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Arduino-UNO Operated Hall-effect Sensor Based Magnetic Field Strength Measurement System

Bidyutmala Saha[1], Sourish Mitra[2], Srabani Kundu[3], Nirupam Saha[4], Sayani Chandra[5], Debraj Roy[6], Pallabi Das[7], Sinthia Roy[8]

Department Of Computer Science & Engineering, Gurunanak Institute Of Technology

Abstract: Magnetic field strength is one of two ways that the intensity of a magnetic field can be expressed. Technically, a distinction is made between magnetic field strength H, measured in amperes per meter (A/m), and magnetic flux density B, measured in Newton-meters per ampere (Nm/A), also called teslas(T). In our proposed work we are using the concept of ADC (Analog to Digital Conversion) in ARDUINO UNO. By using a Hall Effect sensor and Arduino UNO we are going to measure the field strength of a magnet by using UGN3503U sensor. This is a hall sensor which senses the magnetic field strength and provides a varying voltage at output proportional to the field strength. This sensor picks up field strength in the units of 'GAUSS'. So with this sensor we will have field strength as varying voltage. By using ADC feature we will convert this voltage to a number. This number represents the field strength and is shown on LCD.

Keywords: Tesla, Newton-meters, ADC, Arduino Uno, Hall Effect, Gauss.

I. INTRODUCTION

The magnetic field can be visualized as magnetic field lines. The field strength corresponds to the density of the field lines. The total number of magnetic field lines penetrating an area is called the magnetic flux. The unit of the magnetic flux is the tesla meter squared (T · m2, also called the weber and symbolized Wb). The older units for the magnetic flux, the Maxwell (equivalent to 10-8 Wb), and for magnetic flux density, the gauss (equivalent to 10-4T), are obsolete and seldom seen today. Magnetic flux density diminishes with increasing distance from a straight current-carrying wire or a straight line connecting a pair of magnetic poles around which the magnetic field is stable. At a given location in the vicinity of a current-carrying wire, the magnetic flux density is directly proportional to the current in amperes. If a ferromagnetic object such as a piece of iron is brought into a magnetic field, the "magnetic force" exerted on that object is directly proportional to the gradient of the magnetic field strength where the object is located. In our proposed project we can be able to measure magnetic field strength by using microcontroller specially arduino microcontroller. Arduino has six ADC channels. Any one channel or all of them can be used as inputs for analog voltage. The UNO ADC is of 10 bit resolution. This means that it will map input voltages between 0 and 5 volts into integer values between 0 and 1023. So for every (5/1024= 4.9mV) per unit. In all of this we are going to connect a potentiometer or pot to the 'A0' channel, and we are going to show the ADC result in a simple display. The simple displays are 16x1 and 16x2 display units. The 16x1 display unit will have 16 characters and are in one line. The 16x2 will have 32 characters in total 16in 1st line and another 16 in 2nd line. Here one must understand that in each character there are 5x10=50 pixels so to display one character all 50 pixels must work together, but we need not have to worry about that because there a another controller (HD44780) in the display unit which does the job of controlling the pixels (you can see it in LCD unit, it is the black eye at the back).

II. PROPOSED CIRCUIT DIAGRAM AND EXPLANATION

An analog-to-digital converter (**ADC**, A/D, A–D, A2D, or A-to-D) is a device that converts a continuous physical quantity (usually voltage) to a digital number that represents the quantity's amplitude.

A. *Components Required*

1) *Hardware:*

a) ARDUINO UNO,

b) power supply (5v),
c) JHD_162ALCD (16x2LCD),
d) 100uF capacitor (2pieces),
e) UGn3503U.

2) *Software:* Arduino IDE

B. Connections for LCD

PIN1 or VSS is connected to ground.PIN2 or VDD or VCC attached with a +5v power supply. Whereas PIN3 or VEE to ground which gives maximum contrast. PIN4 or Register Selection to PIN8 of ARDUINO UNO board.PIN5 or RW (Read/Write) to ground which puts LCD in read mode eases the communication for user.PIN6 or E (Enable) attached to PIN9 of ARDUINO UNO whereas PIN11 or D4 connected to PIN10 of ARDUINO UNO.PIN12 or D5 connected to PIN11, PIN13 or D6 connected to PIN12 and PIN14 or D7 attached with PIN13 of ARDUINO UNO.

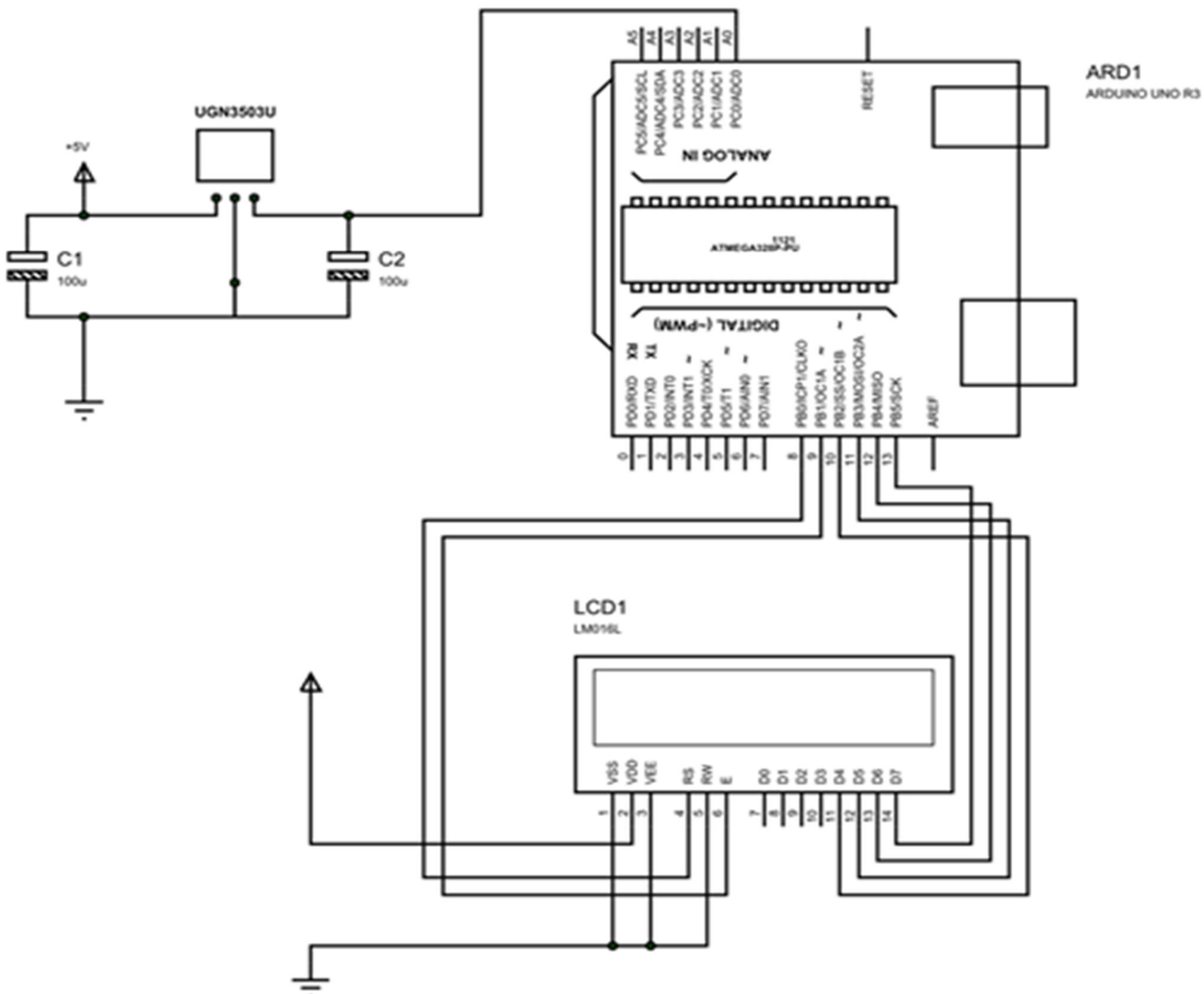

Fig. 1 Circuit diagram for magnetic field measurement using arduino uno.

C. Explanation

In 16x2 LCD there are 16 pins over all if there is a back light, if there is no back light there will be 14 pins. One can power or leave the back light pins. Now in the 14 pins there are 8 data pins (7-14 or D0-D7), 2 power supply pins (1&2 or VSS&VDD or GND&+5v), 3rd pin for contrast control (VEE-controls how thick the characters should be shown) and 3 control pins (RS&RW&E).In the circuit above, you can observe I have only took two control pins, the contrast bit and READ/WRITE are not often used so they can be shorted to ground. This puts LCD in highest contrast and read mode. We just need to control ENABLE and RS pins to send characters and data accordingly. The ARDUINO IDE allows the user to use **LCD in 4 bit mode**. This type of communication enables the user to decrease the pin usage on ARDUINO, unlike other the ARDUINO need not be programmed separately for using it in 4 it mode because by default the ARDUINO is set up to communicate in 4 bit mode. In the circuit you can see we used 4bit communication (D4-D7).So from mere observation from above table we are connecting 6 pins of LCD to controller in which 4 pins are data pins and 2 pins for control.

III. WORKING PROCEDURE OF PROPOSED WORK

For interfacing an LCD to the ARDUINO UNO, we need to know about analogRead(pin), analogReference() and analogReadResolution(bits) functions. UNO ADC channels has a default reference value of 5V. This means we can give a maximum input voltage of 5V for ADC conversion at any input channel. Since some sensors provide voltages from 0-2.5V, with a 5V reference we get lesser accuracy, so we have a instruction that enables us to change this reference value. So for changing the reference value we have analogReference().As default we get the maximum board ADC resolution which is 10bits, this resolution can be changed by using instruction analogReadResolution(bits). This resolution change can come in handy for some cases.Now if the above conditions are set to default, we can read value from ADC of channel '0' by directly calling function "analogRead(pin);", here "pin" represents pin where we connected analog signal, in this case it would be "A0". The value from ADC can be taken into an integer as "int ADCVALUE = analogRead(A0); ", by this instruction the value after ADC gets stored in the integer "ADCVALUE".NOW let's talk a bit about 16x2 LCD. First we need to enable the header file #include <LiquidCrystal.h>, this header file has instructions written in it, which enables the user to interface an LCD to UNO in 4 bit mode without any fuzz. With this header file we need not have to send data to LCD bit by bit, this will all be taken care of and we don't have to write a program for sending data or a command to LCD bit by bit.

Second we need to tell the board which type of LCD we are using here. Since we have so many different types of LCD (like 20x4, 16x2, 16x1 etc.). In here we are going to interface a 16x2 LCD to the UNO so we get 'lcd.begin(16, 2). For 16x1 we get lcd.begin(16, 1).

In this instruction we are going to tell the board where we connected the pins, The pins which are connected are to be represented in order as "RS, En, D4, D5, D6, D7". These pins are to be represented correctly. Since we connected RS to PIN0 and so on as show in circuit diagram, We represent the pin number to board as "LiquidCrystal lcd(0, 1, 8, 9, 10, 11)".After above there all there is left is to send data, the data which needs to be displayed in LCD should be written as "cd.print("hello, world!");". With this command the LCD displays 'hello, world!'.As you can see we need not worry about any this else, we just have to initialize and the UNO will be ready to display data. We don't have to write a program loop to send the data BYTE by BYTE here.

Step 1: Import LiquidCrystal.h header file.
Step 2: Initialize the library with the numbers of the interface pins
Step3: Create an object named lcd of LiquidCrystal class and initialize Register Select Pin, Enable Pin, D4 Pin,D5 Pin,D6 Pin,D7 Pin by calling function LiquidCrystal lcd (8, 9, 10, 11, 12, 13);
Step 4: char //initializing a character of size 5 for showing the ADC result named ADC [5];
Step 5: Call a function where we can be able to set up the LCD's number of columns and rows:

```
void setup()
{  lcd.begin(16, 2);
        }
```

Step 6:

```
void loop()
{
// set the cursor to column 0, line 1
lcd.print("   Wellcome to GNIT"); //print name
```

```
lcd.setCursor(0, 1); // set the cursor to column 0, line
lcd.print("ADC RESULT:"); //print name
String ADCVALUE = String(analogRead(A0)); //intailizing a string and storing ADC value
ADCVALUE.toCharArray(ADC, 5); // convert the reading to a char array
lcd.print(ADC); //showing character of ADCSHOW
lcd.print("   ");
lcd.setCursor(0, 0); // set the cursor to column 0, line1
}
```

IV. CONCLUSION

In our proposed work I want to measure the intensity of a magnetic field by using microcontroller based system. By using a **Hall Effect sensor** and **Arduino UNO** we are going to measure the field strength of a magnet by using **UGN3503U sensor**. Sensor can be able to sense magnetic flux as well as strength and transfer the voltage to the microcontroller. In this proposed Microcontroller based system due to hall effect a hall sensor can be able to senses the magnetic field strength and provides a varying voltage at output proportional to the field strength. In our proposed work actually we can use the concept of Hall Effect and implement it in microcontroller based Arduino system.

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