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Professional paper

MOTORS AND CONTROL OF MECHATRONICS MOVEMENT SYSTEMS

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Abstract

The presented paper aims elaborate on and understand the motors and control of the propulsion systems. Motion control systems are the backbone of many applications in a wide range of industries. Their use ensures greater accuracy, reliability, and efficiency. Many of us already work with motion control systems. Others may encounter a motion control system in their workplace. Therefore, it is essential to understand each component of motion control.

Motion control systems are generally divided into two types: opened circuits and closed circuits. Each system has its advantages and disadvantages. Open-circuit systems are usually more affordable, while closed-circuit systems can achieve greater accuracy and complexity.

The motion controller is the brain of the system which controls the motion path, closing the servo circuit and executing the sequence.

The controller sends a low-power command signal to the motor or amplifier in digital or analog form.

Moving the motor amplifies the signal, produces torque and sets the load in motion, so that the motor drive controls the speed, torque, and direction, determining the power of the motor. Finally, the response sensors record the performance and send information to the controller of any change in engine position or speed. Choosing the right motion control components in relation to the system architecture is crucial as it determines the performance of the machine or the performance of the automated system.

Keywords: motors, amplifier, motion control, reliability and efficiency, open circuitandclosed circuit, sensor.

1 Introduction

The objective of the research project described in this article is to choose the right architectural control in the connections with the connections to the decision-making system after the performance of the machines or the performance of the automated system. Although a wide range of motion control components is marketed by vendors across the globe, designers still need to consider the interdependence of different parts in the system. Failure to consider system requirements may increase the likelihood of

Compliance issues while reducing system efficiency. A unique role in achieving accurate motor control and improving the efficiency of the system is realized by the electronic motion control system which consists of several main elements respectively: controller, motor, motor drive, and reaction sensors. The first main part of this is talking about motors, their types, and about DC motors, types of DC Motors, advantages, and disadvantages. The second main part of this article shows movement systems control basics and motion controllers. In the end, will be shown how to stabilize the oscillations during the operation of the DC motor. We will do the control in Matlab / Simulink by simulating the DC motor model.

For the input of the voltage of 1V, we have derived the output- the angular velocity ω, of the DC rotation.

2 Servo motors

In general, all servo motors fall under the group of permanent magnet motors, both in the stator and in the rotor. Servo motors have integrated encoders that function as response sensors. These sensors collect data about the position and speed of the rotor, enabling servo motors to operate with high accuracy and durability. As motion control technology evolved, engineers discovered that servo amplifiers could be modified and deployed to control other types of motors in the same way as servo motors. Servo motors are used in millions of applications from remotely driven vehicles, and CNC engravers to surgical robots. Servo motors are known for many reasons, including their energy efficiency and their size. But more importantly, they can provide very precise control when they have a feedback device and a servo drive.

2.1 *DC MOTORS: DC*

Motors are used in various applications such as defense, industry, robotics, etc. Due to their simplicity, ease of application, reliability, and favorable cost for a long time has been a pillar of application in the industry. DC Motors have a long tradition in the use of cars with adjustable speeds and a wide range of options and for this purpose, they have had a great evolution. In these applications, the engine must be precisely controlled to give the desired performance. Many varieties of control schemes such as P, Proportional Integration (PI), Partial Proportional Integration (PID), Adapter, Fuzzy Logic Controller (FLCs), and Artificial Neural Networks (ANNs) have been developed for speed control. DC motors.

ADVANTAGES OF DC MOTOR:

- Ease of control;
- Provide high torque;
- Near-linear performance.

DISADVANTAGES OF DC MOTOR:

- High costs of maintenance;
- Large and expensive (compared to induction motor);
- Not suitable for high-speed operations due to switch and brushes;
- Not suitable for explosive or very clean environments.

2.2 *BRUSHED DC MOTORS (single phase):*

Brushless DC Motors are simple motors that rely on magnetic fields to move the rotor. With less complex technology than many of the other motors, the brushed DC motor can offer reliable performance at a relatively cheap price. The disadvantage of this engine as well as other types of engines is that the engines encounter constant friction which over time can cause wear and tear.When electric current passes through the windings, the magnetic field creates a force that causes the rotor to move. The switch is a round piece with metal contact points connected to each of the rotor coil loops.

2.3 BRUSHLESS DC MOTORS (three-phase):

Evolving from Brushed DC Motors (single-phase), brushless DC motors (three-phase) are designed to operate in more compact spaces although without sacrificing performance. Unlike brushed DC motors in which energy passes in a fault spiral in brushless DC motors electricity passes through the stator. While brushless DC, motors are more expensive than Brushed DC motors they are generally more durable and require less maintenance.

3 Brushless AC motors

Similar to DC motors, brushless AC motors pass electrical current through a stator and display magnets on the rotor. The difference is that AC motors run a constant electric current, providing a much smoother rotation. Brushless AC motors are very efficient. As a result, they are very popular among motion control experts and professionals.

3.1 *STEPPER MOTORS:*

Stepper motors have an internal rotor that is influenced by an external magnet. Once the power output under the spiral effect the rotor teeth turn into fixed steps. After the advantage of acceleration of motion, the stepper motors' other advantage has the change of speed and direction.

3.2 *AC INDUCTION MOTORAC:*

Induction motor is one of the most common types of motors in heavy industry and machinery. What distinguishes the induction motor from the rotary motors mentioned above is that induction motors do not use permanent magnets. They rely on a rotating magnetic field created in the stator to induce rotor rotation.

3.3 *LINEAR MOTORS:*

As the name implies linear motors can be thought of as wrinkleless motors. A major advantage of using a linear motor is the speed.

3.4 *LINEAR ACTUATORS:*

Linear actuators combine technology from rotary motors and linear motors to produce a cost-effective machine that enhances functionality compared to the above motors.

4 Motion systems control basics

The motion controller is a subfield of automation, which includes the system or subsystem involved in the moving parts of cars in a controlled manner. Motion controllers act as the brain of the system by taking the desired target position of the motion profile and creating trajectories for the motors to follow. It emits a +/- 10V signal for servo motors and a scale and direction pulse for stepper motors.

5 DC motor simulation in matlab / simulink

Computer simulation is the discipline of designing a model, of a current or theoretical physical system, executing the model on a digital computer, and analyzing the output of the execution. Simulation embodies the principle of learning by working to learn about the system we must first construct a model of type and then act on the model.

Advantages of Simulation:

- Can be used to study existing systems without interruption of operations;
- Proposed systems can be tested before results are performed;
- We can control the time;
- We can understand which variables are most important for system performance.

Disadvantages of Simulation:

- The quality of the analysis depends on the quality of the model and the ability of the modeler;
- Sometimes simulation results are difficult to interpret;
- Simulation analysis can cost time and money;

In Matlab / Simulink a simulation of the DC motor model has been realized. For the input of the voltage of 1V, we have derived the output - the angular velocity ω, of the DC rotation. It is understandable that both through the transmitting function and through the state space we have the same results.

From the results, it can be seen that within 1 second the DC motor has reached an angular velocity slightly above 0.08s-1.

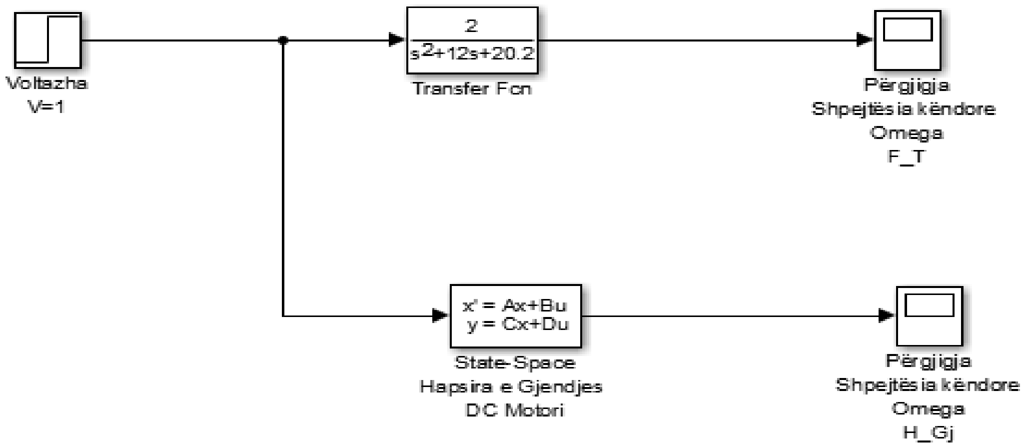


Figure 1. DC motor model simulation.

5.1 *Simulation and adjustment of dc motor with critical pid:*

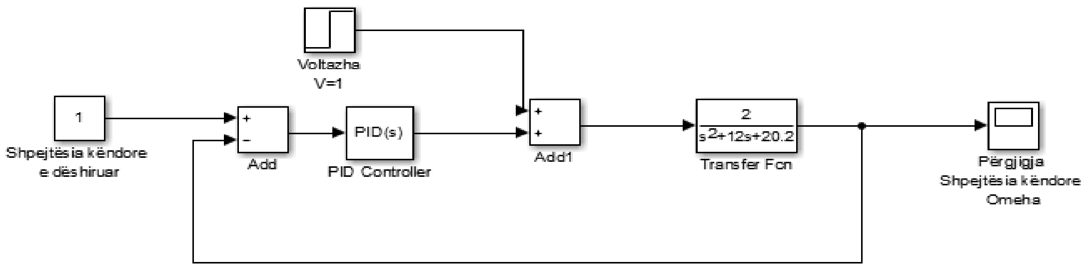


Figure 2. Simulation and adjustment of dc motor with critical PID

Unable to stabilize DC Motor oscillations by adjusting angular velocity in simulink library we insert critical PID in this form.

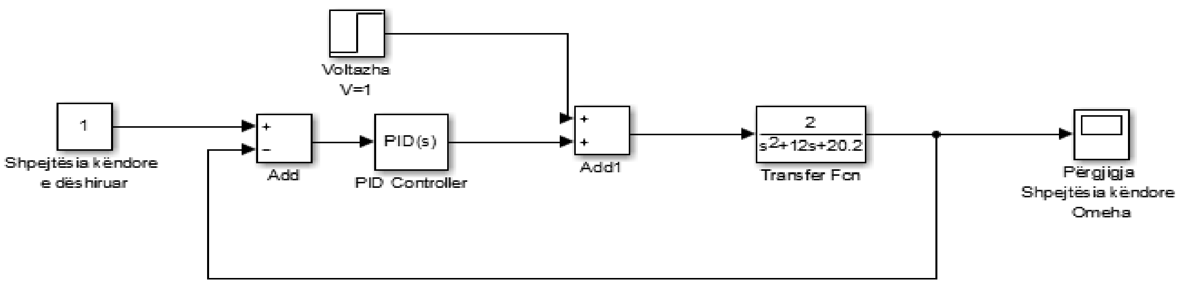


Figure 3. Simulation and adjustment of dc motor with critical PID

After adjusting the critical PID parameters the angular velocity response curve will be:

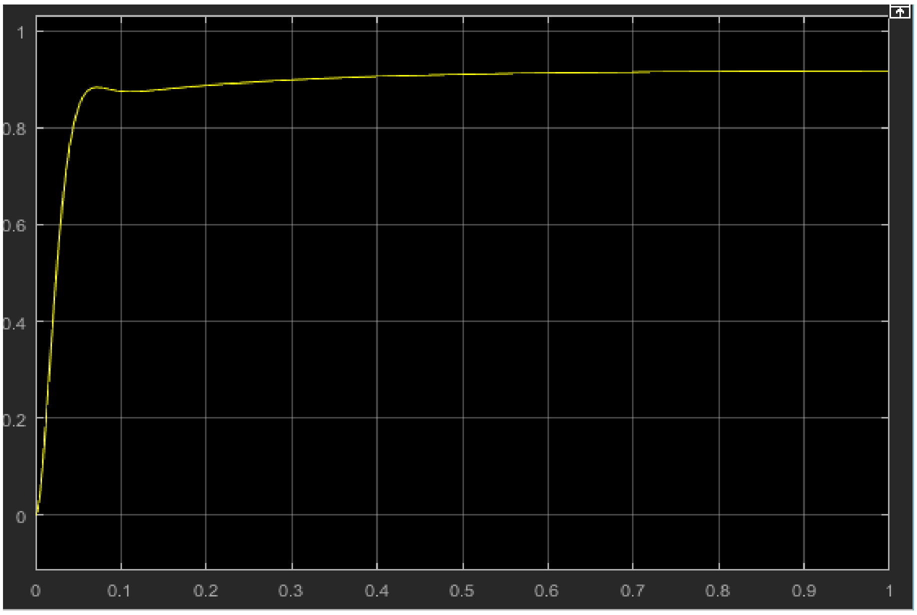
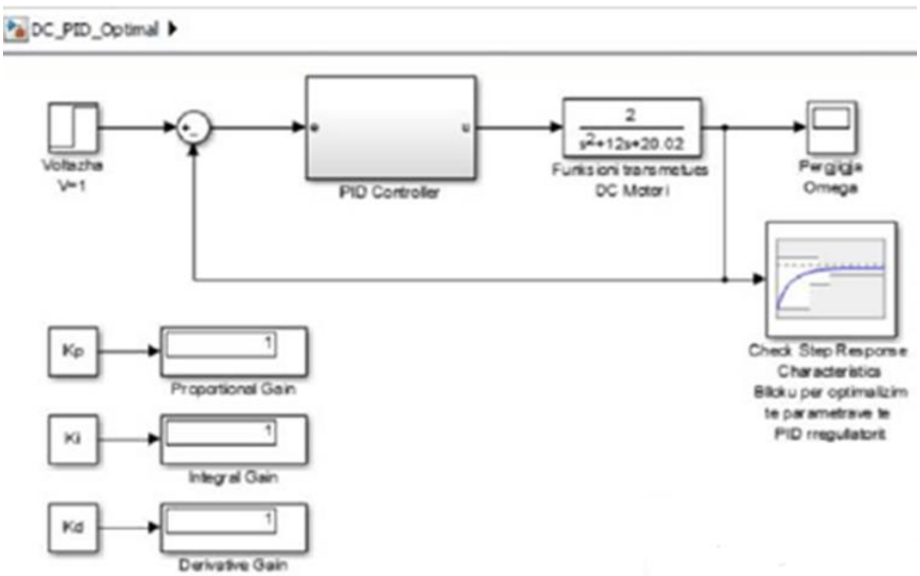


Figure 4. Angular velocity response

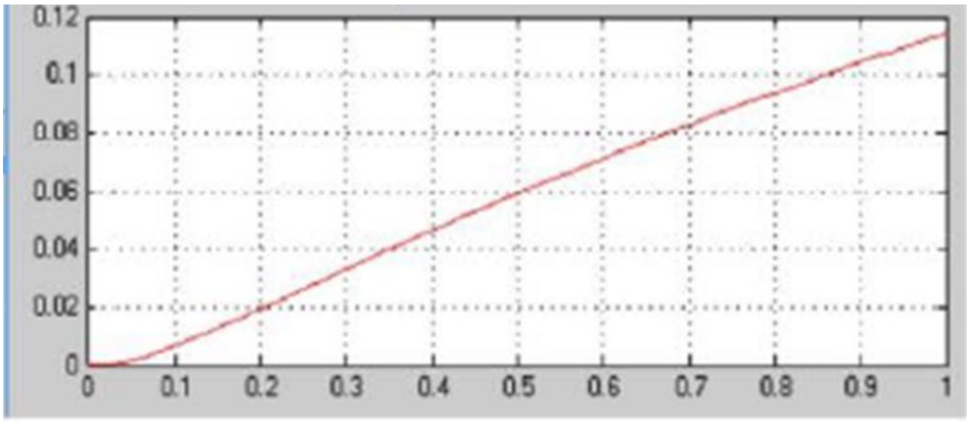
From the curve the DC motor has reached over 0.8s/1 angular velocity but not that 1.

5.2 *Simulation and adjustment of dc motor with optimal pid*

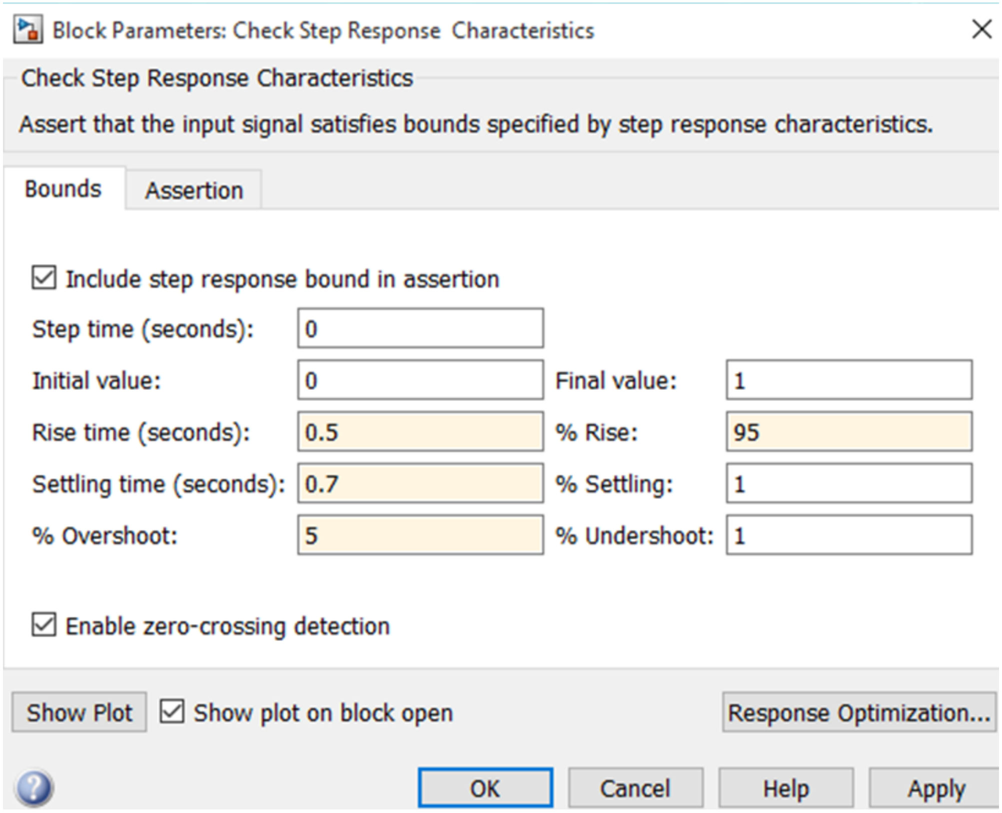
In the simulation with optimal PID, the angular velocity is removed as the same could not stabilize the oscillations, while in its place we will place the block for optimization of the parameters of the PID regulator



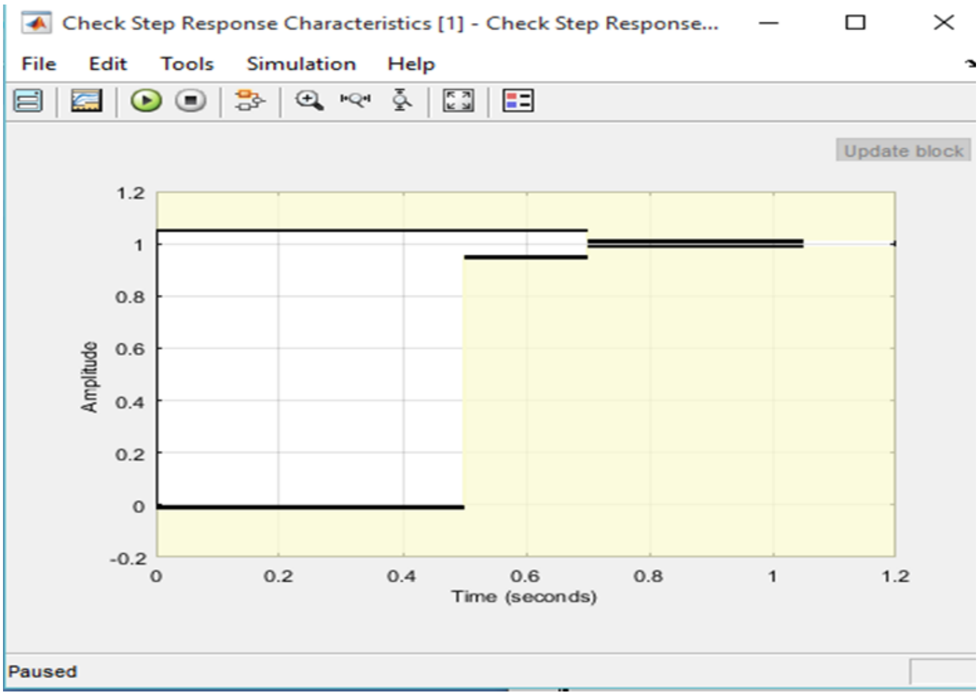
1 Values are given for the proportional, integral and derivative output, from this the output will be presented to us:



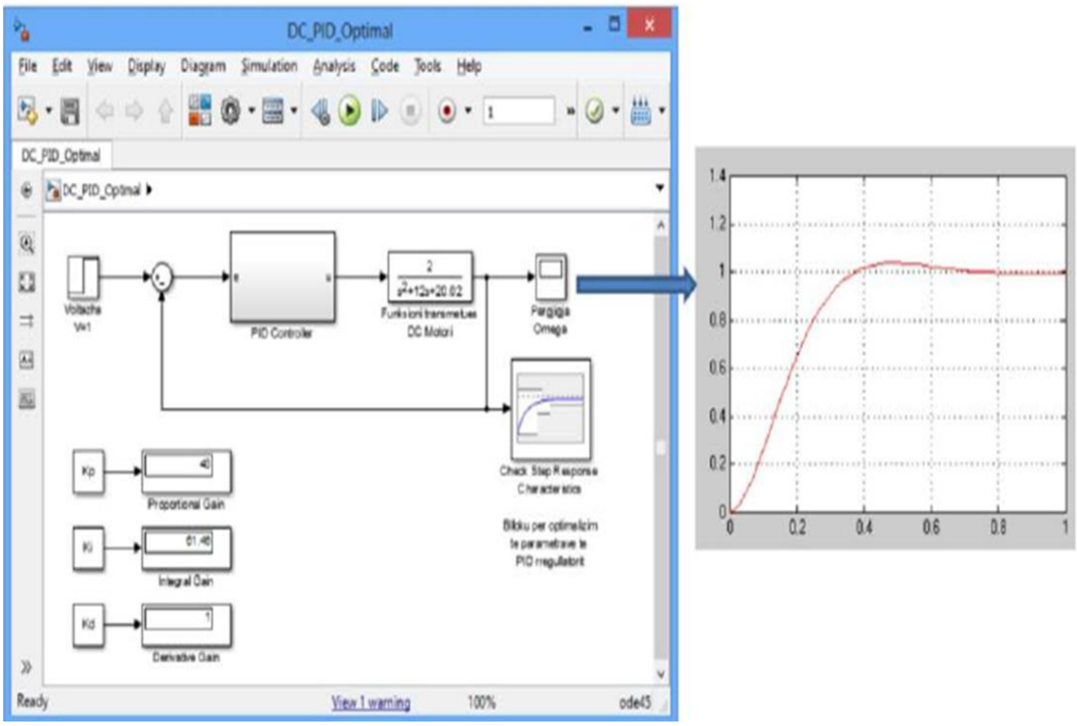
It seems that for PID 1-1-1 for 1s omega has reached close to 0.12s-1. but the value we want to achieve the curve is 1, since this value was not achieved even with the adjustment of the optimization block, we tried to get the required value by adjusting the block **Check Step Response Characteristics**



After giving the above values we click Response Optimization "and we will have the following image:



To stabilize the curve we give the optimal PID parameters: KP = 40; K I = 61.5; KD = 1.



From this we see that the gold curve stabilizes when it reaches the value of 1 and with this we conclude that the oscillations in the DC Motor have stabilized and that the purpose of elaborating the work has been achieved.

Conclusion

A modern motion control system usually consists of a motion controller, a motor or amplifier, an electric motor, and a reaction sensor. The system may also contain other components such as linear guides, belt shafts, screws, or screw guides. A motion controller today can be a standalone programmable controller, a personal computer containing a motion control card, or a programmable logic controller (PLC). All components of a motion control system must work together seamlessly to perform their assigned functions. Their choice should be based on engineering and economic considerations. Motion control systems today can be found in a variety of applications such as material handling equipment, machine tool centers, chemicals, pharmaceutical process lines, inspection stations, robots, and injection molding machines.

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