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Modeling and Simulation of Antenna Azimuth Position Control System

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Abstract

The purpose of this paper is to describe the management system of the antenna position in the frequency range (with transfer functions) and in the state space representation (state time equations), also known as time–domain approach. The results of analytical calculations and programming package Matlab/Simulink will give the clear explanation of the response of the system. It will emphasize the importance of the results and indicate the possibility of further theoretical and experimental work on the same problem as well as the contributions in this field.

Keywords: *Antenna Azimuth Position Control System*

1. Introduction

The antenna azimuth position control system turns the input command in output position. This system is widely used in antennas, robots and computers disks. In this paper we present the systems that are managed with azimuth antenna. We're going to show how the system works and how its performance can be improved. The purpose of this system is the input angle to be turned into an output angle of the antenna. The figure 1 is showing how this system works. The potentiometer converts the angular rotating in voltage.[1]

Similar to that, on the output angle rotations are turning into voltage of potentiometer, which is connected to the feedback. Signal and gain are increasing the difference between the input and output voltage. When mistake will be zero, the motor will not start, or with other words only when the input and output have no match fig.2.

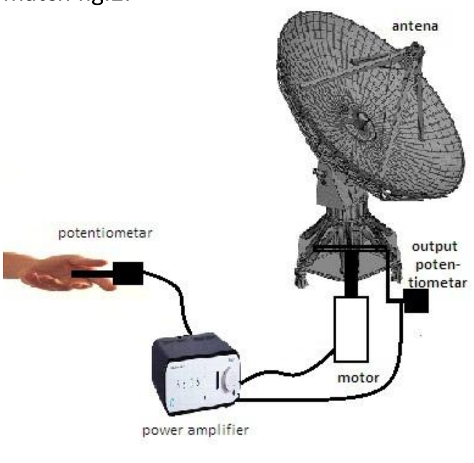

Fig. 1 Concept of the system

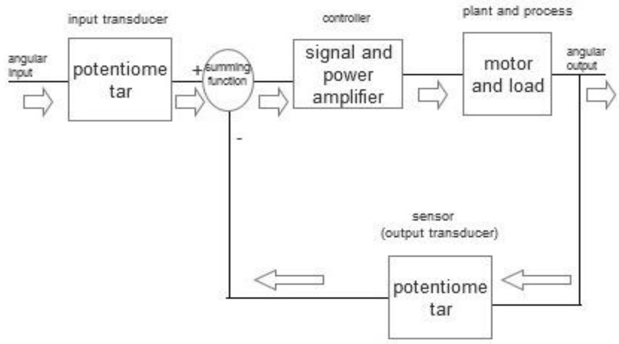

Fig.2 Function block diagram

2. Modeling system with transfer function

This section is dedicated to the physical system which can be modeled mathematically with transfer function. The system typically consist a subsystem of a different type, such as electrical, mechanical, or electromechanical. The first part of this paper contains examples which describes the transfer function on each subsystem. First we identify the individual subsystems of the system, in which you need to find the transfer function. They are presented in Table 1.[2][3]

3. Response of the system

In this section, we use transmission functions obtained from Chapter 2 and the obtained equations to describe the response of the output of this open system. It also showed the importance of the gender system in defining the transmission response. In this case, concept is used to analyze the open system of the controller. The function of the open system consists of an amplifier and motor Load.

Table 1 Subsystems of antenna azimuth position control system

Subsystem	in	out
Input potentiometar	Angular rotation from the user, $\theta_i(t)$	Preamplirier voltage, $v_i(t)$
Preamplifier	Voltage from potetiometars, $v_e(t) = v_i(t) - v_o(t)$	Power amplifier voltage, $v_p(t)$
Power amplifier	Voltage from preamplifier $v_p(t)$	Motor voltage, $e_a(t)$
Motor	Voltage from power amplifier, $e_a(t)$	Angular rotation of the load $\theta_o(t)$
Output potentiometar	Angular rotation from the load $\theta_o(t)$	Preamplifier voltage, $v_o(t)$

[4] Transmission functions of the amplifier, and engine load is calculated at the beginning. Interconnection of two subsystems is given in Figure 3. The different angular positions of the motor and the load is multiplied by s, and the angular speed is obtained, Figure 3. The equivalent transfer function representing the three blocks in Figure 3 is the product of specific transmission functions shown in Figure 3 (b). [5]

a)The use of the transfer function shown in Equation 3.1 , we can determine the nature of the step answer. Step response consists of a robust statement generated by prairie input and transfer function, which is the sum of two exponents generated from each pole of the transfer function. Thus the form of the response is:

b)Ratio and natural frequency of the open circuit can be found by expanding the denominator of the transfer function is

$$G(s) = \frac{20.83}{s^2 + 101.71s + 171} \quad (3.2)$$

$$\omega_n = \sqrt{171} = 13.08, и\ \xi = 3.89 \quad (3.3)$$

v) In order to derive the angular speed of the response of step input, we multiply the transfer function of equation (4.2), with input Step, 1 / s, and got:

$$\omega_0(s) = \frac{20.83}{s(s+100)(s+1.71)} \quad (3.4)$$

With the divide of partial fractions:

$$\omega_0(s) = \frac{0.122}{s} + \frac{2.12x10^{-3}}{s+100} - \frac{0.124}{s+1.71} \quad (3.5)$$

Transformation in the time domain:

$$\omega_0(t) = 0.122 + (2.12x10^{-3})e^{-100t} - 0.124e^{-1.71t} \quad (3.6)$$

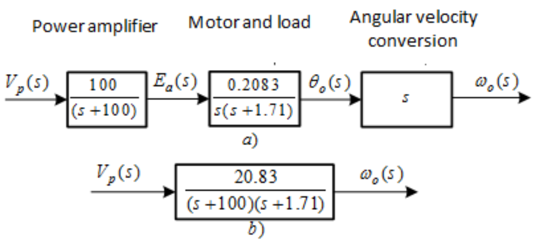

Fig. 3 Block scheme of the system

4. Design of the response of the closed-SYSTEM

This chapter shows that the physical subsystem can be mathematically modeled by transfer function, then they form a feedback. Mutual models can be reduced to a transfer function that represents the system from input to output. Then this transfer function is used to determine the response of the system. The next section describes how to reduce the subsystems to one, in order to analyze and design the transmission characteristics.[6]

Transfer function of the closed system using the algebra of block diagrams

After we find transfer function of each system separately , we collect systems in closed circuit , Figure 4 (a).

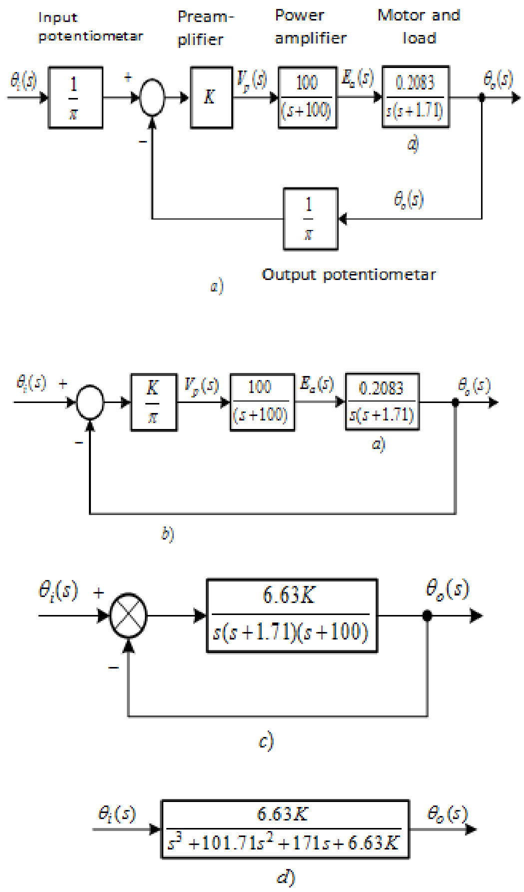

Fig.4 Reduction of block diagram of the antenna azimuth position control system

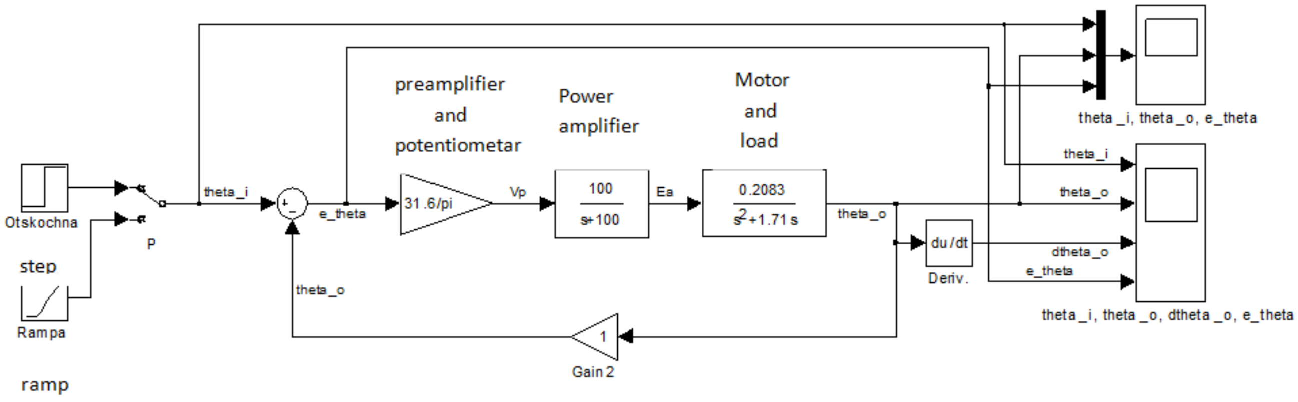

Fig.5.1 Simulink model of the system

The steps taken to reduce the block diagrams are showed at image 4. (a- d) . The figure 4 (b) input potentiometer is responsible for collection of functions and creating a backward system connection. In the image 4 (c) all blocks are multiplied together to form an equivalent transfer function . Final formula for loopback is used and provides a closed transfer function (4.d).[7][8][9]

5. Simulation of systems using the programming package MATLAB / SIMULINK

In this chapter we derive the programming package MATLAB / SIMULINK, in order to model management system, the azimuth antenna.

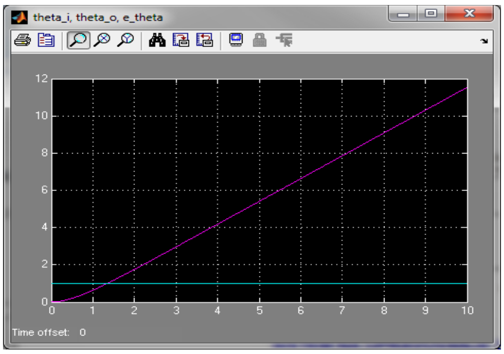

Fig.5.2 Step responses – open loop system

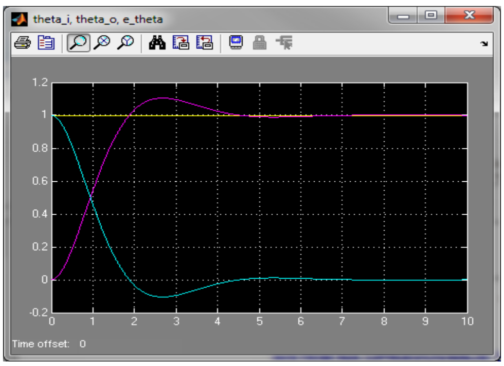

Fig.5.3 Step responses – closed loop system

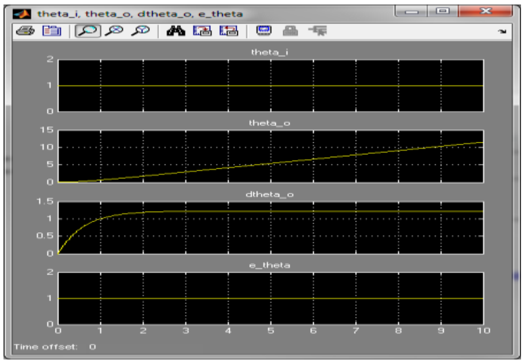

Fig.5.4 Step response-open loop system

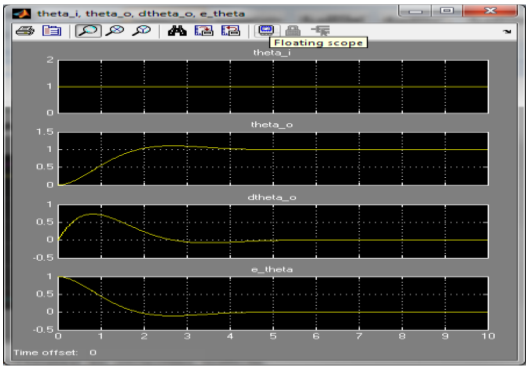

Fig.5.5 Step responses – closed loop system

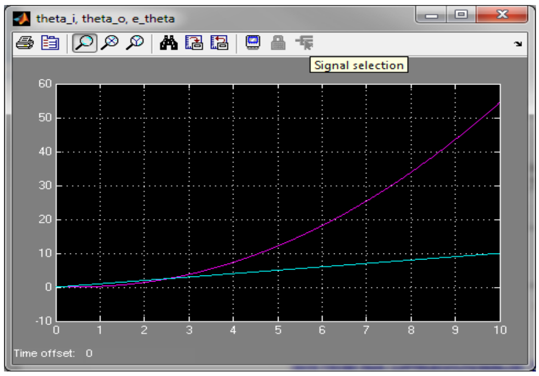

Fig.5.6 Ramp response-open loop system

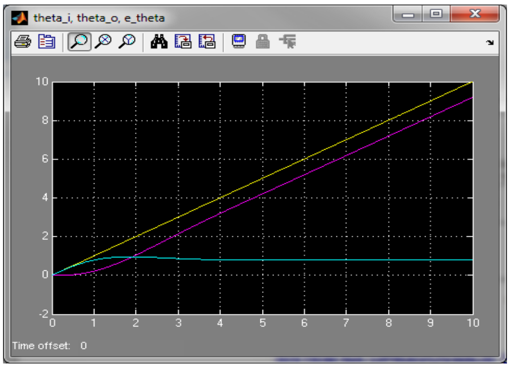

Fig.5.7 Ramp response-closed loop system

As seen from Fig. 5.1 we will see the response system for steps and ramp input signal. Using the oscilloscope it will show the signal before and after sumator, and at the end of the subsystems. Values for the signals will be seen in two cases: when we have an open system and when the system is closed. These values we can see in Fig. 5.2 to Fig 5.9.

Conclusion

The antenna azimuth position control systems greatly simplify and reduce the human work. They're used in many areas of daily life. The system was given to us that had already been analyzed by hand. We first had to read about the system and conceptually figure out how it was working.

We also used Simulink to verify these results. Pictures made in MATLAB show how the system responds to step and ramp signal after each subsystem.

After all completed analysis, this system is completed and his basic concept were understood. All possible solutions are presented above, using mathematical equations and simulation in MATLAB.

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