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FABRICATION OF MICROCONTROLLER BASED SPEED DETECTION AND MEASUREMENT SYSTEM

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ABSTRACT

The speed detection and measurement system used in this fabrication process is based on microcontrollers. It has the ability to detect any item at a given distance and read its speed and distance using an ultrasonic sensor, functioning as a modernized digital tachometer without making physical touch with the object to be measured (contactless). In addition to the aforementioned functions, it also functions as a detector of any stationary rotating object at a predetermined distance by determining the speed using an infrared sensor. The Microcontroller is the brain of the entire system, and it is programmed with instructions to process each measurement signal obtained from the two sensors, giving out a processed output through the Liquid Crystal Display (LCD), which displays the speed in revolution per minute. As a result, it may be inferred that the system can function flawlessly so long as the rechargeable battery is providing power. Since the sophisticated equipment such as Tachometer is very expensive and limited to speed, then it deems necessary to make use local contents to fabricate an instrument that would serve for the purpose. This fabricated instrument has an advantage of reading distance and can be used for speed detection and measurement of related practicals (Speed of various ceiling fans). Two scenarios (Cars and Motorcycles) were taken into consideration for testing to ascertain strict compliance of low speed within township. It is also proven that the work's original goal and objectives were successfully attained.

KEYWORDS: Tachometer; Speed detection; Microcontroller; Speedometer; Liquid Crystal Display

INTRODUCTION

There has been a constant requirement to measure some of the parameters of the supporting equipment throughout the development of science, technology, and engineering. To regulate the measured system or for performance, evaluation, or control purposes, it is necessary to know how quickly spinning parts are in mechanical machines. The Tachometer is an instrument used to measure any revolving body or component and to report that information in revolutions per minute (RPM) (Wikipedia, 2022). The speedometer and a number of tachometers, particularly those found in vehicles, operate and are built similarly. The speedometer monitors the overall vehicle's continuous speed in miles per hour or kilometers per hour, while the tachometer gauges the speed of the individual wheels. Some other parameters have to be considered which design/acquiring a new tachometer these include accuracy, range, precision, display type (Barrero etal.,2000; Tachometer as an Instrument, n.d.).

The aim of this work is to fabricate Microcontroller based speed detection and measurement system. The remaining parts of this paper commenced in Section 2 with the literature review of related work. Section 3 presents the materials and methods while section 4 yields the results and their discussions. Finally, summary of this instrument is presented in Section 5.

Literature Review

There are several circumstances where direct contact between the tachometer and the object under inquiry is not possible. Conventional tachometers require contact between the device and the revolving body. We need a tachometer that can handle such circumstances without needing to be in direct contact with the rotating body, such tachometers are known as Contact-less Tachometer (Contact Type Acquisition Technique, n.d.; David, 2014; Oyelami et al., 2019). According to David (2014), who designed and constructed a contact-less tachometer which could be used in the power engineering lab. The output should be a 6-digit display of revs/min and radians per second. The device should enable the use of several sensors (such as optical or Hall Effect). He explored extensively on sensor technology to achieve goal of the research. We need a tachometer that can transfer the observed results to a remote processing unit in situations where contact-less tachometers alone are not sufficient, such as when continuous monitoring and control of the rev/min are necessary and the test item is located distant from the monitoring station. As a result, this design now has the potential to convey Radio Frequency (RF) signals. The normal range of transmission for RF integrated circuits is roughly 30 meters, however this range can be readily expanded by employing more advanced integrated circuits. This device is built on a microcontroller - ATmega16, speed is detected using the infrared transmitter and receiver pair, readings are displayed using a 16x2 LCD display and the speed limit is indicated by an LED and a buzzer (Salice et al., 2014). Other benefits of contactless tachometers over contact ones include the absence of frictional losses, a large reduction in weight, low power requirements, portability, quick response to changes in speed, greater accuracy, and increased user safety (Contact Type Acquisition Technique, n.d.)

MATERIALS AND METHODS

Materials

The system is made up of the modules that are put into use on the Vero board as well as the physical connection layout, which guarantees the best possible performance of the entire circuit project. The Liquid Crystal Display unit (LCD) module, Infrared sensor, Ultrasonic sensor, and power supply unit module are some of the key modules that make up this work's hardware design. The battery powers the power supply unit, which then supplies the required DC voltage. The ultrasonic sensor's detection capacity was confirmed. The sensor's task is to determine how far a target object is from the emitting ultrasonic sound waves, reflect the sound wave back to the sensor's receiver, and then transform the reflected sound into an electrical signal. The sensor is able to work together with the microcontroller unit and a corresponding distance and speed of the object displayed in cm and rev/min respectively at the output of the LCD (Details about Ultrasonic Sensor, n.d.; Ehikhamenle & Omijeh, 2017). Then ultrasonic sensor detects and measures the distance and speed of any object blocking it part while the Infrared sensor detects and measures the speed of any stationary moving object. The LCD unit displays the output of the sensors (Imam & Manjuma, 2018). The block diagram of the Microcontroller Based Speed Detection and Measurement System describes the arrangement of the various sections that was used in the design and construction work. The block diagram is shown below in Figure 1.

An embedded system's specific operation is controlled by a microcontroller, which is a condensed microcomputer built onto a single metal oxide semiconductor integrated circuit chip. Memory, programmable input/output peripherals, and most critically a CPU are all parts of a microcontroller. Microcontrollers come in a variety of shapes and sizes depending on the manufacturer, memory, architecture, bits, and instruction sets. The microcontroller (ATMEGA328p) is a single chip microcontroller system created by Atmel in the mega AVR family. It has a modified Harvard architecture 8-bit RISC (Reduced instruction set computer) processor core. An ATMEGA328p microcontroller is as shown in Figure 2.

The ATMEGA328p microcontroller is the brain behind processing of the output of the project. It is the meeting point for all other units and they are all connected to it.

The following are the Pin description for ATMEGA328p Microcontroller as programmed for this Fabrication;

i. Pin 1: 5v input voltage through a 10k ohm pull-up resistor is connected to this pin.
ii. Pin 2: A DC pin that is programmed to work with and read data from the IR sensor in the system.
iii. Pin 7: A pin that is programmed to work with and read data from the Ultrasonic sensor.
iv. Pin 9 and 10: are known as OSCI/CLKIN and OSC2/CLKOUT, are the pins where the 16MHz crystal oscillator is connected to as an external clock source, in order to determine the processor clock speed.
v. Pin 11, 12, and 13: An RC pins that is programmed to work with and read data from the keypad in the system.
vi. Pin 14, 15, 16 and 17: An RC pins that is programmed to work with and read data from the keypad in the system.
vii. Pin 23, 24, 25, 26, 27, and 28: An RB pins that is programmed to work with and read data from the LCD in the system.

The circuit diagram, which shows different sections of the speed detection and measurement system is in Figure 3. It is as a result of interconnections of microcontroller pins with power supply unit, ultrasonic sensor, infrared sensor, keypad and LCD. Other diagrams such as pictorial of circuit diagram and keypad are shown in Figures 4 and 5 respectively.

RESULTS AND DISCUSSION

The data collected from the test of fabricated system using regulating levels (1, 2, 3, 4, and 5) to measure the speed level of ceiling fans located at various offices. It is observed that the speed level increases as the regulating level increases and vice versa. However, graphical illustrations are nonlinear. It enables system to know if a ceiling fan is working in accordance to its specification. Then, clarification of the distance measurements in (cm) by the Ultrasonic sensor is in correlation with the other metric system measurement and its maximum distance it can cover is 400cm. Furthermore, the Ultrasonic sensor was tested by measuring the speed of different cars and motorcycle at different routes at their various distances. The sensor was able to make the measurement at the height of 10cm from the ground placed across the vehicles. This followed with the testing of the system, which was carried out at Unilorin Mini Campus roundabout and data were obtained using different devices. In Figure 6, which depicts performance evaluation of the speed levels of various ceiling fans. It is observed that only ceiling fan 3 followed the trend of normal incremental. While others fluctuate by showing bit constant speed levels at different regulating levels. Subsequently, Figure 7 shows nonlinear or complex curves of different cars with distinct speed, some cars reduce speed level appropriately and others maintain their speed levels at the roundabout in both routes. The graphical illustrations are given in the Figure 6 and Figure 7 respectively. This is followed by the programming of microcontroller to perform various functions as required is shown in Figure 8.

CONCLUSIONS AND RECOMMENDATIONS

The primary goal of this study was to construct a microcontroller-based speed detection and measurement system, which can be used to detect and measure any object's distance from the device in centimeters while also measuring its speed in revolutions per minute. Then, it can be used to detect and calculate the speed in revolutions per minute of any stationary rotating object nearby. It is a prototype for the speed and traffic regulation system used in industrialized nations, and if this system is further improved, it might be utilized for this function of a digital tachometer. Additionally, it can be utilized in an instrumentation workshop to gauge the speed of stationary objects like fans and other things for the evaluation of their performances.

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Table 1: Specification of ATmega328

Description	**Value**
No. of Pins	28
CPU	RISC 8-Bit AVR
Operating Voltage	1.8 to 5.5 V
Program Memory	32KB
CPU	8-bit AVR
External Oscillator	0-4MHz @ 1.8V to 5.5V 0-16MHz @ 2.7V to 5.5V 0-20MHz @ 4.5V to 5.5V
Internal Oscillator	16MHz Calibrated Internal Oscillator
Program Memory Type	Flash
Port	3(PB,PC, PD)

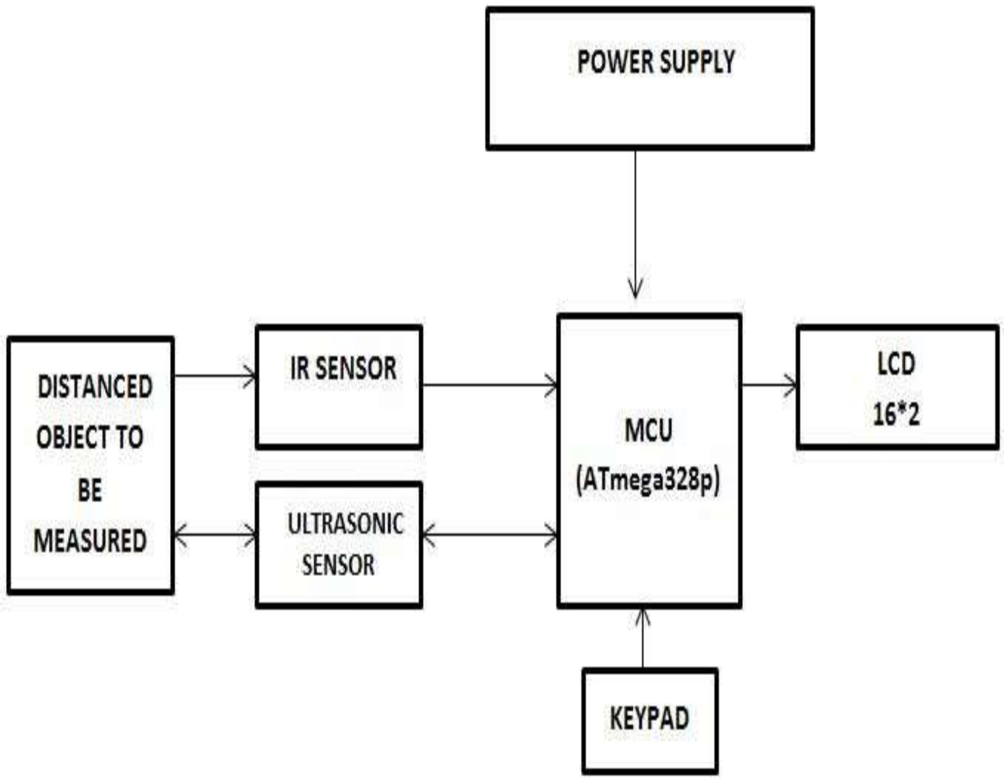

Figure 1: Block diagram of the speed detection and measurement system.

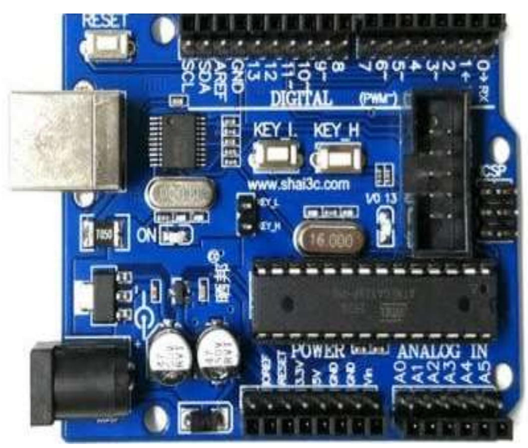

Figure 2: ATMEGA328p Microcontroller

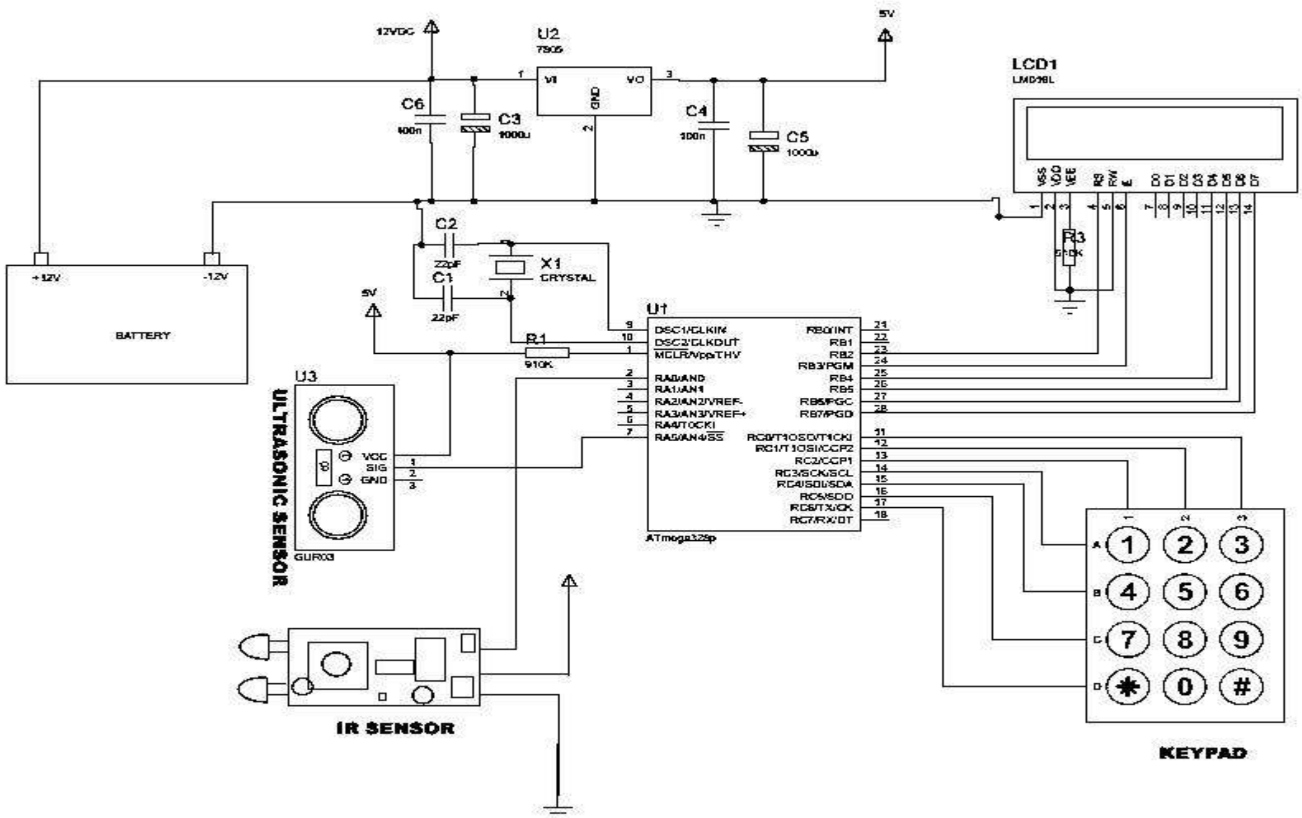

Figure 3: Circuit diagrams of the speed detection and measurement system.

Figure 4: Fabricated illustrations of the speed detection and measurement system.

Figure 5: LCD and Keypad section of the system

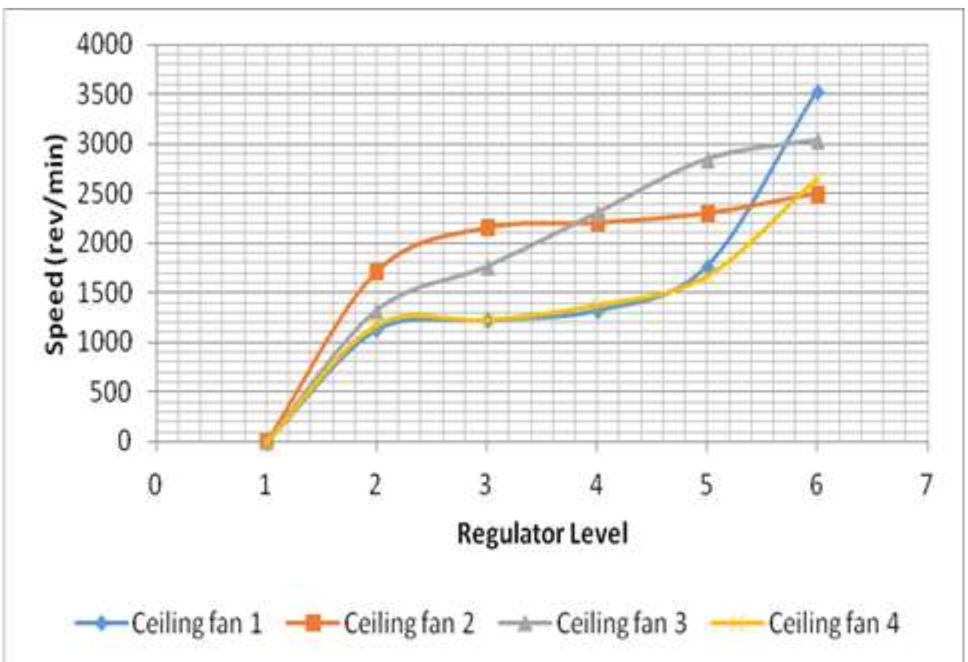

Figure 6: Instrumentation test of speed measurement against regulator level (Ceiling Fans).

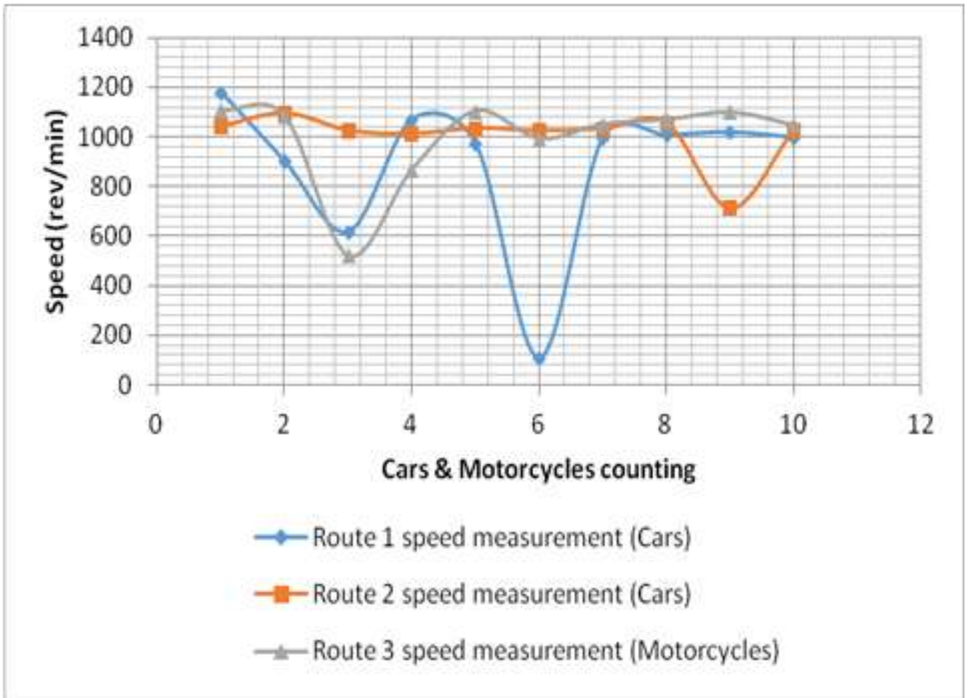

Figure 7: Instrumentation test of speed measurement against Vehicle counting (Cars and Motorcycles).

```
#include <Wire.h>
#include <LiquidCrystal_PCF8574.h>
#include <Keypad.h>
//define the keypad
const byte rows = 4;
const byte cols = 3;
char keys[rows][cols] = {
{'1','2','3'},
{'4','5','6'},
{'7','8','9'},
{'*','0','#'}
};
byte rowPins[rows] = {A1,A0,13,12};
byte colPins[cols] = {11,10,9};
Keypad keypad =
Keypad(makeKeymap(keys), rowPins,
colPins, rows, cols);
LiquidCrystal_PCF8574 lcd(0x27); //
set the LCD address to 0x27 for a 16
chars and 2 line display
float value = 0;
float rev = 0;
int rpm;
int oldtime = 0;
int time;
int echoPin =6 ;
int trigPin =5;
extern volatile unsigned long
timer0_millis;
long duration;
int firstDistance ;
int secondDistance ;
unsigned long start = 0;
unsigned long elapsedTime;
float delayedTime = 1000 *0.5;
int distance;
float speed1;
void isr(){
//interrupt service routine]rev++;
rev++;
}
```

```
void setup() {
 // put your setup code here, to run
once:
 pinMode(trigPin, OUTPUT);
 pinMode(echoPin, INPUT);
 Serial.begin(9600);
 Serial.println("TACHOMETER");
 lcd.begin(16, 2);
 lcd.clear();
 lcd.setBacklight(255);
 lcd.print("welcome");
 Wire.begin();
 Wire.beginTransmission(0x27);
 lcd.init();
  // put your setup code here, to run
once:
 attachInterrupt(0, isr, RISING);
//attaching the interrupt
}
 float GetDistance(){
// clears the trigPin condition
 digitalWrite(trigPin, LOW);
 delayMicroseconds(2);
// set trigPin to high active for 10
microseconds
 digitalWrite(trigPin, HIGH);
 delayMicroseconds(10);
 digitalWrite(trigPin, LOW);
// reads echoPin return the sound
wave traveltime in microseconds
 duration = pulseIn(echoPin, HIGH);
// calculate distance
 distance = (duration * 0.034) /2;
// displays distance on the serial
monitor
Serial.print("Dis:");
Serial.print(distance);
Serial.println("cm");
return distance;
 }
```

Figure 8a: Programming of the Microcontroller for fabricated instrument.

```
void GetSpeed(){
 firstDistance = GetDistance();
  delay(1000);
  elapsedTime = millis();
 secondDistance = GetDistance();
 delay(200);
 Serial.println(elapsedTime);
  double   diff   =   secondDistance   -
firstDistance;
  speed1 =  diff/elapsedTime  ;
  delay(200);
  Serial.print("vel:");
Serial.print(speed1);
Serial.println("cm/s");
  lcd.print("vel:");
lcd.print(speed1);
lcd.println("cm/s");
 }
void loop() {
 if((distance = 1)|| (distance <= 20)){
  GetSpeed();
  noInterrupts ();
  timer0_millis = 0;
  interrupts();
  delay(200);
}
  if((distance = 20)|| (distance <= 50)){
  GetSpeed();
  noInterrupts ();
  timer0_millis = 0;
  interrupts();
  delay(200);
}
```

Figure 8b: Programming of the Microcontroller for fabricated instrument continued