CONTACTLESS IR TACHOMETER

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ABSTRACT

A tachometer is a device that measures the rotation speed of a shaft or disk, as in a motor of other machine. In automotive use, it is used as a gauge showing the speed (RPM) of the engine shaft that is driving the transmission, usually in thousands of rotations per minute. What makes this device special is that it can very accurately measure the rotational speed of a shaft without even touching it. This is very interesting when making direct contact with the rotating shaft is not an option or will reduce the velocity of the shaft, giving faulty readings. This device is built on a microcontroller, an alpha-numeric LCD module, a battery and a proximity sensor or an infrared to detect the rotation of the shaft whose speed is being measured. If we were using proximity sensor, the counted pulses will detect any reflective element passing in front of it, and thus, will give an output pulse for each and every rotation of the shaft. But if we were using infrared, we will put the infrared on both shaft and the tachometer. Those pulses which we get from every rotation of the shaft will be fed to the microcontroller and counted

Keyword:- *8051 Microcontroller , Embedded C programming , IR diode , Photo diode , Tachometer , ATMEGA16 microcontroller, infrared module, dc motor*

1.INTRODUCTION

A contact-less tachometer will let you know how quickly something spins and is frequently used for buses, trains, tractors, trucks, cars and planes. This non contact tachometer version uses a sensor that will sense revolutions through pulses. A contact-less tachometer consists of a shaft encoder and electronic circuits. The output of the shaft encoder provides electric pulses. The frequency of these pulses is proportional to the rotational speed. A speed signal is obtained by processing the pulses from the encoder using an additional electronic circuit. When the wheel or shaft rotates, it has a mirror or a tab that obstructs the path of the light every time it revolves. Then, there is simply a chip to count the number of obstructions per minute. This one is extremely accurate and can handle some of the highest speeds. Speed of a motor is one of the important factors to be considered while dealing with dc motors. It determines the power drawn by the motor, efficiency, loading, etc. Also if the machine runs above the rated speed, it might damage or even burn off the machine. So knowing about the speed of a machine is inevitable in order to calculate or control the speed. Contact less tachometer is a device used to measure speed of a motor by counting the number of rotations per second of a rotating shaft using micro controller. As the name indicates, it can very accurately measure the rotational speed of a shaft without even touching it. This is interesting because making direct contact with the shaft is not an option, and will reduce the speed of the shaft giving faulty readings. This can also be employed to measure the speed of motors which are at unreachable places. This device is built on a microcontroller - ATmega16, speed is detected using the IR transmitter and receiver pair, readings are displayed using a 16x2 LCD display and the speed limit is indicated by an LED and a buzzer. 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. The screen is refreshed after each second. When the speed of the motor is above a fixed value, a buzzer is alarmed and an LED indication is given.

2. IR TRANSCEIVER

IR transceiver is used here for determining the number of rotations of the motor shaft per second. This is done by counting the number of times the slot comes in line of sight with the transmitter receiver pair.

2.1. Transmitter

The Infrared Emitting Diode (IR333/H0/L10) is a high intensity diode, molded in a blue transparent package. The device is spectrally matched with phototransistor, photodiode and IR receiver module. It finds applications in IR remote control units, smoke detectors, free air transmission systems etc. The transmitter consists of an IC 555 timer circuit (astable multivibrator) with an IR LED at the output. The IC 555 timer circuit is designed to produce a pulse of frequency 33 kHz .The pulse produced triggers ‘on’ the transistor which in turn forward biases the IR diode. A resistor is kept in series to limit the current through the semiconductor devices. When the IR diode is forward biased during the on-time of the pulse, it emits infra-red rays.

2.2. Receiver

The IR LED converts the incident IR radiations to an equivalent electric current which when passed through a resistor results in a certain amount of voltage drop. This value of voltage will depend upon the intensity of incident IR radiations or in other words, the distance between IR transmitter and receiver. The receiver is connected in reverse bias in the circuit. The IR rays emitted by the transmitter get reflected back after hitting the target. Receiver coverts this received radiations to a corresponding electric current. The infrared receiver used in this device is the TSOP1738. It is a miniaturized receiver that is used to detect frequencie near a certain range. The range of frequencies for which each receiver works is different. The range for the receiver used here, the TSOP1738 is 38 kHz with 5% tolerance either way. Therefore the timer circuit has to be designed such that it oscillates inside the frequency range specified by the receiver. The receiver gives a high output when it is not receiving pulses within this range and gives a low output when it receives a pulse that is inside this range.This output of this receiver is given to the microcontroller. The microcontroller used here is the PIC18F452. The PIC processes the output from the receiver and computes the speed of the machine by using a timer programming algorithm. This value found is averaged for many time periods and is thus closer to the real value of the speed. This averaging is done so that any errors that may have appeared by way of the device may be negated. The speed computed by the microcontroller is given to a 16x2 LCD system to display the output.

3. WORKING AND CIRCUIT OPERATION

Contact less tachometer is a device used to measure speed of a motor by counting the number of rotations per second of a rotating shaft using micro controller. As the name indicates, it can very accurately measure the rotational speed of a shaft without even touching it.

3.1 Circuit operation

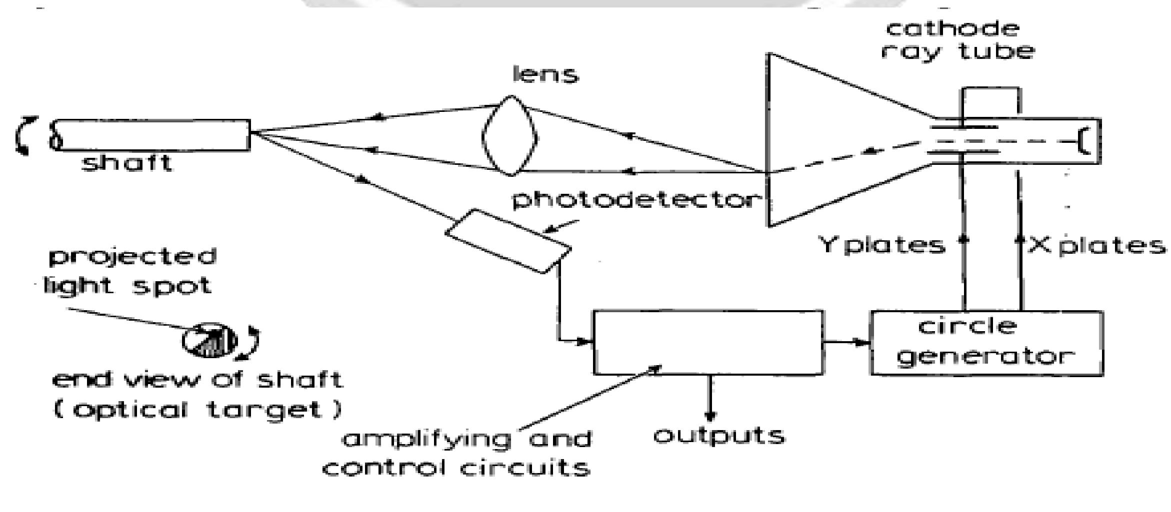

FIG 1 . Pictorial representation of conatact less tachometer.

The contactless tachometer works on the basis of the infrared transmitter receiver circuit. In the circuit we have placed the IR transmitter and receiver at either side of the DC motor such that both are in line. The shaft of the DC motor was fitted with a cardboard with slots such that the IR transmitter and receiver can make connection through the slots. As the motor runs, the IR transmitter fitted with the cardboard also rotates with it. The slot that made on the cardboard and the IR receiver are in line with the IR circuit. Thus, connection between the IR transceiver closed at each slots and current passes through the circuit. This current makes a voltage drop in the resistors connected in the circuit. The voltage across the resistor connected in series with the receiver is transferred to the second pin of port D of the Microcontroller ATmega16.The microcontroller ATmega16 is programmed such that each time the voltage in the pin of microcontroller changes from zero to a high value, it initiates a timer interrupt. The interrupt counts the number of times the voltage variation occurs in the resistor in series with the receiver and sends the value to the LCD display every second. Another timer resets the counter after each second. So we get the number of rotations per second of the motor shaft.

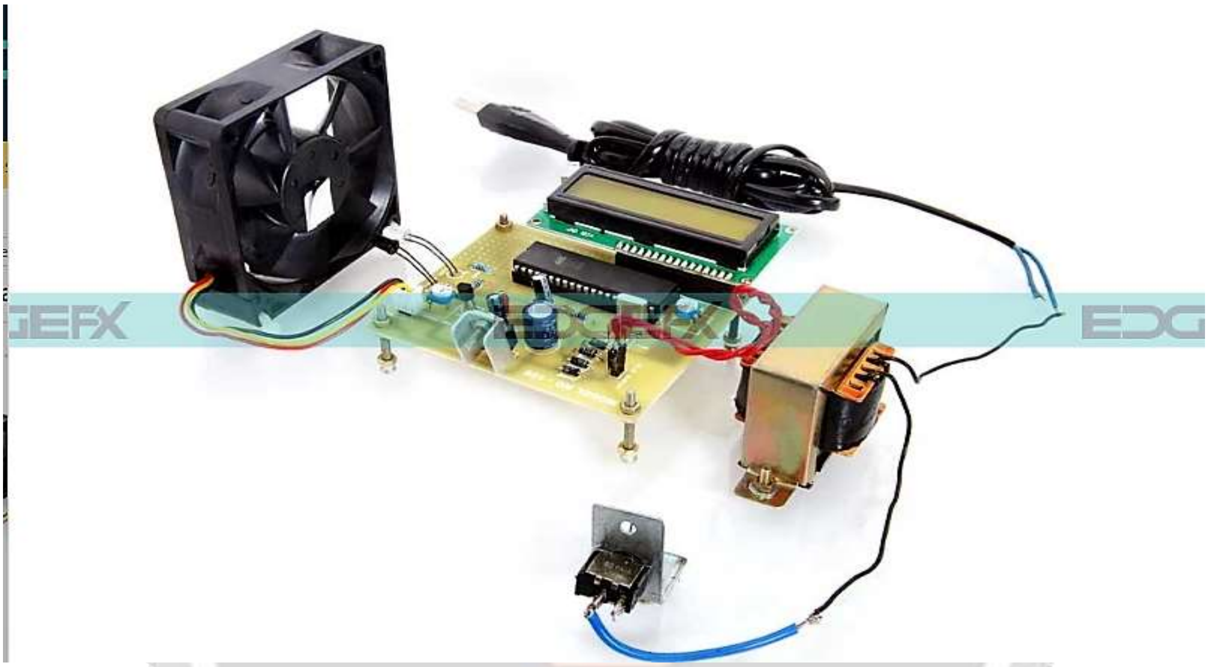

Fig. 2 Prototype of contactless tachometer

The setup provides a LED and a buzzer to make warning or indication of some fixed rated speed of the motor. The LED and the buzzer connect to the microcontroller which monitors the speed of the motor. Such a setup needs a variable potentiometer to be connected across the supply of the motor and thereby the speed of the motor can be varied to an extent. By varying the supply using the potentiometer, the speed of the motor varies and when the speed reaches or exceeds the fixed rated speed, the LED will glow simultaneously the buzzer beeps The Microcontroller is programmed such that when the output of the counter attains a value above a fixed value (in this paper the value is fixed at 29 rps), it sends a high signal to its MSB (7th pin) of port C which is connected in series with an LED and a buzzer. Hence we can get an alert whenever the speed of the motor goes above a fixed value. In real time applications an IR transceiver module can be used instead of the transmitter receiver pair. A receiver is placed at one point on the motor so that each time the center. IR rays emitted by the transmitter and hits the receiver. Each time this happens a counter is initiated.

3.2 IC 555 and Astable Multivibrator circuit

The 555 Timer IC is an integrated circuit (chip) used in a variety of timer, pulse generation and oscillator applications. The IC was designed by Hans R. Camenzind in 1970.The LM555 is a highly stable controller capable of producing accurate timing pulses.With an astable operation, the frequency and duty cycle are accurately controlled by two external resistors and one capacitor. In astable mode, the 555 timer puts out a continuous stream of rectangular pulses having a specified frequency. Resistor R_A is connected between VCC and the discharge pin (pin 7) and another resistor (R_B) is connected between the discharge pin (pin 7), and the trigger (pin 2) and threshold (pin 6) pins that share a common node. Hence the capacitor C is charged through R_A and R_B, and discharged only through R_B, since pin 7 has low impedance to ground during output low intervals of the cycle, therefore discharging the capacitor.

4. STEPS INVOLVED IN CONSTRUCTION

4.1 Step 1

The suitable resistances are selected for the IC555 circuit such that the output oscillates at a frequency of 33 kHz. The output of this circuit is connected to the infrared transmitter diode. Therefore the diode transmits infrared rays at the rate at which the circuit output oscillates.

4.1 Step 2

The pulse reflects off the surface of the machine. The machine surface has a white reflective strip. The reflective strip being white in colour reflects more than the surrounding areas. Since the reflective strip reflects more, a change in reflective pattern occurs whenever the incident infrared rays strike upon this strip. Due to this change in pattern we can understand that it is this strip that is reflecting and not the surrounding areas. As this change in pattern can occur only once in one revolution we can keep this as a count for how many revolutions take place in a given time period.

4.3 Step 3

The receiver module is kept in such a position so that the reflected infrared rays from the surface are incident upon the receiver module. When the receiver module detects a signal with pulse rate within its frequency range (33 kHz $\pm$ 5%), its normal high output goes to a low state.

4.4 Step 4

The output pin from the receiver module is connected to the PIC microcontroller. This change of state is detected by the microcontroller. Now we know that the reflective strip has passed by once. This change of output from high to low is used to trigger a timer. Now the microcontroller checks whether the output of the receiver module has gone from low state to high state. In this way we can make sure that it is the surrounding surface that is now reflecting. When the output changes from high to low it will be due to the appearance of the reflective strip. At this point the timer is stopped and the value inside the timer is stored. This value is the time that has elapsed between two appearances of the reflective strip, ie. the time taken for one revolution. From this we can find the frequency of rotation of the machine and hence find the rpm value of the machine.

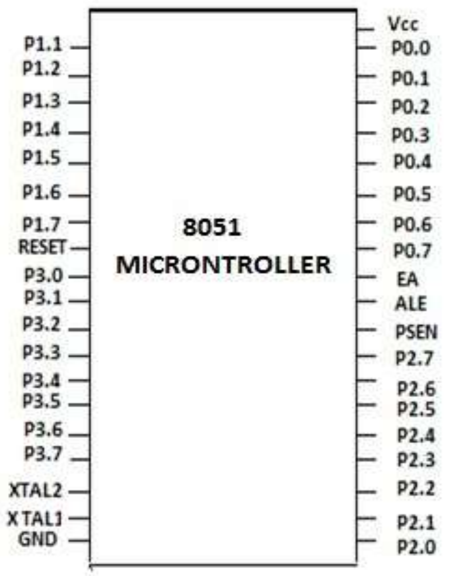

Fig. 3 8051 Microcontroller

4.5 Step 5

This value is sent to the LCD so that it can be displayed.

5. CONCLUSION

The circuit of our paper was designed and implemented. The speed of the motor is displayed on the LCD display every second. When the speed of the motor became more than 29 rps, the LED glowed and the buzzer alarmed. When the speed of the motor again comes back to less than 29 rps, the LED and the buzzer stopped.

6. REFRENCES

[1] R. Bonert "Digital Tachometer with Fast Dynamic Response Implemented by Microprocessor", IEEE Trans. on Industrial Applications, vol.

19, pp.1052 -1056 1983

[2] G. F. Pierce "Frequency determining apparatus", 1144 986, 1983

[3] www.datasheetcatalog.com

[4] http://www.circuitstoday.com/

[5] www.atmega32-avr.com