Abstract
In the present era automation is a popular technique which is seen almost everywhere starting from industrial application to consumer application. This paper describes how the speed of a dc motor is automatically controlled through temperature variation. The dc motors are found to be used like in AC machines, small cooling fans, rob arms as well as in simple toy cars. However this paper uses LabVIEW platform for the interfacing of dc motor. The interfacing circuit is made on NI-ELVIS prototype board which supports to LabVIEW platform. The dc motor used is of rating 12v, 300ma. Since motor speed is controlled through temperature variation, temperature measurement circuit is also interfaced through LABVIEW NI-ELVIS prototype board. The temperature sensor used here is a thermistor (10K) IC temp sensor (LM335). Both temperature measurement and dc motor interfacing is done through LABVIEW software loaded in a PC containing a DAQ assistant card. All the signal communication between LABVIEW and interfacing circuits on the NI-ELVIS prototype board is possible through this DAQ assistant card. Initially the motor speed is set to a particular speed related to a set temperature. The change in temperature is compared with the set temperature. Depending on the variation in temperature the speed of dc motor can either be increased/decreased using the LABVIEW program.

Keywords
NI-ELVIS, DAQ, Lab VIEW, LM335, DC motor.

I. Introduction
Most of the electronic device which is available in the market for the use of day to day life is seems to be automated control type. E.g. some of the device like personal computer CPUs need to operate in a temperature controlled environment. One of the ways to control the temperature using small DC motor cooling fans. This means temperature control is directly maintained through DC motor speed. Besides this there are some industrial applications which follow the said procedure to maintain a constant temperature working environment for the machines. Some of the other applications found in paperers, robot mechanism etc. The speed of the motor can be controlled in many ways. But as per the requirement the motor speed as to vary with temperature variation. Hence the automation is too made through software manner. Thus the paper uses the user friendly instrumentation software Lab VIEW, where the field of work is based on the platform like Virtual Instrumentation.

II. Brief on Virtual Instrumentation, LabVIEW, NI-ELVIS
Conventional instrumentation usually requires large investments, resulting in costly monitoring or control systems, which generally are not able to perform the analysis and control of several signals simultaneously. Considering such points, the application of a new generation of acquisition systems, named virtual instruments (VI), have been considerably increased in the last few years. Such instruments are generally based on a suitable personal computer, a compatible acquisition board and visual programming software, those results in a high performance instrument (flexible, adaptive, high computational capabilities, etc). The concept of virtual instrumentation has been firstly applied to reduce the development effort in industrial automation and laboratorial procedures. Hence Virtual instrumentation is defined as the combination of measurement and control hardware and application software with industry-standard computer technology to create user-defined instrumentation systems. Virtual instrumentation (VI) provides an ideal platform for developing instructional curriculum and conducting scientific research.

A. LabVIEW
LabVIEW, a program developed by National Instruments, is the industry standard for programming computer-controlled instruments. This is a graphical programming environment. Unlike C/C++ where you write the programs in text, in Lab VIEW you create a Virtual Instrument (VI) by graphically composing it from different elements and structures that you place like the blocks of a block diagram and interconnect with wires to indicate the intended signal flow paths. This gives a graphical development environment with built-in functionality for simulation, data acquisition, instrument control, measurement analysis, and data presentation. Lab VIEW gives you the flexibility of a powerful programming language without the complexity of traditional development environments.

B. NI-ELVIS
For the implementation as well as simulation of a Lab VIEW program National instruments has developed a well hardware equipped and software based workstation called NI-ELVIS. The NI-ELVIS environment consists of the hardware workspace for building circuits and interfacing experiments.
and the NIELVIS software. The NI ELVIS software, all created in LabVIEW has two main types: the soft front panel (SFP) instruments and Lab view APIs, which are just additional Labview VIs for custom control and access to the features of the NIELVIS bench top workstation. NI-ELVIS uses LabVIEW-based software instruments, a multifunction DAQ device, and a custom-designed bench top workstation and prototyping board to provide the functionality of a suite of common laboratory instruments. NI ELVIS combines hardware and software into one complete laboratory suite as shown in fig. 1.

III. Working Paper Description
This paper is divided into two parts. In the first part, the present temperature is measured and stored. With respect to the temperature a DC motor is set to rotate at a predefined speed. This means there is a scaling relation between the measured temperature and the voltage input to DC motor.

Now when the temperature value changes, the scaled voltage applied to motor also changes. We had design scaling sub-Vi in such a manner that with increase in temperature the voltage should increase in order to increase the speed of motor. This is with a meaning that if it is required to maintain the temperature at a fixed value, a cooling fan to be attached to DC motor should rotate speedily.

In the second part, the current speed of the motor is measured through the virtual tachometer in the form of RPM (revolution per minute). Finally the temperature versus speed graph is plotted to make sure that, with the variation of temperature the speed of the DC motor also varies leading to maintain a constant temperature.

The block diagram of the whole paper is shown in fig. 2.

IV. Implementation
The circuits are designed on the prototype board for both the parts of the paper are shown in fig. 3.

A. Measurement of Temperature and Making the Motor Rotatable
As shown in fig. 3 above for temperature measurement the circuit used is a simple voltage divider circuit comprising of a resistor and temperature sensor (i.e. thermistor here). The thermistor used here is a negative temperature coefficient type, which means with increase in temperature the resistance offered by the thermistor decreases. In order to display the measured temperature the voltage across the thermistor is scaled in two stages.

The first stage scale the voltage across the thermistor to its resistance offered using the mathematical relation

$$R_T = R_1 \times \frac{V_T}{(3-VT)}$$

(1)

Where

- $R_T$: Resistance offered by the thermistor
- $R_1$: Reference resistance (i.e. 10KΩ)
- $V_T$: Voltage across thermistor

Practically the voltage across thermistor is measured through the DAQ assistant using the DAQ input channel ACH 0+ and ACH 0- provided the NI-ELVIS prototype board. Then the scaling is done in the PC using a sub VI (i.e. Scaling.vi). The scaling sub .vi sub VI is shown below fig. 4.

However since it is required to display the temperature again the second stage scaling is done. The second stage scale the resistance value obtained from the sub VI (i.e. Scaling.vi) to the temperature using the mathematical relation

$$T= \frac{(1/-0.04452)\ln(R/29.95798))}{(29.95798)}$$

(2)

The above mathematical equation can be implemented in the form of another sub VI named as Convert R – T.vi. The second stage scaling sub .vi sub VI is shown below fig. 5.
The block diagram of the part1 (temperature measurement only) implementation of the paper is as shown in fig. 6.

In the first part of the paper it is also required that to generate the voltage to drive the DC motor. This is made possible by manipulating the voltage value obtained through DAQ assistant 1 and outputting the resulted voltage through output channel DAC 0 using another DAQ assistant in the block diagram. Hence the block diagram is shown in fig. 8.

The front panel now displays the resulted voltage at DAC 0 as shown in fig. 9.

In this paper inside it we have taken 3 DAQ assistants (2 of them are for part1 and 1 for part 2), which are also treated as sub Vis in the labVIEW program. The DAQ assistants can be used to interface the practical circuit input/output made in NI-ELVIs board and the virtual instrument inside PC through the PCI card. For the input to the PC the DAQ assistant uses the analog input channels provided in the prototype board. Similarly for the output from PC the DAQ assistant uses the analog output channels provided in the prototype board here.

When the DAQ assistant placed for the first time in the block diagram of a labVIEW program it creates its own VI as per the information given by the user (i.e. whether DAQ assistant is to use I/P or O/P channel and the data type to be communicated). One of the sample diagram for the DAQ assistant to use the I/P channel is as shown in fig.10.
The function of each DAQ assistant in the paper is as mentioned below:

- DAQ assistant 1 receives the voltage available in analog I/P channel ACH 0.
- DAQ assistant 2 receives the voltage available in analog I/P channel ACH 1.
- DAQ assistant 3 outputs the voltage through analog O/P channel DAC 0.

Out of the above three DAQs, the DAQ assistant 1 and 3 are used in the part1 implementation of the paper and the DAQ assistant 2 is used in the part2 implementation of the paper.

### B. Measurement of Speed of the Motor

This is the second part of the paper where the speed of the motor is to be measured with the help of another DAQ assistant being introduced to the main VI. In this part the speed measurement circuit shown in fig.3 earlier comes into action. The round cardboard disc prepared of fixed size with a single groove is attached to the axis of the motor. Hence with the rotation of the motor the disc also rotates. As per the diagram shown in fig. 4 the disc has to rotate in the gap between the faces of Infra Red LED and photo transistor. The reason is that in each rotation the photo transistor conducts once only, hence resulting a pulse output across 1MΩ resistor.

Since the speed has to be measured in the form of RPM, but the available data for this is in the form of pulse output, it is required to count the no. of pulses in each minute. It is to be kept in mind that for each rotation only one pulse generates. This is done by introducing a library VI (i.e. pulse measurement.VI) and a formula node as shown in fig. 12.

Hence the pulse output is taken through another analog channel ACH1+ and ACH- using another DAQ assistant. The input data received through this DAQ assistant is passed through the pulse measurement.VI, then followed by the manipulation circuit to give the speed in RPM. The block diagram of this VI is as shown in fig.13.

The front panel is as shown in fig. 14.

### V. Plotting the Graph Between Temperature Vs Speed

This is the last stage of the second part of the paper implementation, where it is required to plot the graph between temperature and speed. This is because to ensure that with the change in temperature, speed also changes.

At this stage a waveform graph indicator is inserted to the main Vi. However before feeding the data to the waveform graph, the...
array of both temperature speed information is stored through two build array controls. The complete block diagram and front panel now looks as shown in fig. 15 and fig. 16 respectively.

VI. Conclusion
The paper described here is an executable paper. Since the paper comprised of two parts, individual one can be implemented in other applications also. The flexibility in designing the paper using the labVIEW software leads to modify the paper anytime as per the requirement. Since virtual instrumentation is the leading platform for the measurement, instrumentation and control, the practical implementation of the paper can be well realized.

References