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DC SERVO MOTOR SPEED CONTROL BASED ON LAB-VIEW

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ABSTRACT
The notion of control is fundamental for understanding nature and human- made systems, and because of the control on things is a system field, to have a full estimation of control, it is necessary to take a full idea and knowledge on both theory and applications. By using LabVIEW as the motor controller, we can control a DC motor for multiple purposes using only one software environment. I used a simple programming Language Program named Lab-View for that purpose, My objective in this research is to expand an Automatic tuning way for the traditional PID controllers using Lab-View program. the result shows that the use of Lab-View program for real-time monitoring of a motor's encoder response, saved money because the software acted as a substitute for an oscilloscope. The real time response increased the efficiency of program testing andediting.

INTRODUCTION
The PID controllers are well known to the control engineers and these have been the commanding form of feedback control in process control and industrial applications. About 94% of all control loops are in the group of PID. the most common among these is PI controller, as derivative action is not more commonly employed. The major strength of PID controllers is also by virtue of its capability to treat practical issues of actuator saturation and integral wind-up. These controllers have received largely renewed interest from researchers and theoreticians during the last decade [1-10] and references contained therein. This has been possible due to developments in automatic tuning and raised use of pattern predictive control approaches. Numbers of researchers use Ziegler-Nichols tuning rules as a standard, as it is common method though there are many superior methods of tuning available, which can also provide automatic tuning with largely improved performance of treat. Yet it is most simple computationally and has low requirement on plant knowledge. One of the targets is to explain that it is indeed so and there is need to think again over the chosen of standard. yet with the progress in digital technology and Developments in automatic control a wide range of choices are also available. The interest in PI and PID controls has received stimulation with efficient and powerful software packages, and hardware units. yet the hard work is focused on integration of all free techniques in the form of software tool, to implement the relatively best strategy for any kind of given obstruction. This made it easier of on demand tuning with research forwards to still better approach for PID controller tuning. Each method has some advantages and limitations in terms of optimization objectives, computational needs, and plant model suppositions and sometimes these put us in a complicated position to make a fair comparison difficult.

PID controller own the ideal control dynamics including zero steady state error, fast response (short rise time), no oscillations and higher stability. The necessity of using a derivative gain contents with PI controller is to destroy the skipping and the swinging occurring in the output response of the system. best of PID controller advantages is that we can use it with higher order processes including more than single energy storage.

This paper will explain the principles of the PID controller, the loop tuning, the Lab view program and how to use it with the PID controller in loop tuning to reduce expensive and time

1. The Lab -View
LabVIEW programs named virtually, or VIs, And that is as a result of their photos and procedures are like physical instruments, such as viewing oscillations andmulti-meters.

LabVIEW is constituted by a big set of instruments for that acquiring, analyzing, viewing and data storage. Also, instruments to resolve any trouble-shoot written. In LabVIEW, you design an interface, or front- side panel, standards and rules. Knobs, dials, push-buttons and other input mechanisms. Indicators can be used as charts, LEDs, and output views. A code is inserted with a Vis structures after completing the design of the front-side panel. The block-diagram consists from that code. Lab VIEW can be used to deal with such data acquisition, motion and vision of the control devices, as well as GPIB, PXI, VXI, RS232, and RS485equipment.

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we build a user interface in Lab View program by using a number of tools and themes. The user interface has a name of a front panel. You then we will add code using painting performance of functions so to control the front pagethemes.

The block diagram has the wanted code. In somehow, the block diagram looks like a flowchart.

we can buy several software tools to improving this applications. All these tools integrate in Lab View.

LabVIEW's applications are based out on the flow of data. LabVIEW usage are divided into nodes and wires. Every part in a chart is considered to have input or node output. Wires are used as contact points between the nodes. We can use a node can be as straightforward a process as addition, or it can be a very complex process such as a VI subdirectory that has inner contract and wires. Combine the contract and wiring together put the wiring chart. We can derive Wire figure from block diagrams and are use it by LabVIEW translator to run the program. The wiring schemes is unobserved from the programmer. It is an in the middle form used by data authors to run the code. While in a program, a hidden translator verifies that graphs are here to implement. LabVIEW uses that we can built by use of application creating use an engine to execute when the LabVIEW are still used to run the Vis.

Some uses to LAB-VIEW in research:
Many causes make the researchers use the LAB-VIEW program in academic research, some of them are:

- Gather codes and make allocation EXEs.
- Strong and elasticdesign
- Simple to learn, in use, update and fixing.
- Single tool to design and make samples.
- Multidisciplinary uses tool.
- Low combing tosoftware-hardware.
- Easy to use with traditional and old instruments.
- Longlife
- It has the ability to execute algorithms with real time.

The *Control Design and Simulation (CDSim)* module for LabVIEW can be used to simulate dynamic systems. To facilitate model definition, *CDSim*adds functions to the LabVIEW environment that resemble those found in SIMULINK. There is also the ability to use m-file syntax directly in LabVIEW through the new Math Scriptnode

2. Control Design in Lab-view
Control design is a meditative that contain developing mathematical models that describe a physical system, analyzing the models to learn about there dynamic characteristics, and creating a controller to fulfill certain dynamic characteristics.

With Lab-VIEW Control Design and Simulation Module you can construct plant and control models using transfer function, state- space, or zero-pole-gain. Analyze system performance with tools such as step response, pole-zero maps, and bod plots. Simulate linear, nonlinear, and discrete systems with a wide option of solvers. With the NI Lab-VIEW control design and Simulation Module, you can analyze open-loop model behavior, design closed-loop controllers, simulate online and offline systems, and conduct physical implementations

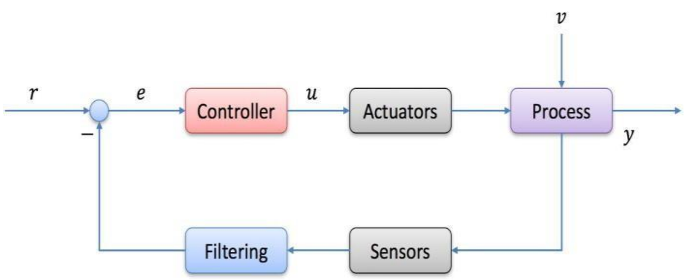

Figure 1 Control design in Lab-view

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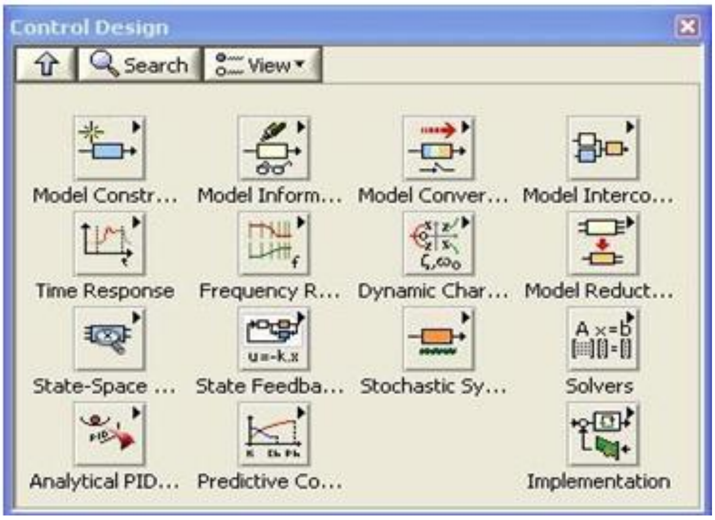
Control Design palette



3. Dc motor and text

Speed control of DC Motor is vital in many applications. The speed control of separately excited DC motors by PID controller is widely used in industry. In this project, we will be controlling the speed of the DC motor using Lab-VIEW. By the Lab-VIEW aided PID controller, the parameters are adjusted to control the motor speed. We will apply several methods in order to obtain best process response for tuning parameters of PID controller. Optimum controllability, peak overshoot, less sensitivity, optimum transients, optimum settling time will be obtained

Figure 2 DV motor

The two modes of control were DC motor and servo motor. In DC motor mode, the motor continuously rotated in either a clockwise or counterclockwise direction with speed display. To control the rotational direction of the motor, the system sent two digital outputs to the H- bridge through the USB-6008 DAQ module based on user selection. The user could start and stop the motor with another digital output to the pin of the H-bridge. Furthermore, the system sent encoder outputs to Lab-VIEW and analog inputs for the user to observe the output waveforms of the encoder and obtain the current rotational speed in revolution per minute of themotor

4. DC motor working

Because all electric supply companies with a furnished alternative current A DC motor rarely used in normal application, so for special applications like in steel mills, mines and electric trains we can benefit from it to convert alternative current to direct current in order to use a DC motor

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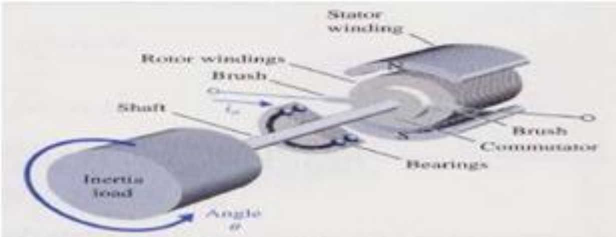

Figure 3:D.c motor working

The cause of that is the speed/torque characteristics of DC motor is much more superior , therefore it is not a strange thing to note that for industrial drives DC motors are popular as 3-phase induction motors , and like DC generator DC motor has three types series- wound, shunt-wound and compound wound, The use of a particular motor depends upon the mechanical load it has to drive.

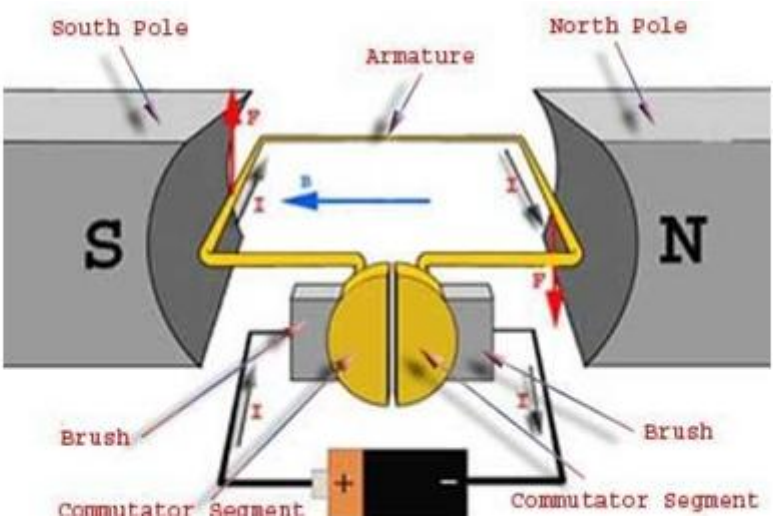

Figure 4: operating principle of DC motor

The very basic construction of a DCmotor contains a current carrying armature which is linked to the supply end across commutator or segments and brushes .The armature is placed in between north south poles of a permanent or an electromagnet as shown in the diagram above.

The DC motor works on Lorentz's power principle That says " any conductor that walk in it electrical current and it is located in a magnetic field, a force will act on it , and the direction of that force will be vertical on the both (the direction of magnetic field and the direction of the electric field) according to Fleming's left hand rule. In order for the middle coil to sill working it should reverse the current in it every half cycle, this done by a commutator who take it power from a battery through two brushes (it consist of strips of copper) and connect it to the coil

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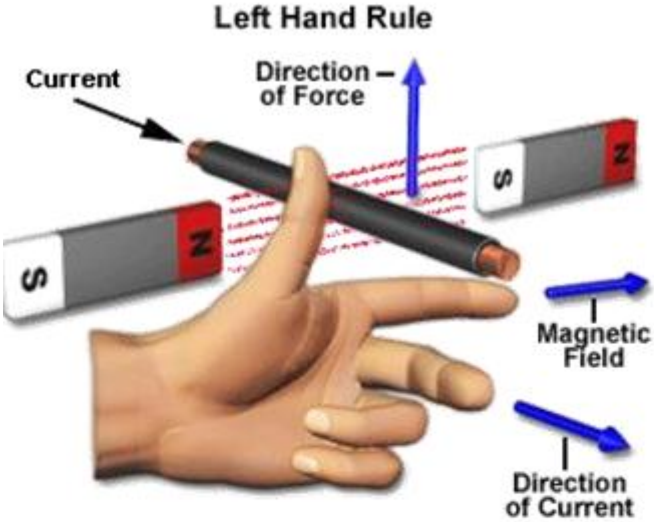

Figure 5: Magnetic field computing for D.C motor.

And because of presence of the magnetic field between the two poles, it is enough to stimulate a new field by using Faradei urging to make the rotating part to begin its work.

When the electric current pass through the fields between the poles a magnetic field will be found like Faradia's induction and as a result of that field a reversed magnetic power will arise to the ends of the file, we can know it's direction easily by the right hand theory, that emerging power will generate a torque that rotate the file.

It's widely known as a scientific fact that a moving charge gives rise to a surrounding magnetic field. Now, it's also crucial to understand what science says about a charge moving through an outer "exogenous magnetic field? The Lorentz force equation is the blueprint to comprehend the mechanical criteria of this electro-magnetic phenomenon.

This force can be defined as the force generated by a moving charge in an electromagnetic field. If ˜E denotes the electric field, ~B denotes the magnetic field; q is a charge moving with Speed ~v in the space, then the charge generates a force given by

$$\vec{F} = q\,(\vec{E} + \vec{v} \times \vec{B}).$$

Practically speaking, consider a wire where a uniform current I is moving. At the starting point, the electric field is assumed to be zero (this is the case of a DC motor), with reference to the quantity of charge dq found

In an extremely small section d~` of the wire, the force in the previous equation may be computed as a function of i:

$$\begin{aligned} d\vec{F} &= dq\,\vec{v} \times \vec{B} \\ &= dq\,\frac{d\vec{\ell}}{dt} \times \vec{B} \\ &= \frac{dq}{dt}\,d\vec{\ell} \times \vec{B} \\ &= i\,d\vec{\ell} \times \vec{B}. \end{aligned}$$

It was observed that, ∞ refers to the incidence angle between the straight wire and the field. The wire was used of length *l*, and the force magnitude F as supplied by

$$|\vec{F}| = i\,l\,|\vec{B}|\ \sin\alpha,$$

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F is perpendicularly placed on the position of the field and the wire used follows the right- hand screw rule "as shown in figure 6"

Based on equation, we need here to use a firm rectangular-shaped coil made of a wire where an*I* current flow through, appropriately positioned in an outer "exogenous magnetic field". As it can be shown in figure 3, hypothetically speaking if 1 is actually the wire length that is perpendicularly placed to the magnetic field plane, then two forcesare applied to the coiled mentioned above. Since the angle ∞ of equation "6" is _2 (that is vastly dependent on the side of the coil considered), then it turns out that the magnitudes of the two forces are the same

$$|\vec{F}| = |\vec{B}|\, i\, l.$$

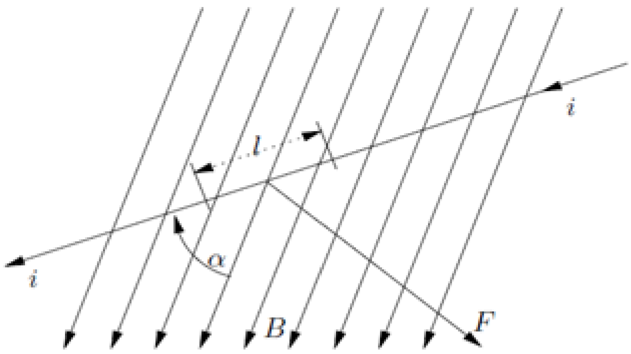

Figure 6 Force experienced by a current-carrying conductor located in a uniform magnetic field

While the coil is squarely shaped, F that is forms a torque that is applied at the coil-center because of the current I that flows on directions opposite to each other at the sides of the coil and that is vastly dependent on the position of the angle θ in accordance to the field. Particularly speaking, if the length of the edge of the square is d,then

$$T = 2\,|\vec{F}|\,\frac{d}{2}\,\sin\theta = |\vec{F}|\,d\,\sin\theta;$$

Where, it must be taken into account of the previous equations yields

$$T = |\vec{F}|\,d\,\sin\theta = |\vec{B}|\,i\,l\,d\,\sin\theta.$$

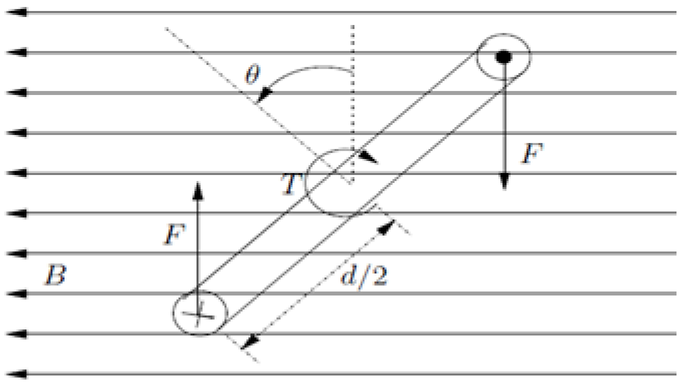

Figure 7: Torque experianced by a coil in a uniform magnetic field

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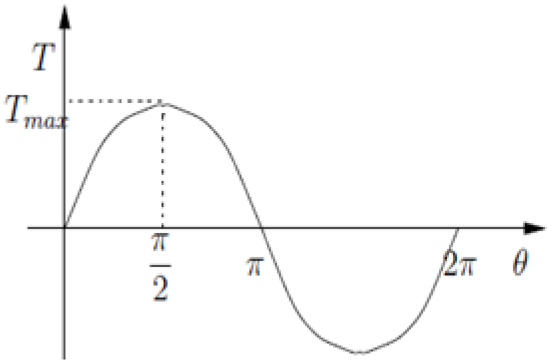

Figure 8: profile of the torque T experianced by a coil in a magnetic field as the rotation angle θ varies.

Lets consider the last equation and it must be noticed that the indicated torque here is significantly dependent on the angular position of the rotor coil θ. Assume that rotor's motor has the coil itself in it, then the produced torque is in high accordance with the motor'sposition; in addition to that, if the torque of the load charge is available, the rotor's motor keeps spinning clock-wise and subsequently counter- clock-wise. In fact, the torque produced is noticed to have the amplitude but opposite sign if the above mentioned coil spins at an angle π
(as shown in Figure 4).

And hence the process' goal is to make the motor apply a steady positioned torque. the solution suggested is to enter a commentator on the rotor shaft itself made by two parts and attached to the rotor rollers and the brushes that slide between those parts as rotor swings(as shown in figure 5".

In the configuration described, in each half- motor commotion we must mark the current move in the coil changes. so, if fully attached parts are placed respecting to the location of the coil, the torque shape of Figure 4 are properly reversed through the half-commotion "as seen in Figure5".

The suggested solution is performed, although the torque always gave the same mark, it still depends heavily on the position of the rotor. So the obvious solution of the matter is to multiply the number of coils in the rotor and segments of the commentator, attach each pair of corresponding parts to the coil in somehow that when the brushes are working that coil, the rotor angle is $\theta = \pm\frac{\pi}{2}$ (i.e., the highest position of the torque). It switch off that, if N separate windings are located on the rotor,

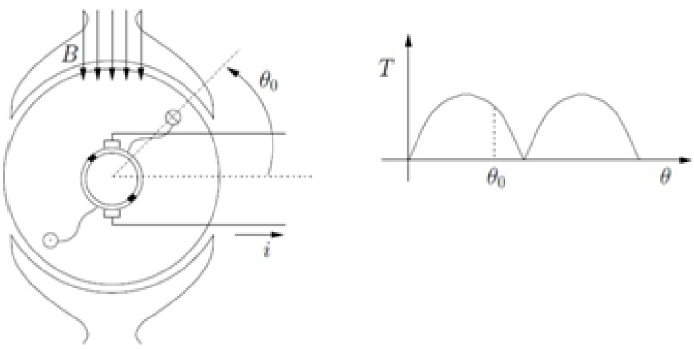

Figure 9: Torque excerted by a motor by the motor when a 2 segments commutator is used.

For the 2N reflector of the parts and the torque shape will be by 2N half sinusoids (relating to the torque t by each coil) that overlap in one period (as shown in Figure 6, where cc indicates the general commutation angle). In that

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method, the torque ripple may be increased as we need by amazing N and the remaining ripple can be observed to be filtered by the mechanical system, for that reason the resulting torque may be closer as follows

$$T = i\,l\,d\,|\vec{B}|.$$

Last but not least, as to equation "3 " the flux ϕ Is in proportional accordance to |B | (note that the angle B in equation (3) is equal to $\pi/2$; as a indeed the flow is presumed to be direct inside the motor), it turnedout."

$$T = K_{\Phi}\,\Phi\,i,$$

where $K_{\Phi} := l\,d/A.$

PID CONTROLLER IN INDUSTRIAL APPLICATIONS

1. Proportional Response

We use The P controller with a single power storage to settle the steady state process, the main use of P controller is to reduce the steady state error, so when the proportional gain K the error in the steady state reduce, in spite of the this reduction the P controller cannot destroy the error in the steady state of the system, when we reduce the proportional gain the capacity will reduce, fast dynamic, wide and satisfied frequency band and a big noise sensitivity. The P controller also use when the error in the steady state is constant and acceptable.

In addition of that it is easy to determine when we apply the P controller the rise time will be smaller and after a certain value from reduction for the steady state error so the increase in K parameter will lead to over response in the system. The P controller also cause inconstancy if there was late or dead time. The over inconstancy lead to more problem and also the noise process will be over

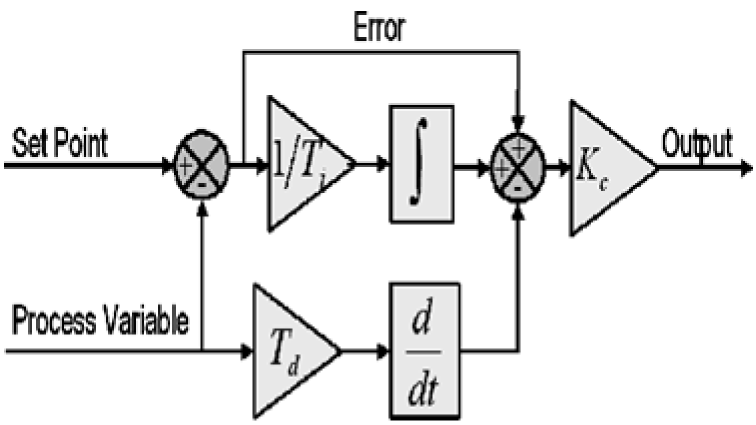

Figure 10: the basic of the PID controller

Integral Response

THE I controller is a suitable controller to each the error value and the error time. the I response is a sum of the moment errorover time and it gives accumulated displacement that must be correct previously. So the integral control Ki will have the ability to destroy the steady state error, but it may made the transient response worse. The I controller parameter are shown below:

$$I = K_I \int_0^t error(t)dt$$

The proportional controller also used in in areas that the speed didn't mention in it, and since the I controller have the ability to discover the future errors so it cannot decrease the arise time and finish the oscillator.

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Derivative Response

The main purpose from using the derivative is to increase the system stability by make the control true because it has the ability to discover the future system errors, and to prevent the sudden change in the error signal value we take the derivative from output response instead of signal error. So the D design is suitable to system changes in signal error, and more the derivative make the process noise lauder so it cannot be used alone

The D control KD will have the ability to increase the system stability, reduce the overtake, and make the transient response better, the derivative equation are givenbelow:

$$D = K_D . \frac{derror(t)}{dt}$$

2. Tuning PID controller

Switching the temperature control unit is proportional to the values to be adjusted, integrated, and derived in order to obtain the better possible control in this special operation. If the controller cannot provide an algorithm that has been turned on automatically, or if the algorithm that is automatically set cannot provide sufficient control for a specific position, the unit should be turned usingthe method of trial and error.

The following is a tuning procedure for the Omega CN2000controller. It can be applied to other controllers as well. There are other tuning actions which can also be implemented, but they all use similar trial and error methods. Note that if the controller uses a mechanical sequence (instead of a solid state relay), a longer cycle time (20 seconds) should be used at the start of the operation.

The following definitions may be required:

- Bold - known as a duty cycle. Total length of controller time to complete one on / off cycle. Example: With a 20 second cycle time, a time of 10 seconds and a 10 second shutdown time represents a 50 percent power output. The console will turn on and off while within the relative range.
- Bold - The temperature range is expressed in% of the entire range or degrees within which proportional action takes place. The greater the relative range, the greater the area around the point at which the relative procedure occurs. These times are often referred to as gain, which is equivalent to the relative range.
- Bold, also known as reset, is a function that adjusts the relative band-width with respect to the set point to compensate for dropping of the set point, it sets the temperature controlled to determine the point after the stability of the system.
- Bold, also known as rate, controlled rate of rise or fall of system temperature and automatically adjusts the relative band to reduce overtake orundertake.

Note: instructions for switching the tri-mode controller may differ from other modulation procedures. The self-tune characteristic is usually implemented to reduce the need to use that manual action settings for the basic output. However, modifications can be made to self- turned values if wanted.

3. Ziegler-Nichols method

For a long time ago the PI controller was more widely used than PID controller, because the PID controller is quick with no waverer, more times it show unsettled even if small changes in the input set point or any turmoil to the process than the PI controller. Ziegler-Nichols Method is one of the most effective methods that increase the uses of PID controller

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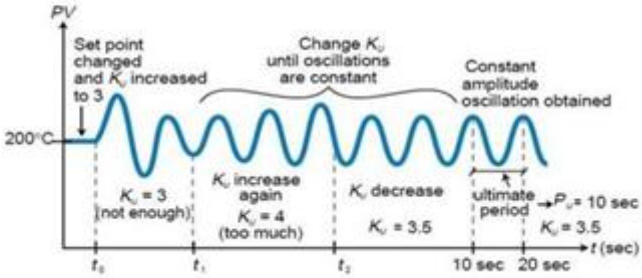

Figure 11: Ziegler-Nichols PID tuning way

To understand the PID response, logically in the beginning we must check if the proportional gain we made is positive or negative, here the inputs will increase slowly so if the steady state error positive , so it can't be negative, then the Ki, Kd set to zero, and just Kp value will be increase until it make Periodic fluctuation when the output response. Kp steady value will arise to the final and as a result the whole process will depends on two factors and the other parameters will respond as the table below

Figure 12 : Ziegler-Nichols PID controller tuning method, modifying Kp, Ki and Kd

Ziegler–Nichols method giving K' values (loop times considered to be constant and equal to dT)			
Control Type	Kp	Ki'	Kd'
P	$0.50K_c$	0	0
PI	$0.45K_c$	$1.2K_p dT/ P_c$	0
PID	$0.60K_c$	$2K_p dT / P_c$	$K_p P_c / (8dT)$

4. Techniques for fine tuning:

In order to calculate the constants, they are converted according to one of the optimal mode, or the correlation or stability analysis should be assumed as the primary values. These values are ought to be implemented to the process so that experimental data to a closed loop performance can be obtained and modified so that appropriate monitoring performance can be obtained.

To identify those adjustments, we need to rely on the initial dynamic responses, and the terminology is often a fine conversion, And that is crucial as to the errors in the basic state process and oversimplification of the modulation method. An accurate tuning method can be described as a process that can be controlled by a PI-algorithm. At a matter of fact this procedure can simply perform and produce extra information for the way control-modes work when combining the control procedure.

After calculating these initial parameters and after accessing their values in the algorithm, the status switch of the controller can be changed in automatic mode to permit the controller to calculate those values and change the last element. so, the response to the change point set is determined to calculate if the tuning is actually favorable. A change point set below is for:

a. So it can be displayed when the personification is executed.
b. Smooth output focus on time-disturbance, a simple step to reach.
c. Size can be chosen by the responsible engineer.
d. Effects of P and I controllers can be disconnected, which greatly extend the diagnosis method of control.

As shown in Figure 12. Where the response step of the control system is given with PI appropriately. The most significant aspect here to consider is the right way to change in the manipulation variable when changing the set point. Because of the relative status and equal to the KcEit), that is equivalent to the KSP (f). This change is in the beginning approximate from 50 to 150 percent of the change in the final stable case. secondly advantage is the late side, because of the dead time, between the time of change of the specified point and whenever the

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controlled variable is initially recorded. Clearly, no control here can minimize this above mentioned delay to a lesser extent than that dead time. During the time of the time, the error is found constant, so that the relative expression are not prone to change, and the duration of the integral is multiplied in a linear way in relation to the KcEit) /Tj. However, when the controlled parameters starts to react actively, the relative expression begins to decline, and when the integrated period is observed to increase continuously. When the transient response ends, the relative term that is subject to error is zero and the integrative period has modified the doctrinaire variable to a value that make the offset to zero

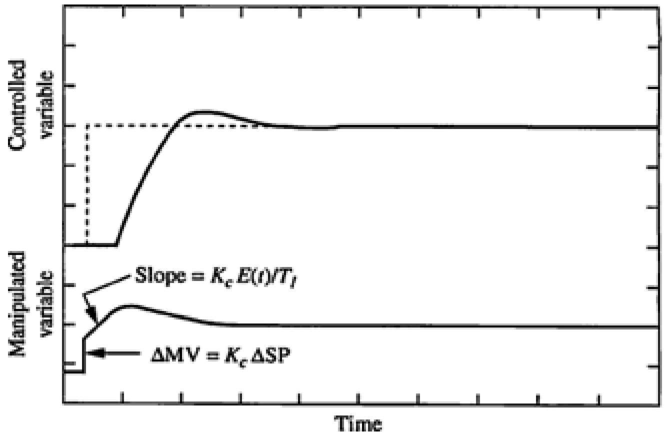

Figure 13. Typical set point response of a well-tuned PI control system

Interpreted value maybe observed when a controller is properly viewed, giving the response in Figure 13.9. It seems that the control response is slow, that lead to large IAE and long time to back to the particular point. Transient analysis indicated that there is primary change in the manipulation variable when the set point changes, and is called the P controller "kick", it is just about 30 % of the last value, which indicated that the value is too small to gain of the control. Conclusion to make here is that the system's behavior can be vastly amend by increasing the gain of the control. probably, multiple soft steps, with plant testing at every step to calculate the changed results. The performance of the control system can be greatly improved

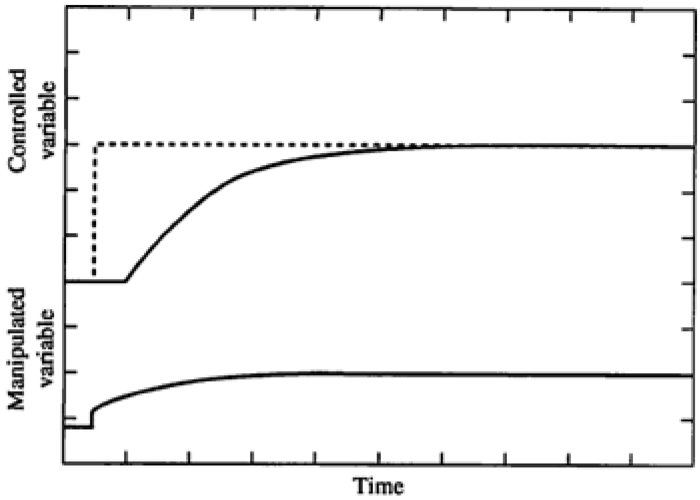

Figure 14. 223 with the controller gain increased by a factor is shown in fig 13

5. PID loop applications

We can use the PID controller in to dominate different alterable variables, including those who hurts by manipulating other process variables. By another meaning, everything we can calculate and treat we can benefit from it for PID loop control. like the air pressure in the length of air ducts. A simple pressure sensor can be used

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it from it to calculate duct pressure and anything that can raise that pressure, such as the dampers that control by solenoid or variable speed fan. This is all component that we needed for PID controller. temperature, flow rate, chemical composition, speed, and level are the other ideal PID loop goals or targets.

Some control systems ask for the PID controller to use it in waterfalls and networks because that the most PID loops setup, as an example the a master control gives signals that used by slave controllers.

The control of PID gives more control action earlier than what is found to be possible with P or PI control. This minimizes the impact of a disturbance, and reduces the time must be taken for the level to go back to its original point.

SIMULATION AND RESULTS

The main goal in this research is to improve an online automatic tuning way for PID controller, an online characteristic for a proposed method allow for the PI continuous adapter to keep their acts when the process pass through variety processing status, the new way combine between the pattern- based and standard rules to improve a planned self-control. This operation is very useful to determine the operation dynamics, the reason of that is disorders or set change. The standard is very important to change the general control guidelines to determine elicitation motive. An end elicitation motive fixed the PI parameter very good so its performance was perfect. In the real application we can all parameters values and the set-point to percent before pass them through the PID controller.

Note that the downstream loop, also known as the inner loop, which is the compressor's velocity control, it should be faster than the outer loops. It is usually something wanted number 10 to the factor. beside, pulsed is guaranteed The response speed is simulated across the use of lags.

After simulation , and connect all the needed blocks, we have the block diagram as shown in figure 15

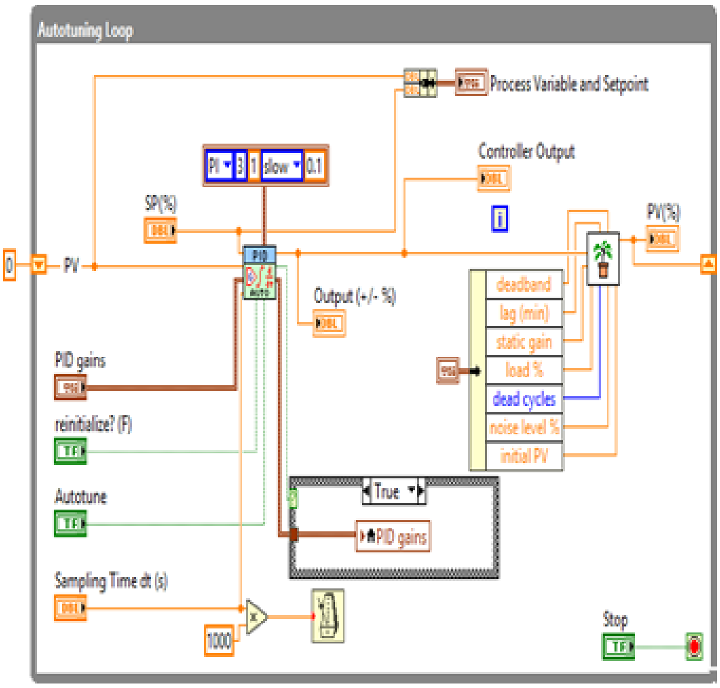

Figure 15 :Block diagram and control loop for planet

The front panel which indicates the process variable and the set-point are shown in figure below

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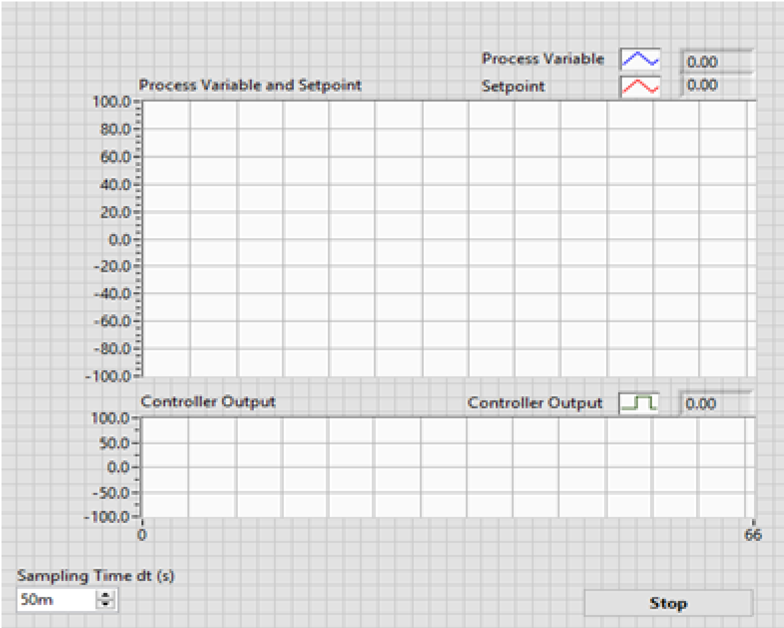

Figure 16:Front panel for process variable and set-point

The proposed tuning method in this paper differs from that previous methods in three aspects: first, the proposed way adapts the PI to get certain characteristic time gain which is more gravity to do its work out that the other complicated characteristics like, gain/phase margins, frequency-domain specs, pole placement, ISE, complicated objective functions, etc. the main performance for the time domain also allows for a simple perception for the new response so the process can make it online performance better for possible trade off. The second aspect is the tuning method focus on general and well known tuning principles instead of that heuristic and/or expert knowledge, the last aspect is that the tuning method use the future forestations in output results which allows advanced correction for PI parameters , this provides good tuning especially with that process with dead or reversed response. as shown infigure.17"

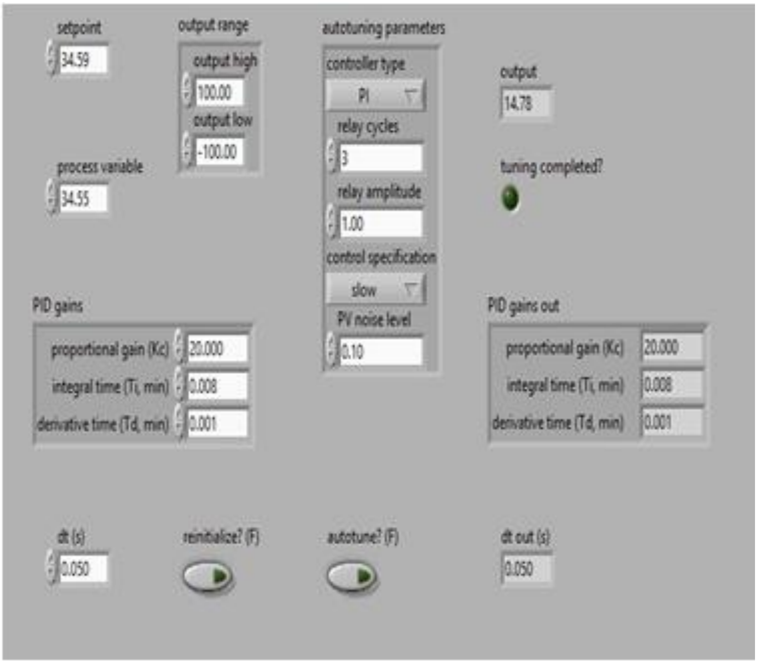

Figure 17:PID Auto-tuning parameters

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The planet characteristic which indicates the process gain , process load, valve deadband, and the measurements of the noise for the planet are all shown in figure18.The planet is consist of a D.C. motor with the variables depending on the PI controllers parameters

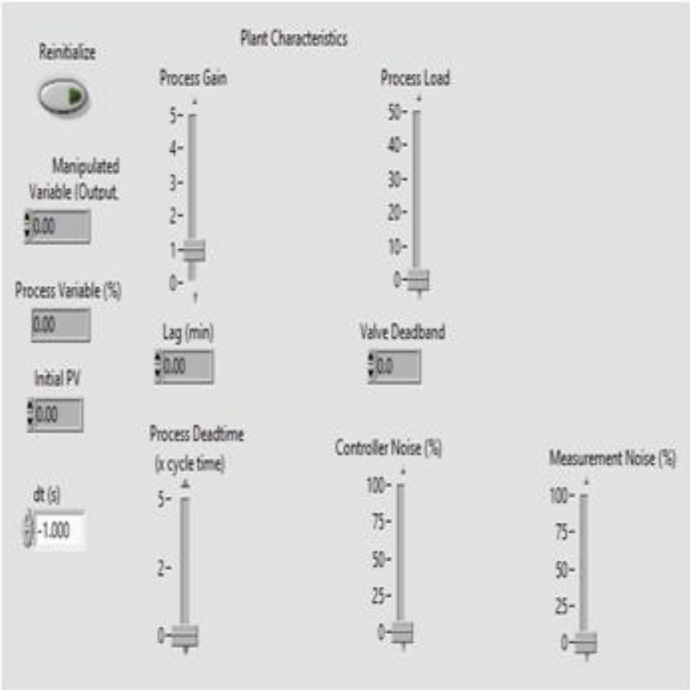

Figure 18: plant simulator

The set-point and process variables for the output are in colors bar in the front panel. The increasing and decreasing based on 100% in the green bar in figure19

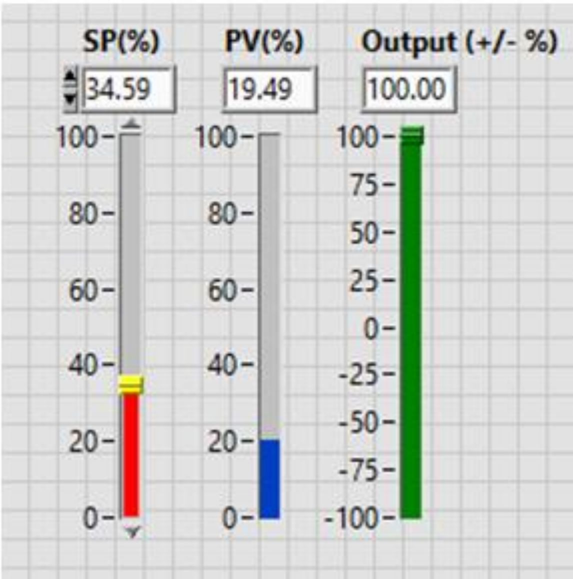

Figure 19: set-point and process variable parameters

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The gains of the PID controller are shown in figure.20

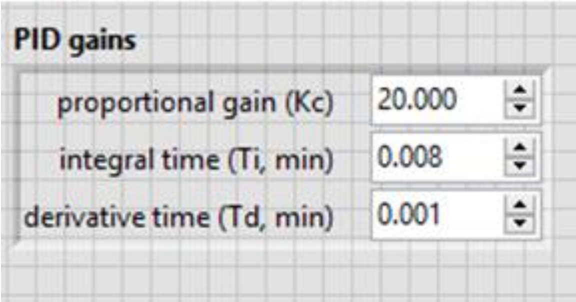

Figure 20 PID gains in front panel

The output response of the system pointing to the process variable and set-point.

The response of controller which depends on the PI gain decaying from (100) to zero with the time .in this case we take a different sampling time(second) , starting from 50msec , 80msec .& 120msec .as shown in figure 21, figure.22,and figure.23

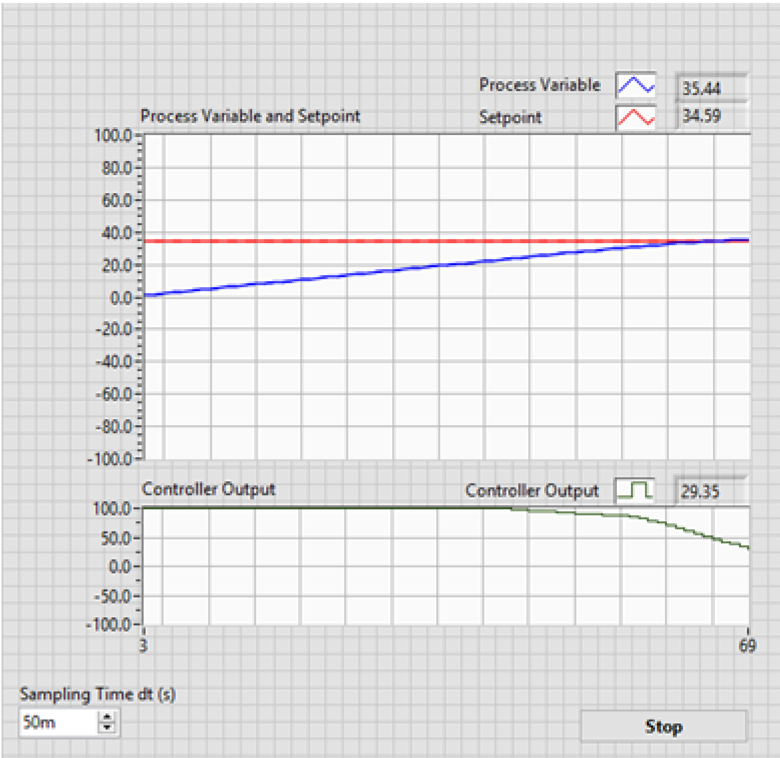

Figure 21: controller output for sampling time= 50msec

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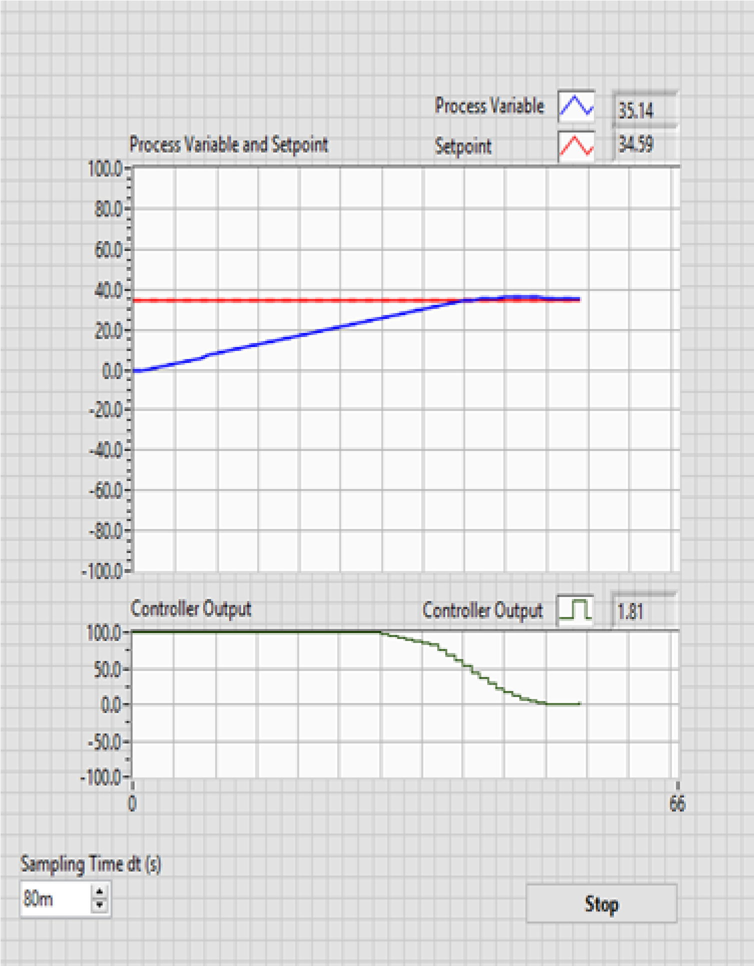

Figure 22 : process variable and controller output for sampling time =80msec

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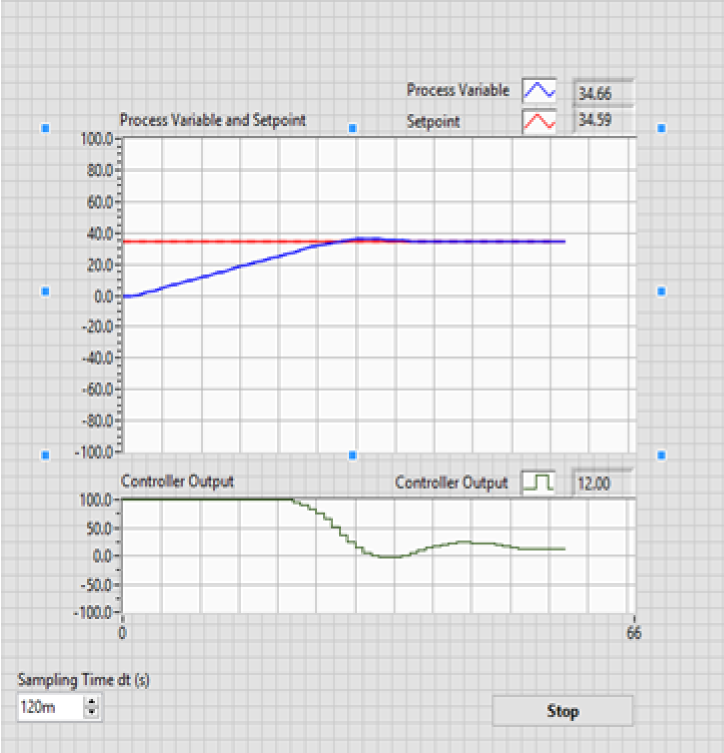

Figure 23 : controller output for sampling time = 120msec.

CONCLUSION

In my research I used a simple graphical programming language of Lab VIEW for real- time monitoring of a motor's encoder response, which saved money and costs because the software acted as an alternative for an oscilloscope. The real-time response increased the efficiency of program testing and editing. Lab VIEW proved an excellent choice for DC motor control.

In Future we can improve the use of Lab- View program with DC motor by using NI LabVIEW as the motor controller, we can control a DC motor for multiple purposes With the push of a button in LabVIEW, a DC motor can start, stop, and turn in any wanted direction. Also , we can simply adjust the position by turning a virtual knob in LabVIEW software to rotate the motor shaft to the desired angle."

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