parallel loop each action parameter i.e kp,kd,ki is independent of each other.

Whereas cascaded pid loop each part is dependent.

- In a cascaded PID control control system the two other parameter for example I and D will depend on P,hence the values can’t be determined without the first one being processed.Increasing and decresing values of any parameters will have an higher impact on entire system and the curve destabilizes more,the entire system has to be tuned from the beginning. Reducing the value of any constants will result in unexpected operation and no much chance of optimisation will be available.
- Cascaded loops are more accurate ,disturbances dont cause harm and are used more in industrial process.
- We can easily vary the value of P in the parallel loop and see small effect by it but in cascaded loop it drives both D and I.
- In parallel PID loop not only does the increase in Kp more than required causes the overshoot but the decrease in Kp also causes the overshoot.