Chapter

Modeling and Simulation of a DC Drive Integrated through a Demultiplexer

Fatima Isiaka and Zainab Adamu

Abstract

As expected, digital circuits are mostly ubiquitous and a necessary part of our modern and everyday life. Most of our electronics are formed from its configuration. Also new applications are now being designed almost all the time. This is fairly a most recent phenomenon. This chapter is aimed at integration of a DC motor to its demultiplexer encoders for the modeling of a complex system. Almost every mechanical movement that we come across is accomplished by an electronic motor, which are a means of converting energy to mechanical source. Almost all DC motors work on the same principles so the main objective is to apply direct current that operates through the interaction of magnetic flux and an electric current to produce rotational speed and configured torque to the demultiplexer encoders for the automation of a complex engine starter system. On several reruns, the result shows that the DC motor and DMF machine will be an important factor for mechanical device integration and composition of most demultiplexed machines.

Keywords: demultiplexer encoders, direct current, magnetic flux, automation

1. Introduction

Digital circuits represent logical possible values that combines the most basic building blocks of its configuration using the role of logic which defines the physical behaviour of the process. Its principles is formed from modularity of analog circuits that allows users to create circuits of mind-boggling complexity that are reliable and consistent [1, 2]. Digital circuits have become so popular and successfully that it can be used to produce programmable processor with fast and even running capabilities. Its importance is based on remarkable flexibility which can be implemented to produce a remarkable diversity of functions, which means that a device can do a lot of things based on its flexible programmability. The fundamental components includes AND, OR and the inverter (**Figure 1**). The flipflops is another storage device based on digital circuits that holds a logic value; the most common one is the D flipflop. One sure way of representing a digital circuit is using schematic diagrams that shows a collection of its components that are connected together with lines and adders. They are also designed by using hand-drawn methods during the 1980s [3–5]. Computed aided tools are developed to reduce the amount of effort necessary to stipulate circuits and verification of the output correctly.

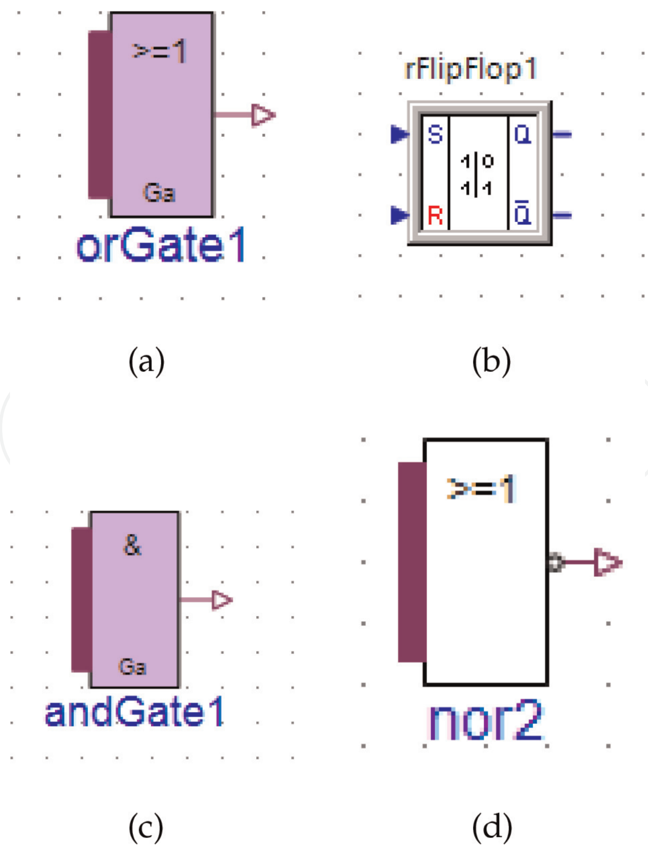

Figure 1.
The AND, OR and NOR gates, together with the flipflops. (a) The OR Gate with one output port. (b) rFlipFlop with two inputs and outputs. (c) The AND Gate with one output. (d) The NOR Gate with a single output.

1.1 Programmable processors

The most important digital circuit is the programmable processors (PP) (**Figure 2**). The figure shows a simple generic processor and an additional memory device, which can be observed as an array of storage location, identified by an integer index known as ROM and RAM address. Each location in the memory is stored in a fixed-length integer processors with 32–64 bits [6, 7]. For the PP, we are going to be making use of the WashU-2 software and VHDL Language. The memory in the processors is used to save and store two types of information which includes the instructions and data [8, 9]. An example of the instruction could be two or more numbers together or transfer of a value between the processors and

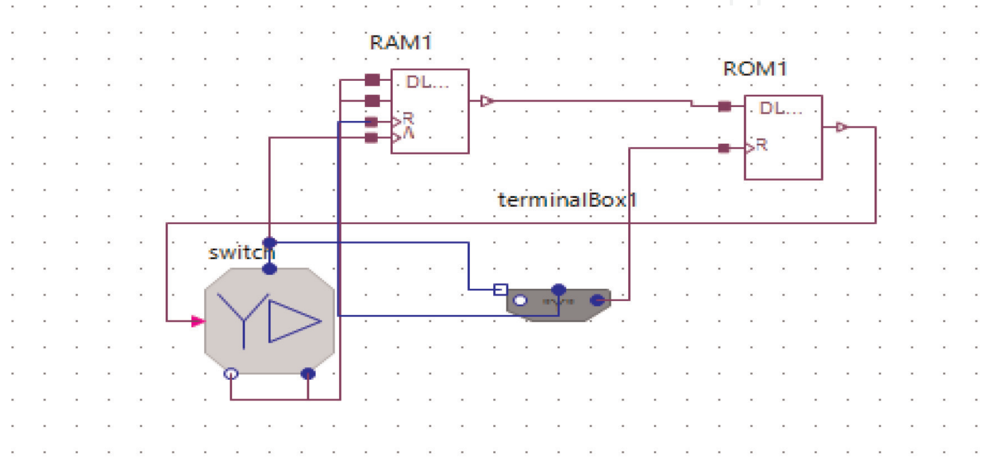

Figure 2.
Diagram indicating a simple programmable processor with a RAM and ROM.

memory. The processors includes internal storage capabilities (registers) that holds intermediate data or information.

1.2 The demultiplexer

In digital circuits, the demultiplexer represents one to many, which is one internal input to multiple outputs. By applying control signal the input is steered to the output. The 1–4 demultiplexer has 1 input bit, 2 control bit and 4 output pits (**Figure 3**). The data or information (D) bits is transferred or transmitted to the data bit of the output lines, depending on the value of the inputs AB, which are the control bits.

The DC motors are distinguished by their ability to operate from possible direct current and work on their motor principles. The DC motors are basically electromechanical energy conversion devices that are essentially a *mm* of transfer between an input side and an output side [10, 11]. The parts mostly necessary for electromechanical energy conversion are the direct current log, the induction log and the synchronous logs, these are used extensively for rigorously energy conversion purposes. When electric energy are supplied to the conductor, the interaction of current flowing in the conductor produces mechanical force and energy. The extended force is exerted upon the conductor and presented as flux which is associated with the mechanical motion. The input load is the electrical energy, while the output load is the mechanical energy [12, 13].

The DC motors consists of sets of coils in permanent magnets or stator, these are connected to the demultiplexer. The stator are mostly stationary outside while the motor are composed of windings connected to the external circuit through mechanical commutator. The value of mechanical force extracted upon the conductor can be expressed as:

$Force = Dx(x * L)$ where D is the density and L is the length of the conductor, X is the value of the current that could be flowing in the conductor.

The chapter mostly discussed the configurations of a DC motor machine (**Figure 5**) integrated with a demultiplexer to produce an engine starter system with induced variables of electromagnetic flux [14]. The value of the induced current flowing through the armature is dependent upon the difference between the applied voltage and the counter voltage. The current due to this counter voltage tends to oppose the very cause for its production according to the opposite resultant response to the demultiplexer [15–17]. During simulation of the entire system, the outputs were re-evaluated at process time. In the demultiplexer, when a process is

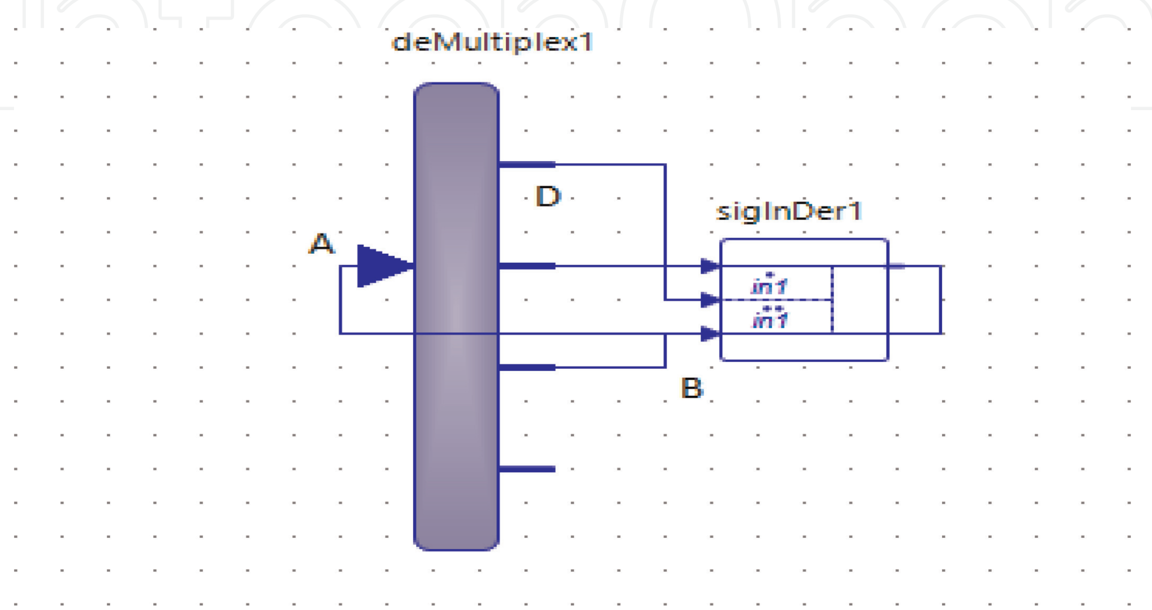

Figure 3.
The DC machine circuit.

being utilized as a definite combinational circuit from the point signals to the process are included in the list of induced signals used for the test procedure [18]. As such, a process is defined or serve as part of the combinational circuit, therefore any input signal in the process can be related to the sensitivity list for the entire system (**Figure 4**).

The Figure above (**Figure 4**) shows the schematic diagram of the DC motor, it has two different circuit port I_a and I_f [19]. The field current and the frame-work circuits. The inlet of the DC motor is in a form of electrical power while the outlet or output is mechanical with a power voltage. The field-curve is supplied from a separate voltage source in its equivalent circuit board representing the resistance and induced field twist. The current produced in the curve establishes the magnetic field necessary for the motor operation. In the frame-work or rotor circuit, the voltage speed applied across the motor terminals is the flow of current in the frame-work circuit and the resistance R_r of the frame-work circuit winding, is the total voltage induced in the armature or frame-work circuit. Applying the Kanel Voltage Length is the armature circuit gives the following equation:

$$V^T E^b + I_a R_a \tag{1}$$

where V^T is the voltage applied to the frame-work or rotor terminals of the motor and R_a is the resistance of the rotor curve. The total induced current is typically represented by electrical power and the terminal voltage by the volts (V). Sometimes at end point, the motor speed is equivalent to null value. The rotor current at initial point is large enough to induce resistance flux in the magnetic field surrounding the rotor point. The power transfer equation is given as:

$$P_d dv = K\Theta I_a \tag{2}$$

and induced voltage is given as:

$$E_{b2} = K\left(K_f I_{f1}\left(\frac{2\pi N_i}{60}\right)\right) \tag{3}$$

with operating speed N_i and field rotor current I_{f2}.

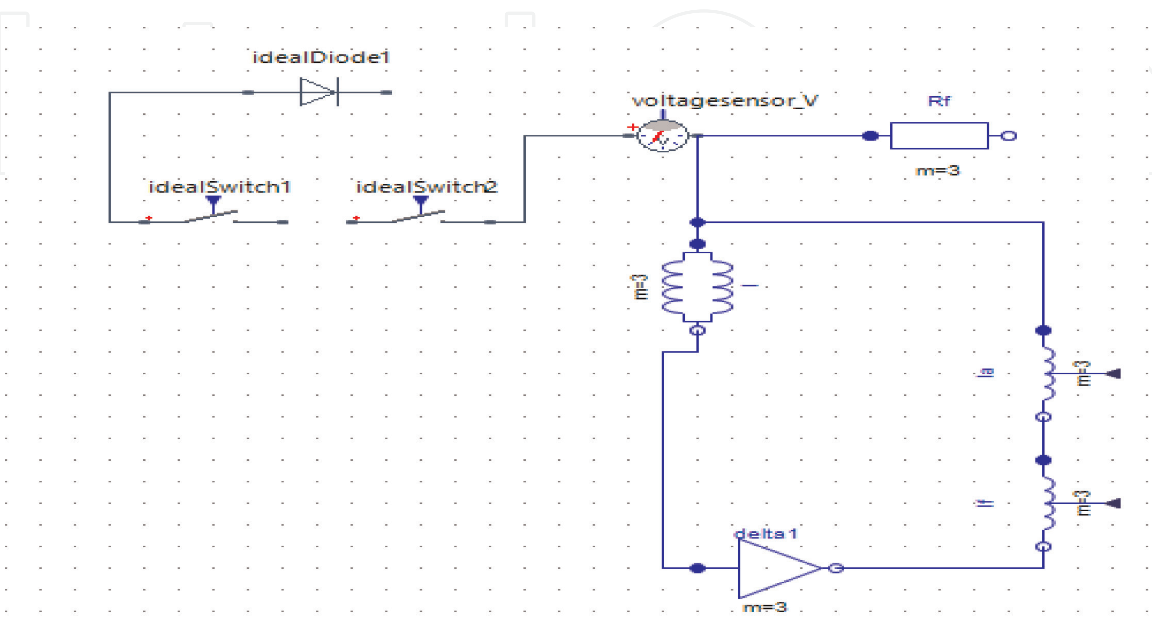

Figure 4.
The DC machine circuit.

For utility purposes, the DC motor serves as a form of integral with the demultiplexer, we needed to understand the characteristic curves, which involves the torque or speed curve and power curve or machine curve (**Figure 5**). The difference or similarity between the two is most significant in choosing a DC motor for the particular circuit integration. Therefore, the torque for the rotor is given as:

$$T_{ddc} = K\phi I_a \tag{4}$$

The graphs below (**Figure 7**) shows the difficulties during parimiterizing from a synchronised catalog data. The model is filtered based on the input data from the machine operating data to the resultant output form. And care is also taken when transferring data to model from the physical main unit. The results are cross checked in some of the characteristic operating points. The motor runs up with load, the friction are also considered and achieved a no load speed of 5144 rpm with a current of 0 ohms. When a friction of 0.0018 Nm applied, the current is adjusted to a catalog value of 600 for the DMF machine. The speed is increased to 100 for the starter machine and still maintain a high catalog value. This particular difference can be explained by tolerance in manufacturing and considered by increased catalog data. The exemplars is achieved and the no load speed is maintained. The practical test on the machine demonstrates how to use the rotor converters to implement a speed control for the DC motor. The speed for the freewheel controller's output is the set value for a subordinated torque control oriented field. The controllers uses or make use of an intern model for the motor and requires the starter machine's current as input. The DMF's output (**Figure 7**) is also necessary stator voltages in the constant rotating frame of the reference machine (**Figure 6**). Most of the output are termed or came out as neutral or normalised.

The element DMF changes the reference frame into machine variables (ABC) and calculates switching ratios for a possible pulse width modulation. Furthermore the element worm-freeWheel maps the line currents into the *dm* reference frame. Note that for correct mapping scale has to be set to 2/3. The reference frame (worm-freeWheel) is the rotor system. In this example the switching ratios $DMF.s_{abc}$ are directly used by ideal-Unswitched-Inverter which converts the DC voltage into the necessary line voltages. The model demonstrates the use-case short-circuit of the power supply. In this simulation there is a short circuit at time 1.5 s

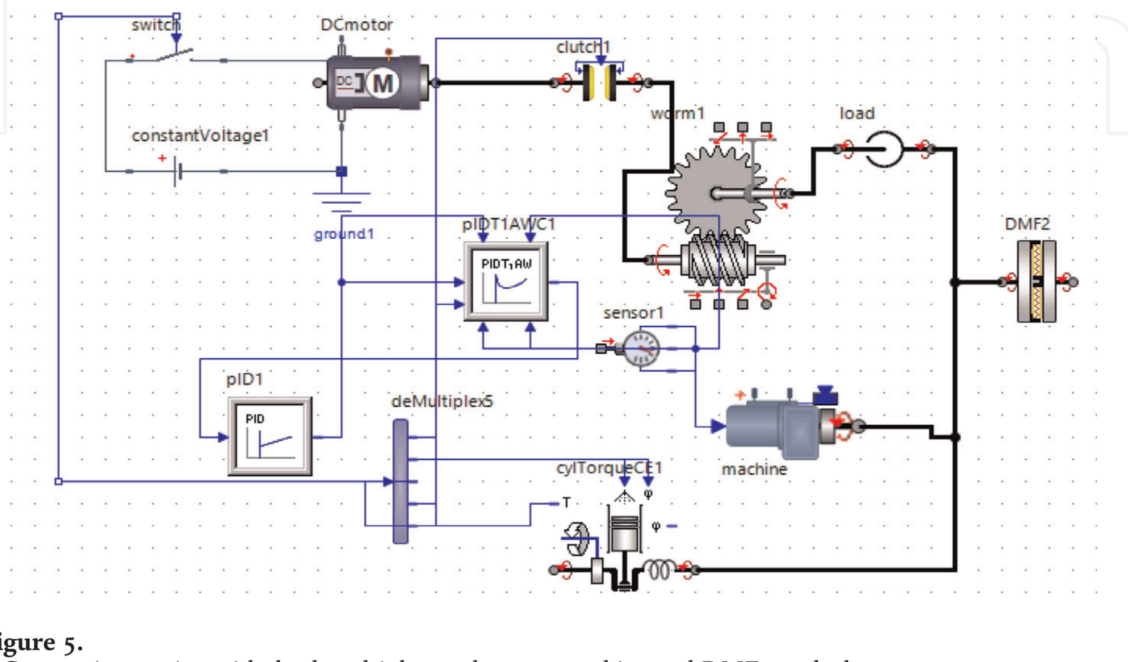

Figure 5.
DC motor integration with the demultiplexer, the rotor machine and DMF speedvolt.

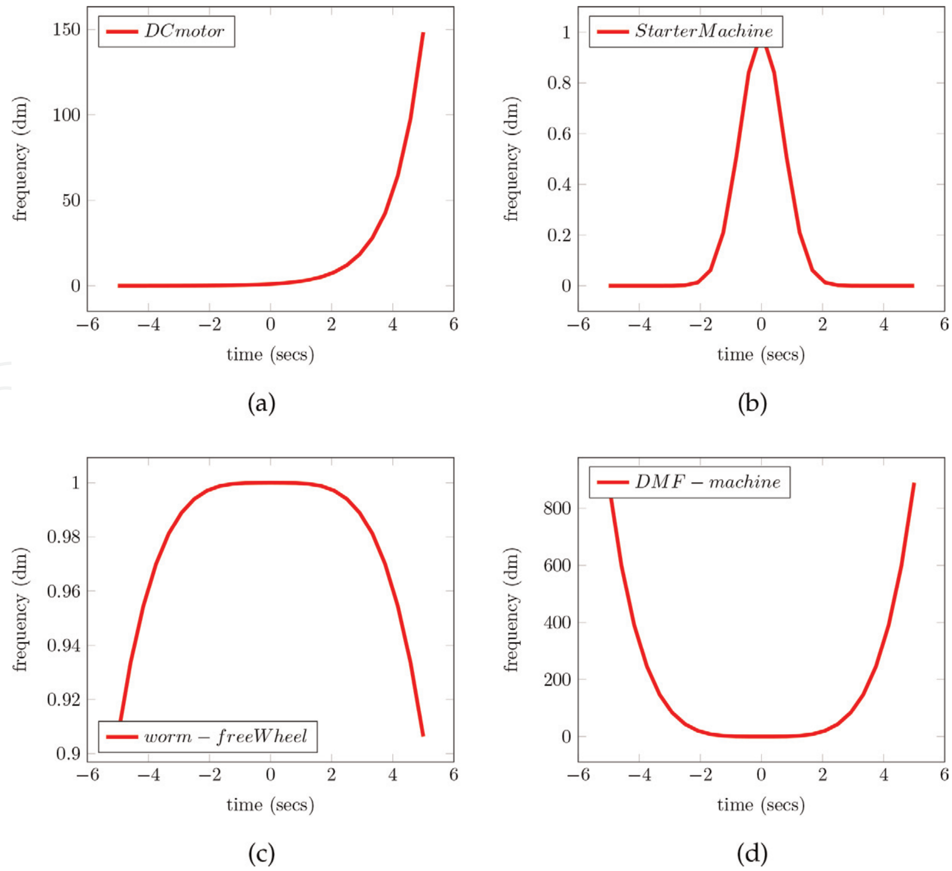

Figure 6.
Graphs indicating current flow for input voltages of the motor, freewheel and starter machine. (a) The inverse error rate of the DC motor voltage, (b) Up peak error rate for Starter Machine, (c) Normalised current flow for the freeWheel controllers, (d) Neutral current flow for the DMF machine.

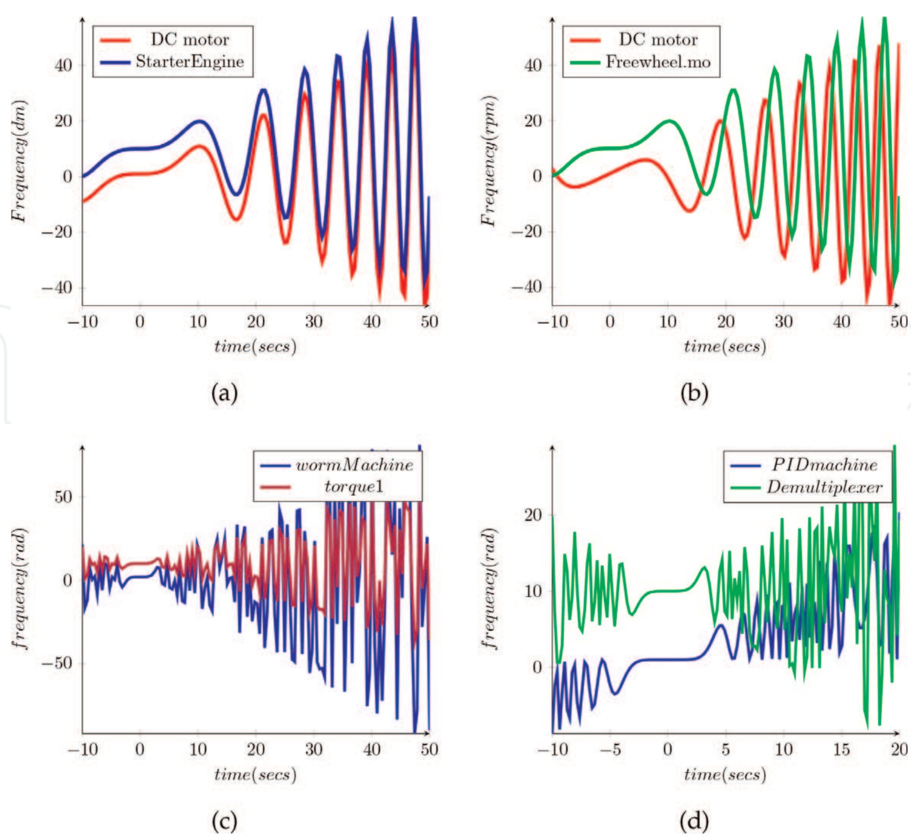

Figure 7.
Resultant graphs or results from reruns of input data for DC motor, starter machine and DMF machine. (a) Synchronised voltage for DC motor and Starter Engine, (b) Synchronised voltage for DC motor and Freewheel, (c) Synchronised current flow for worm Machine and torque control, (d) Synchronised current flow for PID Machine and Demultiplexer.

DOI: http://dx.doi.org/10.5772/intechopen.89068

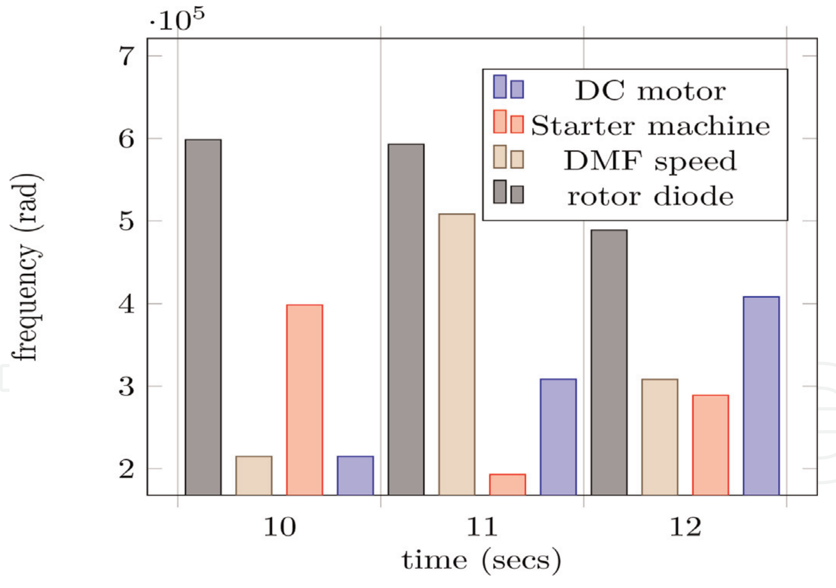

Figure 8.
Machine performance rate of DC motor, the demultiplexer, the rotor machine and DMF speedvolt.

and produces high transient currents and a torque peak. After less than 1 s the induction machine comes to a standstill (**Figure 7**).

On several reruns, the more the input data the more changes in result output during process visualization. The DC motor and the starter engine work in sychronized format than the other machines used for the integration and process flow. The freewheel serves as a buster to the end machine. The sample size was reduced for the PID and demultiplexer because the number of error rates increased as more samples or input data was tested for the process flow. Based on performance rate (**Figure 8**), the DC motor and DMF machine will be an important factor for most mechanical device integration and composition.

2. Conclusion

This chapter mostly talks about the DC motor integration to the demultiplexer with other machine, while simulating most of its machine parts or circuits such a the torque and DMF that serves as a buster. The amount of load of constant torque decreases in speed as the rotor resistance is increased. The overall resistance in the rotor circuit or machine is increased by applying a constant variable as the resistance of the rotor winding is fixed for a given motor. All machines that serves as buster is described briefly in the above sections and are all used to control the DC motor by changing the external resistance in line with the rotor. The relationship between the torque speed and its applied voltage in terms of the DMF controllers is indicated in the figures and provide a smooth variation for the speed control. The losses and efficiency of the DC motor and demultiplexer can be corrected by a constant rerun and applying more input voltage. So, for our future purposes, we intend to produce a physical mechanical configuration for practical runs and visible speed monitoring and make proper decisions on appropriate integration and torque control of the load due to rotational loses.

Acknowledgements

The authors wish to acknowledge and thank both the Nasarawa State University and Ahmadu Bello University Zaria, for providing the Modeling software and assistance during the production of this chapter.

Author details

Fatima Isiaka[1,2]*† and Zainab Adamu[2]†

1 Nasarawa State University, Keffi, Nasarawa State, Nigeria

2 Ahmadu Bello University, Zaria, Nigeria

*Address all correspondence to: fatima.isiaka@outlook.com

† These authors contributed equally.

References

[1] Ziegler J, Nichols N. Optimum settings for automatic controllers. Transactions of the ASME. 1942;**64**: 759-768

[2] Krishnan T, Ramaswamy B. A fast response dc motor speed control system. IEEE Transactions on Industry Applications. 1974;**10**(5): 643-651

[3] Wan-Zhen Z. PLC Analysis and Design Applications. Electronic Industry Press; 2004

[4] Kissell TE. Industrial Electronics. 2nd ed. Prentice Hall; 2000

[5] X. Xing Ming. PLC Control System Reliability Design. Automation and Instrumentation, 2009

[6] Theraja BL, Theraja AK. In: Chand S, editor. A Textbook of Electrical Technology. 22nd ed. Vol. 2. Chapters 29–30. 2005. pp. 996-1078

[7] Motor Drives. Available from: http://www.ee.ttu.edu/motordrives

[8] Gottlieb IM. Electric Motor and Control Techniques. 2nd ed. Jameco. pp. 32-54

[9] Bimbra PS. Power Electronics. Delhi: Khanna Publishers; 2007

[10] New Haven Display. NHD-0216K1Z-NSW-BBW-LLCM (Liquid Crystal Display Module) Datasheet, 2008. Available at: www.newhavendisplay.com/specs/NHD-0216K1Z-NSW-BBW-L.pdf

[11] Texas Instruments. MCT2, MCT2E Optoisolators SOES023 Datasheet. 1983 [Revised: October 1995]

[12] Fardo SW et al. Electrical Power Systems Technology. 3rd ed. CRC Press; 2008. Chapter 14. pp. 349-399

[13] Singh MD, Kanchandani KB. Power Electronics. McGraw Hill; 2008

[14] Bird J. Electrical and Electronic Principles and Technology. 2nd ed. Newnes; 2003. Chapter 22. pp. 328-350

[15] Sen PC. Electric motor drives and control: Past, present and future. IEEE Transactions on Industrial Electronics. 1990;**37**(6):562-575

[16] Rashid M. Power Electronics Circuits, Devices, and Applications. 2nd ed. Prentice-Hall; 1993

[17] Ogata K. Modern Control Engineering. 5th ed. 2010

[18] Mazidi MA, Mazidi JG, McKinlay RD. The 8051 Microcontroller and Embedded Systems-Using Assembly and C. Delhi: Pearson Prentice Hall; 2009

[19] Morbid A, Dewan SB. Selection of commutation circuits for four quadrant choppers. In: Proceedings of International Journal of Electronics'03. 1988. pp. 507-520