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SPEED CONTROL OF DC MOTOR AND ITS APPLICATION IN IDENTIFICATION OF THE OBJECT USING ANN

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Abstract— *In this research paper, the DC motor is controlled by a sensor which is used to sense the size of an object. The identification/sensing of object are based upon Artificial Neural Network. The proposed work is useful for enhancing the capabilities of the DC motor drive system for its use in conveyor belts and in security checks at airports, malls where objects are separated on the basis of shape, size, colour and weight. The Effectiveness of the Network is analysed by using different control/sensing methods like PID and Neural network. To regulate the speed and to separate/ identifying the object, the Neural Network is interlinked with speed control model of the DC motor.*

Keywords—*ANN, P CONTROLER, PI CONTROLER, PID CONTROLER , BPNN, BRUSHLESS DC MOTOR.*

I. INTRODUCTION

In everyday life we come across numerous applications of electrical motors such as electric pump used in house hold applications, in power plants, conveyor belts used in industries robotics, etc.
There are many motors, but primarily they can be classified into two categories:

- AC Motors
- DC Motors

For each and every application of electrical motors the speed control [4] is also required. Various controllers like Proportional, Proportional cum Integration and combination of three PID [1] are used for controlling the speed of motors. The paper is about the controlling of the speed of DC motor, which is based upon the shape and size of objects. A brushless dc motor is used for the research purpose. The PID controller [1] is employed in the feedback process to regulate the speed of the DC motor. The speed control of DC motors is easy as compared to AC motors. In a DC motors, speed depends upon the following factors:

- Speed is directly proportional to the voltage across the armature terminals.
- It is inversely proportional to the magnetic flux induced in the poles.

Hence the speed can be controlled by either varying the armature terminal voltage or by varying the field current i.e. changing the flux. A prototype model is developed in MATLAB/Simulink for verifying he results for this system. The speed is regulated according to the different objects using different controllers. The structures/shape of the objects is identified by the Artificial Neural Network program [6]. This program is developed initially for identifying Apple and Oranges but it can further be extended for many more shapes and sizes such as luggage at airports and railway stations, heavy objects put on conveyor belts for detection.

II. CONTROLLERS

A controller monitors and affects the operational behaviour of a dynamic system. By adjusting inputs, we can affect the operational behaviour of the system [2]. For example, when air temperature is too high or low, a sensor may be used to turn on or off the air conditioned or heater in a house/building.

2.1. Types of Controller

The different types of conventional controllers [5] which generally used are listed below-

- Proportional Controller (P)
- Proportional-cum-Derivative Controller (PD)
- Proportional-cum-Integral Controller (PI)
- Proportional-cum-Integral-cum-Derivative Controller (PID)

2.2. Proportional-cum-Integral-cum-Derivative Controller or PID Controller

As we have used controller PID in this paper, this is discussed in detail here. A PID controller is a controller in which the error or correction signal is depends upon Proportional-cum-Integral-cum-Derivative property. The system

is close loop; feedback signal obtained by PID controller is used for controlling. It is mostly used in various control systems employed in different process industries. A PID controller calculates error which is the difference between a measured value of process variable and a pre defined set point. The error is minimized by adjusting the inputs. The PID parameters used in the controller should be varied according to the nature of the system, for optimum use.

PID controller output is calculated by summing up the derivative, integral, and proportional values. Let *u* (*t*) be output of the controller, the final expression for the output of PID controller is:

$$\mathrm{u(t) = MV(t) = } K_p e(t) + K_i \int_0^t e(\tau)\,d\tau + K_d \frac{d}{dt} e(t)$$

Where the variable parameters used for changing the output are:

Proportional Gain Kp: If Kp is large, it means quick response of system when the error signal is large. The proportional term also compensate the system. A large value of proportional gain will cause instability. It also causes high oscillations in the system.

Integral Gain Ki: If Ki is large, it means that the steady state errors will be eliminated rapidly.

Derivative Gain Kd: If Kd is large, it will reduce overshoot, but sluggish transient response which may cause unsteadiness in the form of signal noise.

III. BRUSHLESS DC MOTORS

In brushless DC motors is an advanced DC motor. The problems related to the commutation are reduced in brushless DC motor. In brushless DC motor commutator and brush arrangement is replaced by outside electronic change-over switch. This switch is synchronizing position of the rotor. The efficiency of without brush motors is around 88-90%, whereas DC motors with conventional commutation assembly is around 70-75% only.The application of brushless DC motors lies where more precise speed control is required e.g. CD drives, video recorders, laser printers, photocopy machines and other digital devices. There are several advantages over the conventional commutation motors:

They are very efficient as compared to AC fans which use shaded-pole motors, the operating temperature is less than the AC fan. This cool operation increases the life of bearings of fan.

As such there no friction, the life of a DC brushless motor, is much longer compared to a commutator and brushes DC motor. Commutation also causes electrical noise and RF noise, which is avoided in this case. Because of this brushes, a motor may be used effectively in electrically sensitive devices like CDs or computers.

There are mainly three aspects of operations of a motor application.

i. Starting of motor
ii. Speed Control of motor
iii. Braking of motor

The speed of the motor is increased from rest state and made to run at the required operating speed. It is known as starting of the motor. The second part is controlling the speed of the motor as per the requirement of the load. Finally, the running machine has to be stopped, by reducing the speed. It is called braking. The torque speed characteristics of the machine are adjusted to obtain these as load characteristics variance is not feasible. When more than one method are available for achieving the speed control, then many external factors and criteria like, running cost, efficiency, initial cost and ease of operation are also applied for the selection of the suitable methods. Due to the absence of equipment like transformer, DC motor operation in general is considered to be a constant voltage DC supply.

IV. ARTIFICIAL NEURAL NETWORK

An artificial neural network (ANN) is a mathematical neuron that is similar to the structure and functions of biological neural networks**.** It processes information received in input, using a interconnection connection of neurons to calculate the output.ANN controls its structure based on internal or external information flowing through the network [7]. They are usually used to find patterns in data or to model relationships between input variables and output variables [11], [12].

4.1. Construction of ANN

ANN is made up of different interconnecting artificial neurons. An ANN may either be used to increase an overview of biological neural networks or for solving artificial intelligence problems without actually realizing the model of a real biological neuron. The biological neural network is very complex and has some characteristics that may seem unnecessary based on a study of artificial networks [9].

4.2. Feed forward Neural Network

A feed-forward neural network is an ANN in which the connections between neurons do not form a direct cycle between deferent neurons. This feature makes feed forward neural network different from other models of neural networks. The feed-forward ANN was the numerous and arguably simplest kind of ANN invented. In this artificial neural network, the flow of information travels in one way only that is feed forward from the input nodes to the output nodes via hidden nodes. There are no loops or cycles exist in the network.

4.3. Single-Layer Perceptron

This is the oldest type of neural network. This is a single-layer perception network. It consists only a single layer of output nodes. It is the simplest kind of feed-forward network.

This calculated value is compared with some threshold value. If this is greater than the threshold value the neuron fires and takes the activated value (1); If this is less than the threshold it takes the deactivated value (-1). Neurons with such kind of activation function are also known as artificial neurons [8].

4.4. Multi-Layer Perceptron

In multilayer perception network, multiple layers of employed. These computational units are commonly interconnected in a feed-forward way. Each neuron impervious layer has direct connections to the neurons of the successive layer. An algorithm of learning methods is used by multi-layer networks for learning purpose.

V. TRAINING OF NEURAL NETWORK

To perform a task, neural networks can be overtly automated by manually creating the topology and then setting the weights of each link and threshold [3]. This is known the training of neural network. However, this circumspect one of the unique strengths of neural network: the capability to program themselves. The most vital technique of training a neural network is trial and error method. If the network isn't providing the desired results, then weighting of a random link is varied by a random amount. On following such steps, if the precision of the network goes down, undo the change and make a different one. It is time consuming but the trial and error technique yields required results.

5.1. Neural Network Model

A basic neural network model is shown in Figure1 below. A single input neuron can be realized by using a scalar input ‘p’ multiply by the scalar weight ‘w’ to form ‘wp’ which is fed to the summer all along with bias ‘b’ multiply by ‘one’ [10].

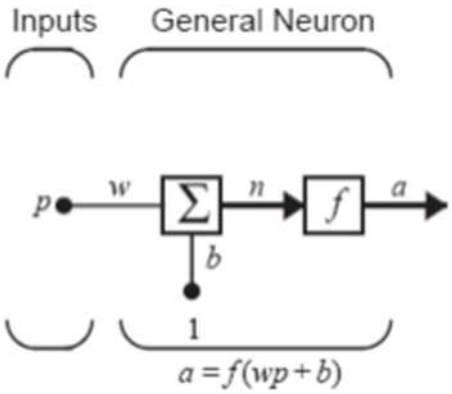


Figure 1. Fundamental Neural Network

In this NN model net input is wp+b and the output a is
a=f (WP+b)
f- Represent transfer function
w and b know how to be adjusted by rule of learning.

In Figure 2 a model of trained neural network is shown which is modeled in matlab.

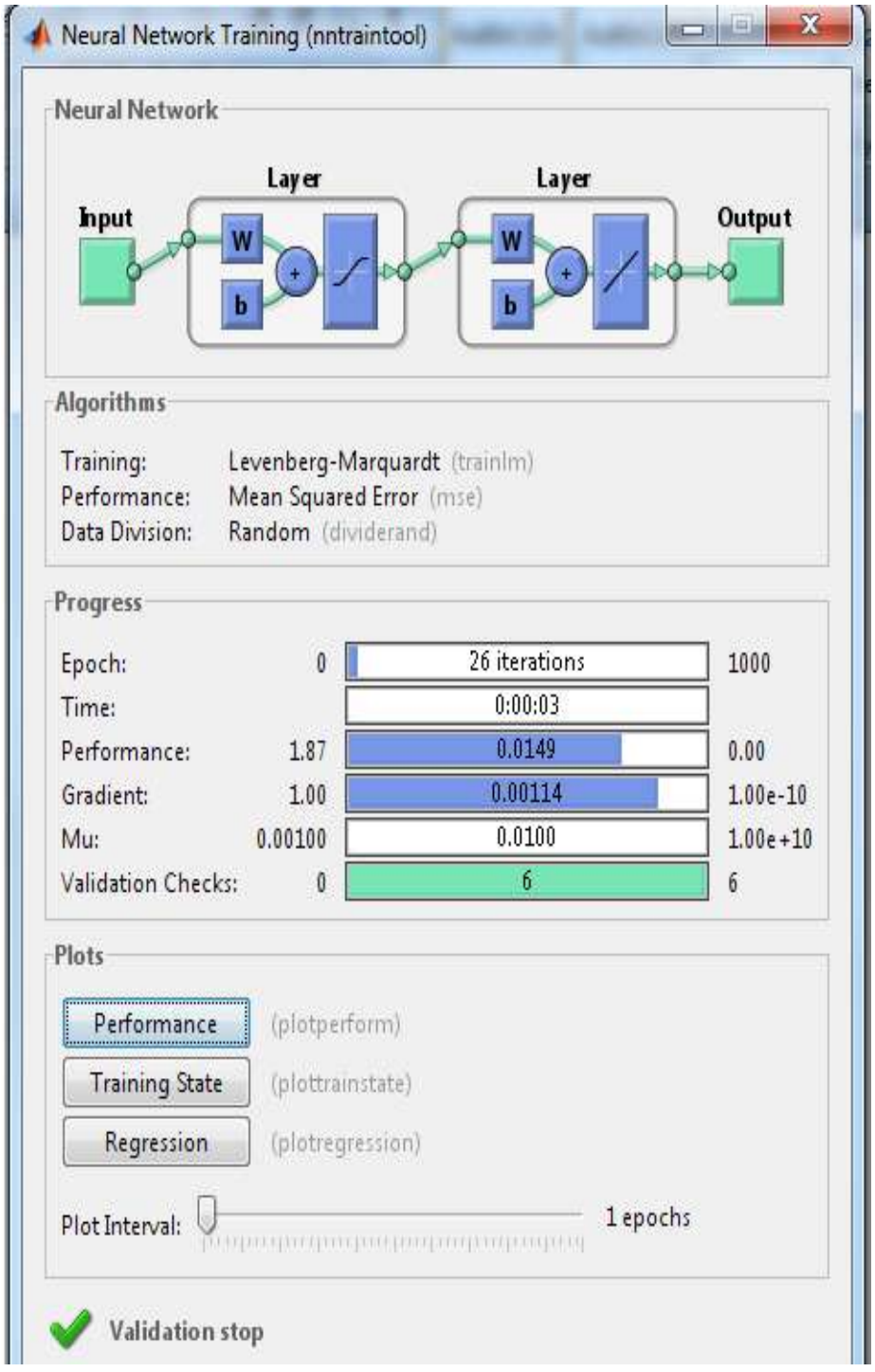


Figure 2. Neural Network Trained Network in Simulink/MatlabSoftware

For the better regulation of the speed and to separate/ identifying the object, the Neural Network Model is interlinked with speed control model of DC motor as shown in figure 3. The specification of DC motor and PID controller is shown in Figure 4 and Figure 5 respectively.

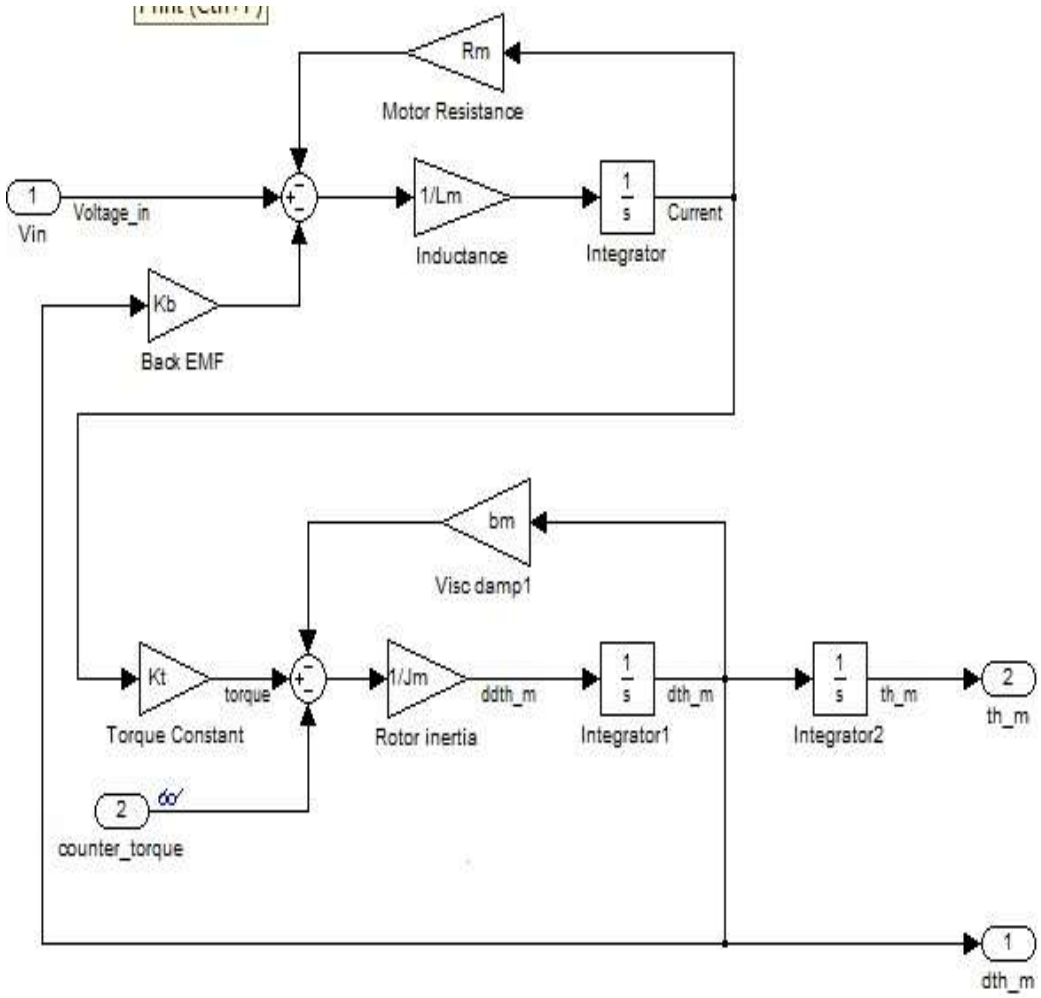


Figure 3. Simulink/Matlab Model with PID & DC Motor Drive Controller

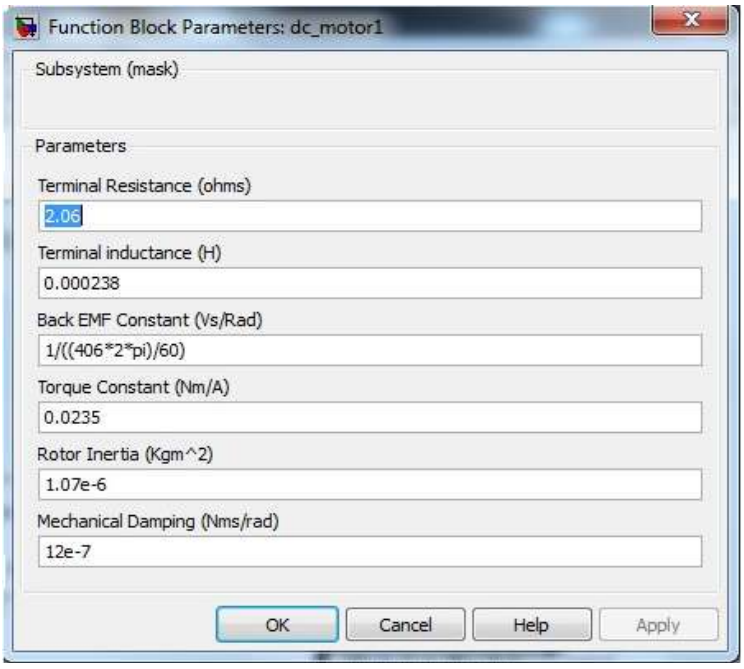


Figure 4. Motor Specifications in Simulink/Matlab

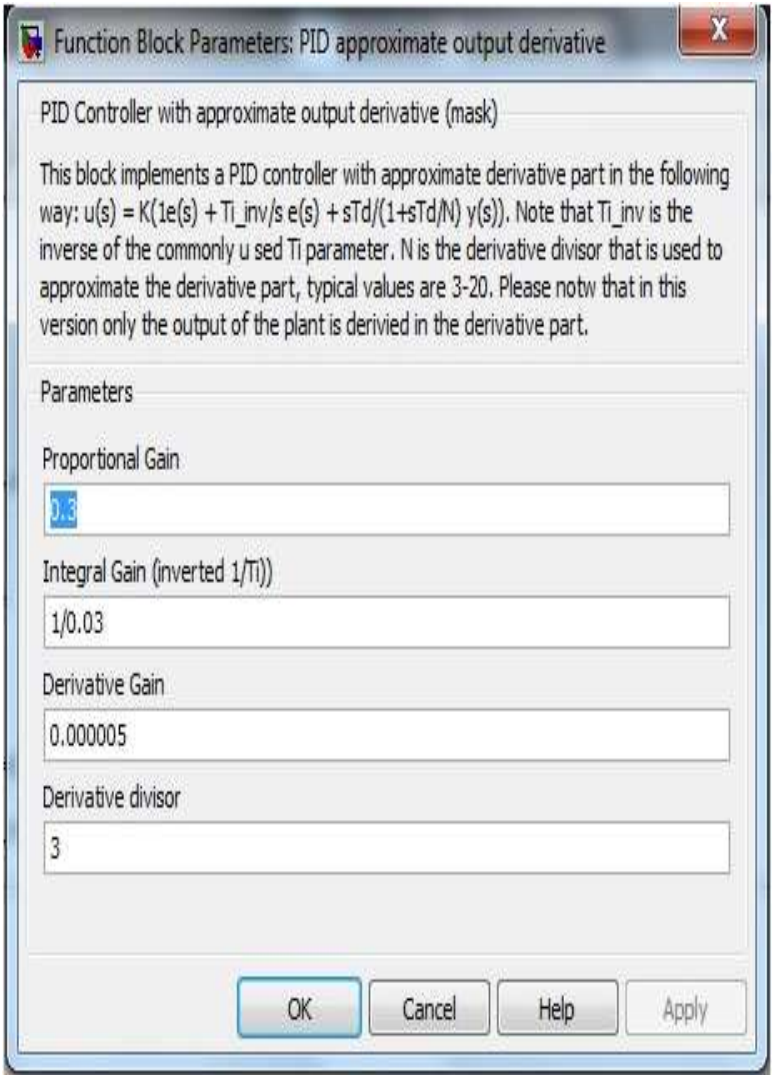


Figure 5. PID Specification Simulink/Matlab

The Outlook of complete model using PI, PD as DC motor drive controller and artificial neural network for object identification and sensing as shape 1 or shape 2 depending on input characterstics is shown in Figure 6 below.

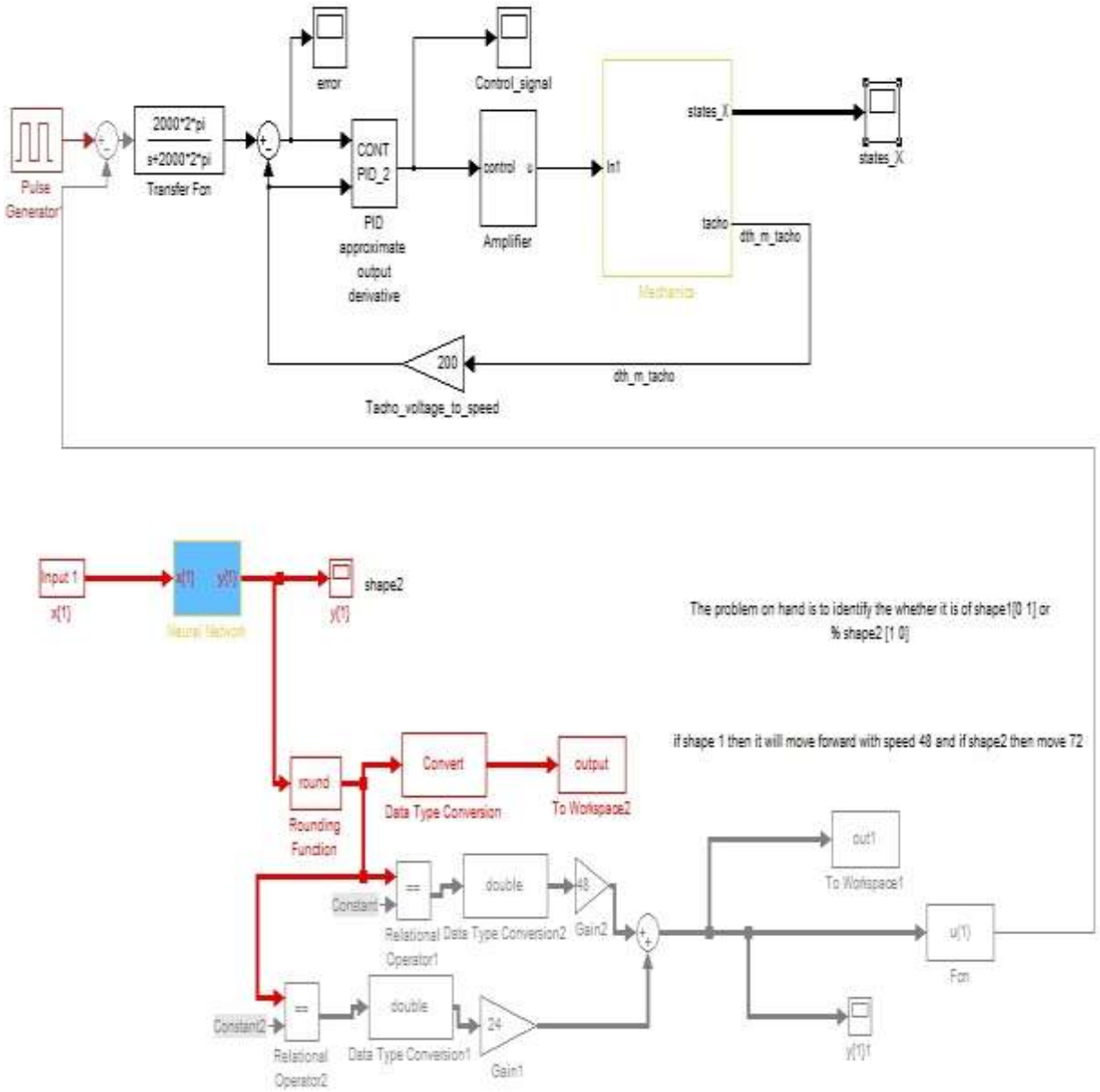
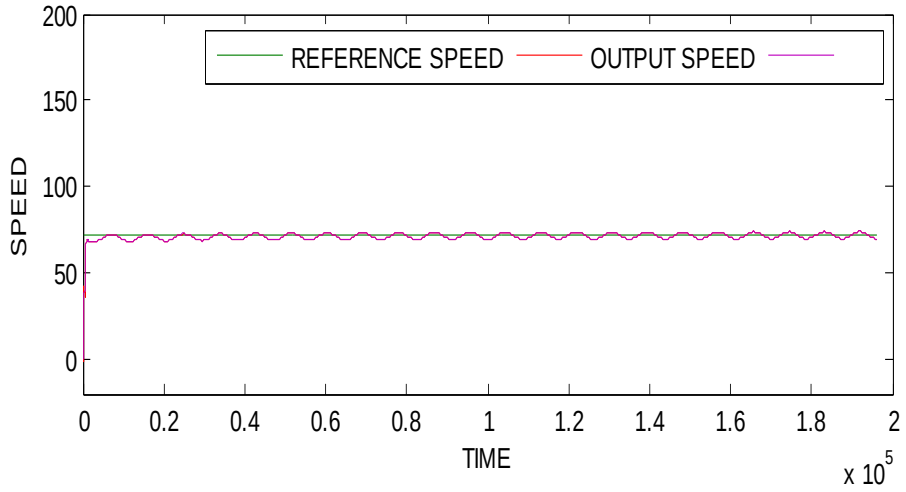


Figure 6. Outlook of the Complete Model of Proposed work in Simulink/Matlab Software



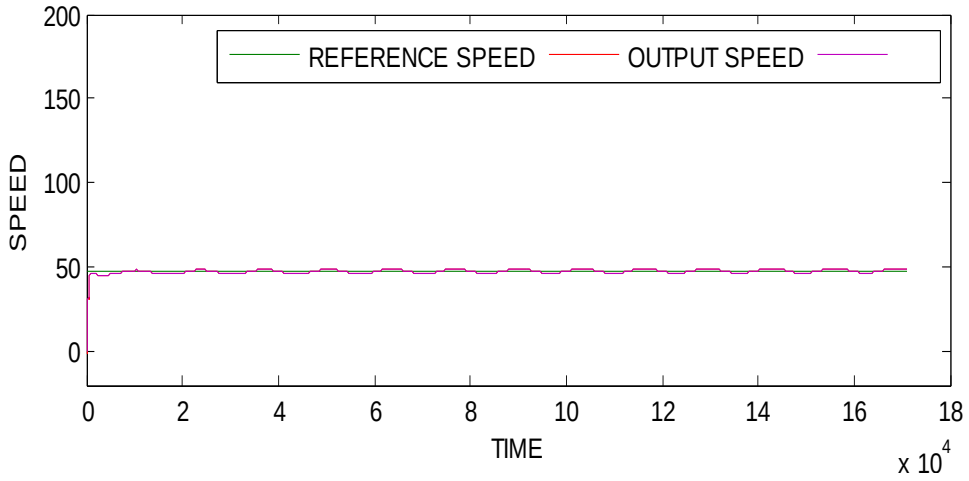


Figure 7. Graph of speed v/s time- if shape 1 then it will move forward with speed 48 rpm and if shape 2 then it will move with speed 72 rpm

VI. CONCLUSION

The Graph in Figure7 shows the effectiveness of the proposed controlling scheme for the speed control of a DC motor using a controller like PID, and a Neural Network. An application is developed to separate objects depending on the characteristics such as size, weight, color which are used to train the ANN and finally objective to compare them is achieved. When objects of two different shapes are used for detection, a neural network model separates the object by identification, which is connected to dc motor model and the speed of motor is controlled accordingly by PID controller. . For all simulation work of the model and to get the training data set Matlab@/ Simulink software R2014a version 8.3 has been used [13].

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AUTHOR'S DETAIL

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