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Arduino Based Contactless Speed Tracking System

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Abstract: This paper proposes a contactless system for speed tracking to control the speed of electrical motor load. For contactless speed measurement, the Infra-Red (IR) sensor module is used to calculate the number of revolutions of rotor at every minute as pulses. Conventionally, the speed was detected using tachometer through direct contact process, however the accuracy gets affected due to vibrations caused and resolution varies abruptly. Hence, the contact less or non-contact approaches were evolved to achieve accurate speed tracking. In this work, the tracking scheme uses an IR sensor module to count the RPM pulses which is transmitted to Arduino Nano. After computational process of Arduino controller, the necessary suitable control action is initiated for the speed control of motor. Also, the computed Revolutions per Minute (RPM) speed is displayed in Liquid Crystal Display (LCD) board for direct user interface access. This contactless tachometer design facilitates the RPM calculation for a motor without any direct contact with the rotating object.

Index Terms **- Speed Tracking, Arduino Nano, Infra-Red Sensor, Digital Tachometer**

I. INTRODUCTION

With evolution of automobile and transport system, the necessity of speed calculation arises for evaluation of system performance. A German engineer named Dietrich Uhlhorn developed the first tachometer in 1817, which was widely utilized to measure the speed of machines using gauges. Within 20 decades, world-wide, this simple invention plays an inevitable role in every driving vehicle system. The Tachometer is a tool to record the rotation speed of a shaft / disk and the analog device generally uses gauge to display the revolutions per minute (RPM) on a calibrated analogue dial.

A digital tachometer is a digital device that measures and indicates the speed of a rotating object. A rotating object may be a bike tire, a car tire or a ceiling fan, or any motor, and so on. Generally, a digital tachometer comprises of a display unit for user interface and memory storage for computational process providing numerical readings instead of dials and needles. Tachometers are very well-situated in monitoring and controlling the motors in industrial automation for process control of manufacturing industrial plants like chemical, pharmaceutical, textile, etc., Conventional tachometers requires contact between the device and the rotary body; there are various applications where this direct contact implementation is not possible. To deal with such conditions, a tachometer which operates in non-contact mode is essential; such tachometers are known as Contact-less Tachometer. This work [1] proposed the idea of speed detection using IR transceiver along with speed display unit and speed control using pot circuit.

A Contactless tachometer [2] with auto cut off scheme is developed for the protection of motor circuit under abnormal running conditions. In this work [3], an electronic instrumentation circuit is employed for counting the revolution with analog display. For simple user interface, a time-based readings of revolution per minute (RPM) is measured and displayed on analog dial for monitoring purpose. A low-cost contactless digital tachometer is designed with wireless communication technology for user interface and monitoring, which performs well with operating RPM higher than 300 [4]. In current scenario of industrial growth, the induction motors plays a key role

in every stage of control operations. Hence, it is essential to monitor and control the speed of its performance in all kind of it drives. Speed of a drive is also an important factor to be considered while analyzing the efficiency and loadability of motors. A simple, low-cost and a nonintrusive technique can be adopted using vibration based spectral analysis for motors [5]. A MATLAB-based algorithm will find out the motor speed by identifying the mechanical frequency of the rotor shaft from the harmonic content of the vibration signal captured through accelerometer.

In this work, a contactless tachometer is developed using Arduino and automatic motor control is achieved using relays. With this designed module, the current running speed status of a motor can be provided and also based on that information; the supply control is possible at higher voltages. This is sample paper format only please use this format and follow this structure as per your requirement

II. Significance of Speed Measurement

In various segments of industrial and commercial plant operations, the speed measurements of different drives were indispensable [6]. Such kind of measurements can be carried out in a number of ways, based on the nature of the object to be measured. A tachometer is a gadget that records the rotational speed of a shaft in a machine. The word tachometer is derived from two Greek words tachos meaning “speed" and metron meaning "measure". Tachometer used for the speed measurement of industrial drives works on the principle same as tachogenerator, in which a motor is operated as a generator to produce the voltage based on shaft velocity with load disconnection. The rotational speed of the shaft can be easily determined by calculating the output voltage produced using a sensor circuit, which can be of electromagnetic, electronic or optical type design. Using these tachometers, the rotational speed of the drive motor can be calculated by finding the number of revolutions made by the machine in every single minute termed as speed unit ‘revolution per minute’ (RPM) and it is also referred as revolution counter.

In similar construction and operation of automotive speedometer, special tachometers are used in automobile industry. But the tachometer measures the instantaneous speed of a rotating drive at every transmission, whereas the speedometer tracks the continuous speed of the fast moving car in an hourly rate. Various other physical parameters that have to be considered while selecting a suitable tachometer were range of measurement, power, accuracy, type of measurement and display unit.

Based on the nature of incoming signal, data acquisition, the type of output signal need, the tachometer can be broadly categorized and furthermore sub-categorized in each type as listed in the Fig.1 below. Based on the indicating meter type, the tachometers can have output signal in the form of analog or a digital, in which the analog tachometer has a dial, with a needle to indicate the current reading and extreme operating limits [7]. However, the digital tachometer directly reads the numeric output which has become extensively used now a day.

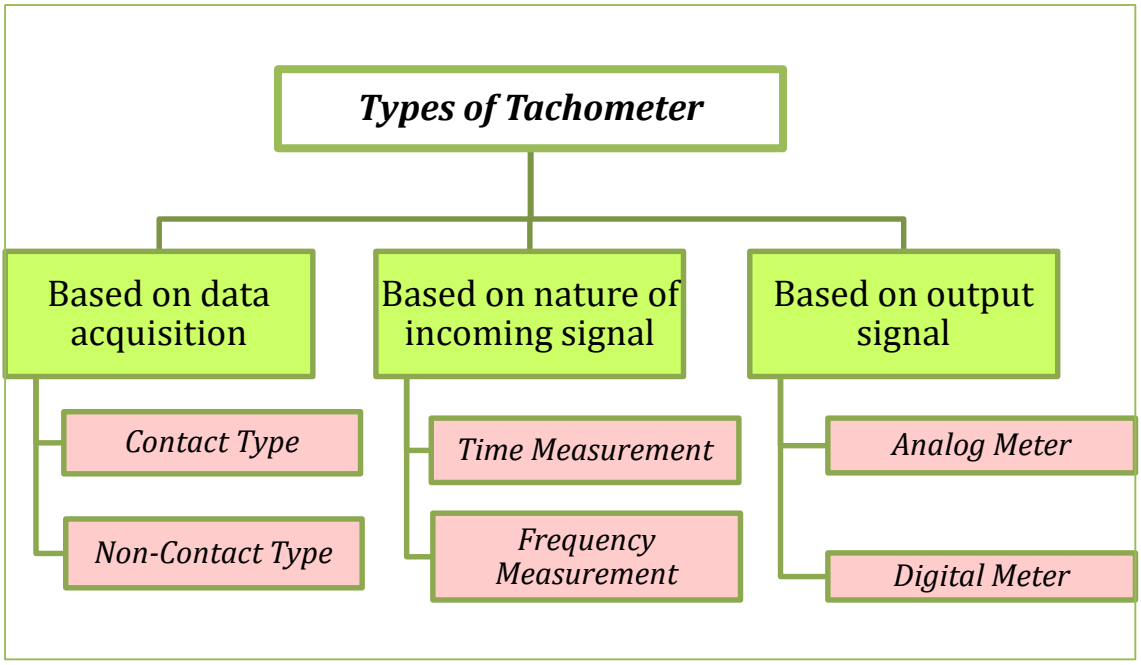

Figure 1 - Classification of Tachometer

III. Arduino Module For Non-contact Speed Tracking

Initially, the circuit-based tachometer is used to monitor the running status of a motor. This circuit would keep a track of the running speed of the motor and would cut off its supply when the speed exceeds the rated speed. The

basic principle involves a simple embedded system with a sensor, a controller and an actuator. The sensor consists of a white LED and a phototransistor, the microcontroller will be preloaded with a compiled code and the actuator can be used as a device to control or and to display the current operating speed. The sensor senses the speed of the motor without actually being in contact with it by the principle of white light transmission and reflection and generates a signal. This signal is converted into an electric signal and fed to the microcontroller, which is programmed to calculate the speed in terms of the number of motor revolutions in one minute. This speed is displayed on the LCD. Fig.2 shows a non-contact type tachometer that can be used for speed tracking system.

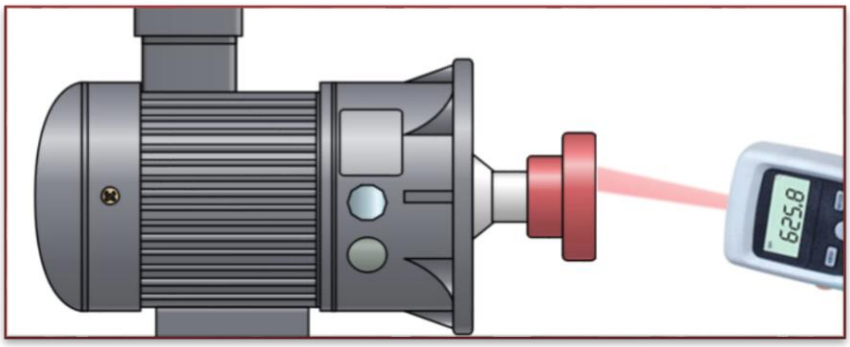

Figure 2 - Non-Contact Type Tachometer

Arduino Nano plays a vital role which is based on the ATmega328P microcontroller. The IR sensor module present consists of a LED and a photodiode. A motor will rotate in front of the sensor; the light emitted from the LED will get reflected from the wheel and would fall on the photo diode thus the infrared sensor would give out a pulse as an input to the Arduino nano. The speed will be displayed to the 16X2 LCD screen. Also, the Arduino board will be set up to a particular value for the speed of the motor, when the motor speed or the revolutions count would succeed the specified value a cut off circuit placed will come into function using relays. Thus, the power supply of the motor is cut off. Fig.3 below depicts the operation of speed tracking system using Arduino module.

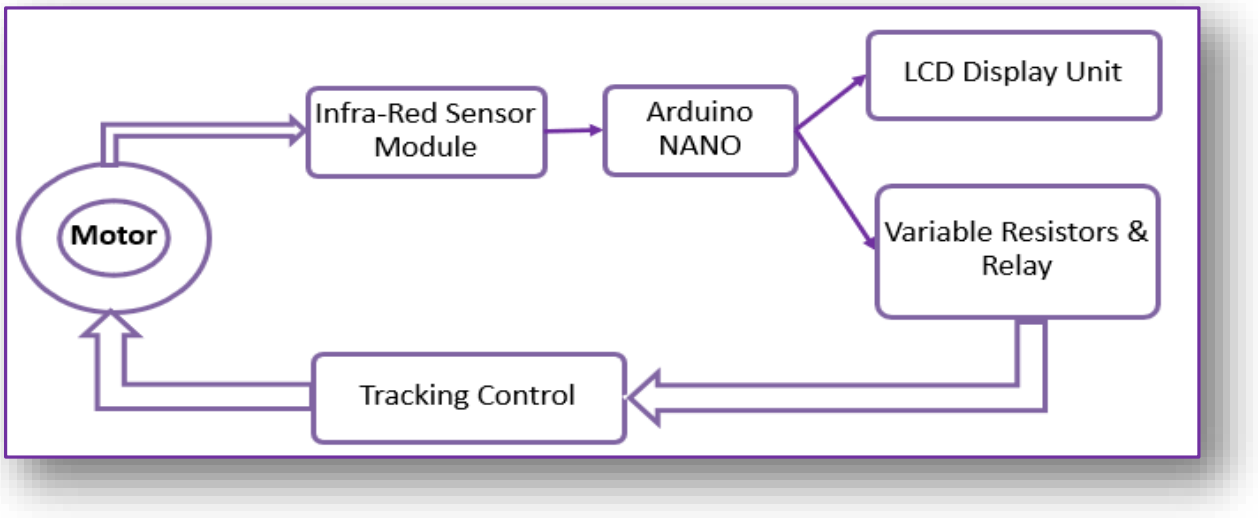

Figure 3 - Arduino Based Speed Tracking Mechanism

The speed tracking has three major units, namely, IR sensor module, Arduino Nano and the Liquid LCD display. When the rotating object is placed in between LED (i.e.) IR transmitter and the photodiode (i.e.) IR receiver, the microcontroller (i.e.) Arduino nano provides an interrupt. Based on the time interrupt and the time interval the speed is measured in rpm. The measured speed is displayed in the LCD unit. LCD port provides the signals needed for a standard character-based LCD module [8]. The display has 8 pins which are connected directly into the microcontroller. It displays 16 characters by 2 lines. The operations performed by the Arduino module for continuous tracking of motor speed is enlisted in the following steps and also depicted in Fig.4 below:

- When the motor starts its operation, the IR sensor sends the signal to Arduino NANO module.
- Arduino module determines the speed of the running motor at each and every instance and the tracked signal is sent to user interface through display unit.
- The calculated speed at every instance is then and there checked for any speed violation by the Arduino module.
- Based on the tracked signal condition, the suitable control action is initiated for the motor through the control circuit as follows.

- When the running speed of the motor is below or at rated speed of the motor, the speed signal is sensed and displayed in the LCD; else the motor supply gets cut-off when the motor starts to run above the rated RPM.
- The variable resistor/relays are used to perform the necessary actuation control needed for speed tracking system.

Relays are used for necessary control of motor speed by passing through a low-power signal, or where several circuits must be controlled by one signal [9]. Relays are the components which allow a low power circuit to switch a relatively high current. The on/off switching control is achieved using relay circuits and signals that must be electrically isolated from the controlling circuit itself can be done.

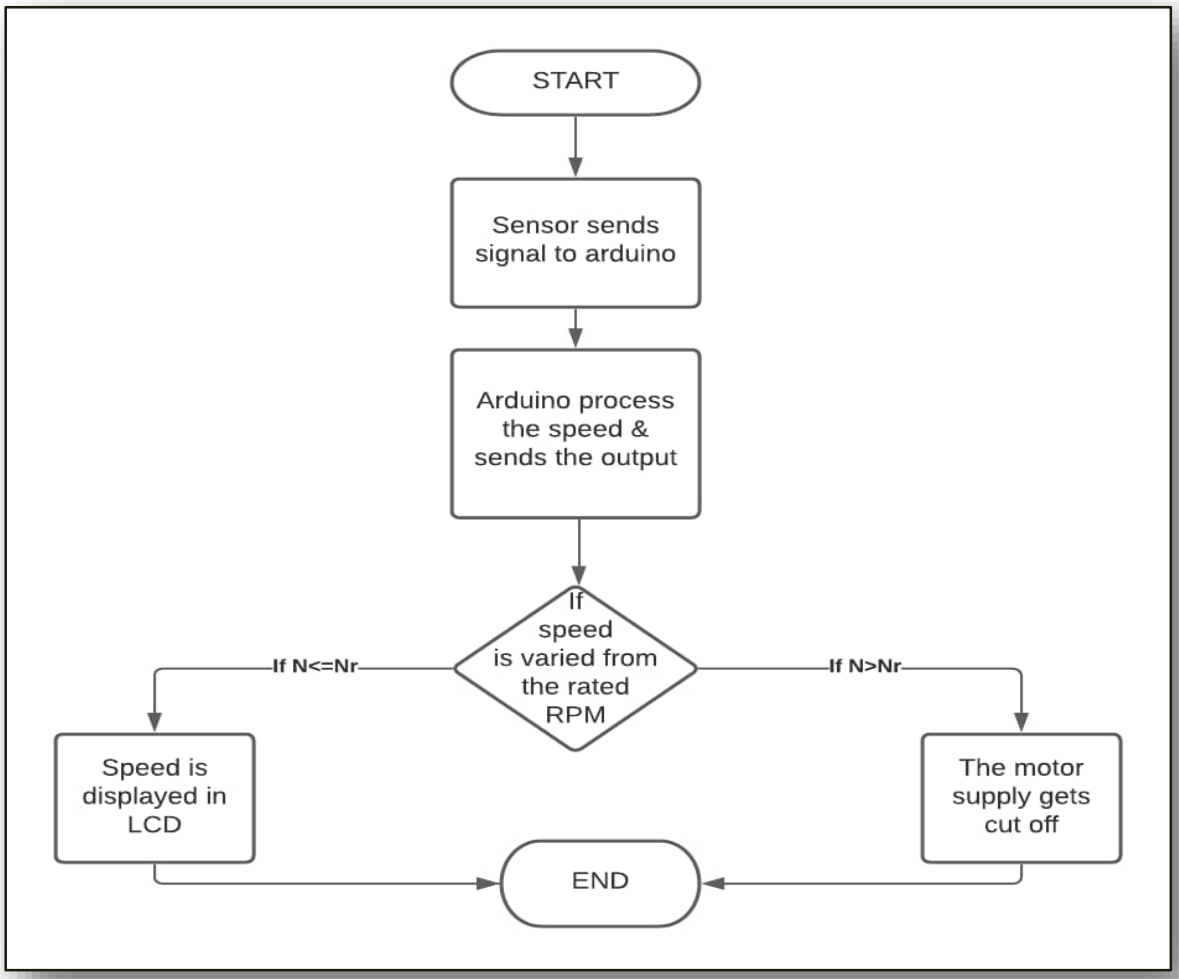

Figure 4 - Flowchart for Operation of Arduino Module

IV. Results & Discussion

The hardware setup developed to achieve the necessary speed tracking for the motor system is shown in Figure 5 below. This can be employed to measure the speed of motors which are at unreachable places. The image shows the tachometer circuit that has been used as our test model for tracking the RPM of a dc motor that has been powered independently.

Figure 5 - Hardware Setup

This device is built on a microcontroller – Arduino Nano (Atmega328), speed is detected using the IR transmitter and receiver pair, readings is displayed using LCD display and the speed is controlled by relays. It works on the principle that the number of times the IR receiver-transmitter circuit is cut and re-established in a second gives the number of rotations per second. The value is displayed on the LCD display.

In this hardware, the kit shows an initial RPM of speed build-up tracking that the IR module tracks from the motor rotational circuit that is being tested by us. The basic concept includes an Arduino with the background of c programming from embedded systems that employs an IR sensor, an Arduino microcontroller, an LCD output screen and a source from generating the output to be measured. The IR sensor module involves an IR transmitter LED and an IR photo receiver, the microcontroller used is loaded with a C programmed code and is stored in its memory until it is reset, and the actuator is an LCD display device, displaying the real time speed being measured from the motor surface.

V. CONCLUSION

In this contemporary era of industrial evolution, the speed measurement of industrial motor plays an inevitable task of system process control [10]. In this work, the contactless tachometer was developed which measures the speed of the rotating object kept in contact. The number of rotations can be calculated by counting the number of pulses in ranging of infrared sensor. Furthermore, this work can be extended for automated loop process control to operate the motor under speed limit violation conditions for safe operation.

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