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Detection of Coloured Objects by the Implementation of Sigma Delta ADC

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Abstract— Colour Detection has became much important in modern applications. High-performance analog to digital converter collectively referred to as sigma delta converters has been implemented at the first stage which is highly significant in recent commercial wireless communications. The main aim is to develop a colour detection method with improved accuracy by designing a colour sensor with Light Dependent Resistor and the implementation of Sigma Delta ADC into the Microcontroller. The Microcontroller used has an inbuilt ADC which is a conventional Nyquist converter which possess analog components that are highly precise and very much immune to noise. To avoid these effects, implemented an oversampling converter that require simple and highly tolerant analog components. As the next stage, objects with different colours are sensed with the implemented Sigma Delta ADC with greater accuracy. Thus experimental observations shows that compared to the nyquist converters, the oversampling converters can extend their detection to primary and secondary coloured objects.

Index Terms—**colour sensor, microcontroller, nyquist converter**, **oversampling converter, sigma delta ADC**

INTRODUCTION

Generally, we distinguish the objects with feature such as shape, size, texture, colour . Of which the most common feature used to detect the objects is colour. In modern applications, detection of coloured objects has became much important. Colour Detection scheme has considered high popularity among the researchers as it is desired as one of the estimating quality. In recent colour detection methods it requires the use of the colour detector or the colour sensor [1]. As per the application we can use different sensor solutions for the colour detection method. Unlike the current or pressure sensors where it depends only on the physical values like pressure or current, but the identification of colour requires a substantial or subjective element.

The interaction between the light source, an object, and an observer results in the colour that we see. Two characteristics such as transmittance and reflectance are defined depending on which the light falling on an object will be reflected or absorbed. The concept behind the transmittance is that in the field of optics, the transmittance refers to the fraction of radiation that passes through the sample with a specified wavelength and absorbance refers to the amount of radiation that has been absorbed by the sample under a specified wavelength. The physical properties of the colour such as colour intensity and wavelength should be well known in order to understand the concept of colour sensor. For example, red colour will absorb most of the bluish and greenish part of the spectrum while reflecting the reddish part of the spectrum, thus appears reddish to the observer. This is the principle of how an observer can detect the particular in case of both reflected light and for that of self-illuminated objects. When an object is illuminated with light, the illumination will reach to the human eye which is then refined by the eyes receptors, and thus interpreted by the brain. The brightness of the colour is estimated by the amplitude of light wave [18].

Eventhough human eyes can distinguish different colours differently, but people usually distinguish the same colour differently. In order to avoid such problems require a precise colour detection and proper management [5]. So, a better solution lies in detecting the colour by calibrating the colour sensing devices from expensive spectrophotometers to economical RGB colour sensors.

The colour sensor designed have a relation between the amplitude of light wave and the resistance of the photo resistor (LDR) used [1]. As the amplitude of light wave increase the resistance of LDR decreases and vice versa. As the colour varies, the amplitude of light wave also changes, hence the voltage drop across the LDR also changes. It is then recorded through a signal conditioning circuitry and thus can be converted to the suitable range usable by the microcontroller and thus controls the angular position of stepper motor according to different colour combinations sensed by the LDR. Thus, a Colour sensor of low cost, easy to operate with reasonable accuracy and precision is designed with LDR and LEDs. It is then interfaced with the 10-bit microcontroller into which a Sigma Delta ADC [24] is to be implemented that improves the accuracy of detection of coloured objects.

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I. RELATED WORK

Colour Enhancement of TV Picture using RGB Sensor [3] described the enhancement of colour in the TV picture that used AM33RG-01 optical sensor to compute the intensities of outer illumination.The system developed an algorithm in which mentions that as fluorescent, incandescent or day light illumination irradiates on CPT, the brightness, saturation, hue and contrast of colour image became changed. In this method, Cost of the colour sensor is high.

Colour Detection for Monitoring Plant Growth [4] for measuring plant leaf colour, as an indicator of plant health status, has been developed for plantlets growing in a modified micro propagation system. Leaf colour sensors provide information, in a non-destructive manner, on the health status of tissue by comparing the sensor outputs to pre-determined optimum values.

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Microcontroller Based Two Axis Solar Tracking System [7] implements a prototype of two-axis solar tracking system based on a PIC microcontroller. The parabolic reflector or parabolic dish is constructed around two feed diameter to capture the suns energy. This two axis auto-tracking system has also been constructed using PIC 16F84A microcontroller. This auto-tracking system is controlled with two 12V, 6W DC gear box motors. The five light sensors (LDR) are used to track the sun and to start the operation.

Design of Color Sensor and its Application on Angular Position Control System [1] proposed as to explore an approach of constructing a simple, low cost colour sensor using tri colour RGB model which defines all colours as an additive combination of the primary colours Red, Green and Blue. Therefore, the voltage drop across the LDR is varied whenever the light of different intensities from the LED falls upon it which in turn changes the angular position of the stepper motor.

Design and Development of Object Recognition [9] described that the colour is the most common feature to distinguish between objects, sorting, recognizing and tracking. In this paper the 'Objrec' algorithm is written in MATLAB for performing the operation. The 'Objrec' algorithm is executed to identify the object and send the appropriate commands to the microcontroller using serial communication for the robot to perform the sorting operation.

Design and Development of Colour sensor using APD[6,16] describes the outline of the development of the colour sensor meant for the radiation-robot .A colour sensor is developed with APDs. In this method, APD requires high reverse biasing voltage. As it operates in high voltage, several precautions has to be taken. It also consumes a large amount of power than compared to other photodiodes. When an APD is used over a wide range of temperature, it is necessary to use a some kind of temperature offset to control the reverse voltage according to the temperature.

II. PROPOSED METHODOLOGY

In the proposed method, first stage deals with the implementation of Sigma Delta ADC into the 10-bit Microcontroller (16F877A) that can provide much greater resolution. First, a color sensor has to be designed using a LDR that works on the principle of light. In light or dark conditions, LDRs or Light Dependent Resistors are very useful. In dark conditions, the resistance of an LDR is very high, around, 1 000 000 ohms, but as they are irradiated with intensity of light resistance drops dramatically. For a particular biasing voltage LDR can be much advantageous compared to that of APD[6,16]. Here the light intensity of LDR is calibrated with different biasing voltage The LDR is provided as a voltage divider network and the output voltage is then fed to a signal conditioning section .The signal conditioning circuit[1] is provided in order to make value of voltage suitable to be fed to the microcontroller. The output voltage of signal conditioning circuit is around 0-5V.Then the Sigma Delta ADC (16-bit) is implemented into the 10-bit micro-controller and compare with the predefined data to check the color and accordingly the controller take the decision to rotate the motor in a particular direction which is programmable. Another effort is then being made to compare the color detection ability with the inbuilt ADC of the microcontroller and thus had a comparative study regarding their accuracy. The block diagram of the proposed method is as represented below as shown in the Fig.1

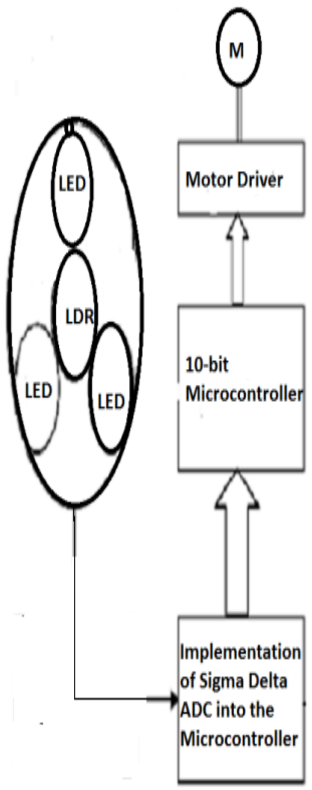

Fig .1. Block Diagram of Proposed Method

A. Principle

Light Dependent Resistor is a photoresistor made of high LED resistance semiconductor, can also be referred to as a photoconductor. Depending on the intensity, angle of incidence and wavelength or frequency of the light, the LDR based colour sensor that has been designed by tri color sense the colour of an object or a light and produce an electrical signal [1].

There are basically two types of LDR:

• Positive Coefficient LDR

• Negative Coefficient LDR

As the intensity of the light increases, the resistance increases. This type of LDR is called positive co-efficient LDR [28]. When the LDR is provide with a supply, depending on the intensity and wavelength of different colours of light that approaches the LDR, an output voltage is produced across it. The relationship between the light falling on the device and the resulting output signal determines the sensitivity of an LDR or photo detector. A resistor in series is connected with LDR in order to measure the voltage across

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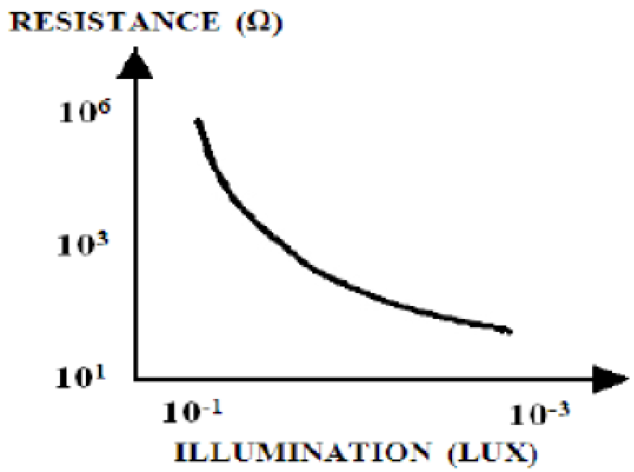
the LDR, thus making a potential divider, and the voltage across the LDR is proportional to the current [1].



As in the fig 2, as the intensity of the light that is observed increases, the resistance of LDR decreases [28]. Thus the voltage measured across the LDR increases with the decrease in the resistance across the LDR, with the increase in the intensity of the incident light. This type of LDR is referred to as the negative coefficient LDR [28] .

An oversampling converter based on Delta sigma modulation known as delta sigma data converter has been implemented into the controller unit [22]. After the implementation of the Sigma Delta ADC into the controller unit, to achieve the required angular position of Stepper motor to be used in robot arm movement in response of the colour sensed by the colour sensor. The stepper Motor Driver IC ULN 2003 has been connected with the output of the microcontroller. The controller unit executes the developed control software and generates the sequence of bit pattern 9, 3, A, 6 to energize the windings of the stepper motor through the driver IC ULN2003 which changes the angular position of the Stepper motor in anticlockwise direction.

B. Design of the colour sensor

The colour sensor circuit consists of the light source (LED) and a detector (LDR) [10]. The light source is operated manually. The detector detects the illumination of each coloured ray in terms of resistance of the LDR. The LDR is surrounded by Red, Green and Blue LED which are connected in parallel to each other. A 5 volt supply is given to glow the LEDs. Each LED is turned ON one at a time and the intensity of light reflected back to the cadmium sulphide photocell (LDR) is measured. Thus when each colour is reflected upon the LDR, different values of resistance across the LDR are obtained, [6].

C. Implementation of Sigma Delta ADC

For the modern high resolution & precision industrial application such as modern voiceband & audio application, sigma-delta (Σ-Δ) ADC is the most appropriate converter .Its concept lies from the pulse code modulation (PCM) systems. These transmission techniques called delta modulation and differential PCM [24]. We can achieve higher transmission efficiency. As in these techniques we are instead of transmitting the actual samples transmitting changes (delta) in value between consecutive samples [22,23] .

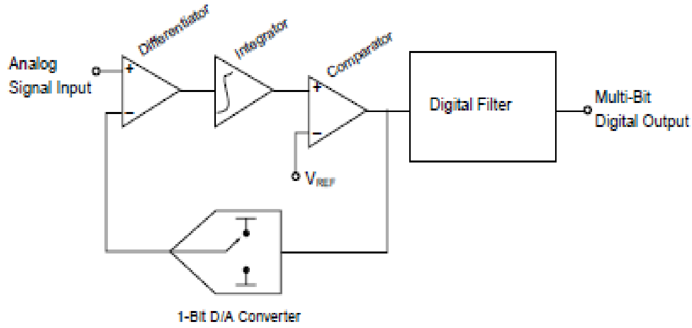


Fig 4. Block Diagram of Sigma Delta ADC implemented into the Microcontroller [2]

IV. Hardware &Software Specifications

A. Software Specifications

The coding is done in Mplab in embedded C. The detection of the colored objects are written in PIC 16F877A microcontroller. The following steps are involved in the software development:

- Coding
- Compiling
- Simulation
- Burning

1) Coding:

High level languages such as C, Java or assembly language are used for coding [9]and debugging. For this model the coding is done in Mplab using embedded C language as shown in fig.5

2) Compiling

A compiler for a high level language helps to minimize the production time [9]. Although inline assembly was possible, the programming was done in strictly in Embedded C. The compilation converts C program into machine level language .The microcontroller understands only the machine level language.

3) Simulation

Simulation is the resemblance of the operation of a system in real world over time. The process of simulation requires that a model be implemented; that represents behaviours of the selected physical. The simulation represents the operation of the system over time. The simulation of the system is carried out in Proteus 7.6.

4) Burning

Burning the machine language file into the micro controller's program memory is achieved with the dedicated programmer, which is attached to the PC peripheral. PC's serial port has been used for this purpose. Here PICkit2 [9] Programmer has been used.

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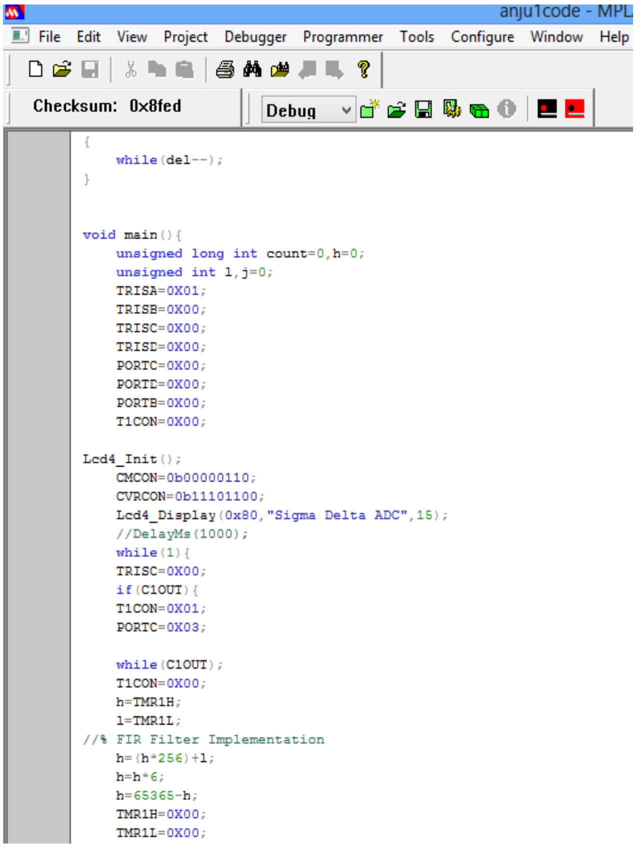

Fig.5. Mplab Programming Window

B. Hardware Development

Hardware development of this work is divided into two:

- Interfacing Section
- Power Supply

The hardware board consists of*:*

- Power Supply
- MAX 232
- *ULN2003*
- Stepper Motor

V. RESULTS

As the first stage implement the Sigma Delta modulator which was then interfaced with the third order FIR filter thus got the final output as the digital conversion of the analog signal of the range 0-5V .The implementation of Sigma Delta ADC in Proteus is as shown in Fig.6

The Delta Sigma modulator is the heart of the DS ADC. It is responsible for digitizing the analog input signal and reducing noise at [23] lower frequencies. In this stage, noise shaping is the function implemented by the architecture that pushes low frequency noise up to higher frequencies where it is outside the band of interest.DS converters are well-suited for low frequency, high accuracy measurements. The sigma delta modulator that converts the analog signal into 1-bit stream is obtained as follows in Fig.7

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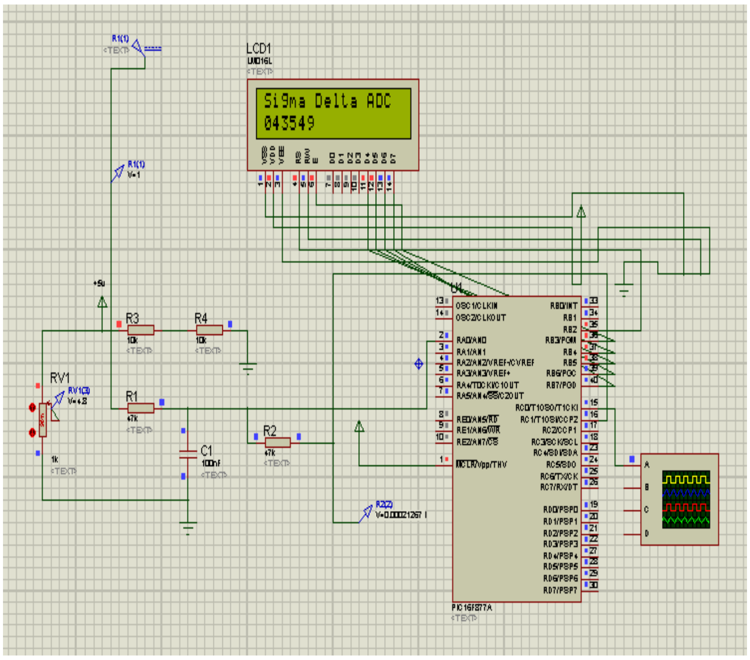

Fig.6. Hardware Implementation of Sigma Delta ADC

The Delta Sigma modulator is the heart of the DS ADC. It is responsible for digitizing the analog input signal and reducing noise at [23] lower frequencies. In this stage, noise shaping is the function implemented by the architecture that pushes low frequency noise up to higher frequencies where it is outside the band of interest.DS converters are well-suited for low frequency, high accuracy measurements. The sigma delta modulator that converts the analog signal into 1-bit stream is obtained as follows in Fig.7

At the next stage designed the colour sensor with LDR and tricolour LEDs. The LDR is surrounded by red, green and blue LEDs. As the intensity of the light increases, the resistance of the LDR decreases. The LDR is having a maximum resistance when it is not illuminated with light which is around 2 M ohm. The entire circuit board is given the power supply of 5 V. The colour sensor that has been designed is as shown in Fig.8

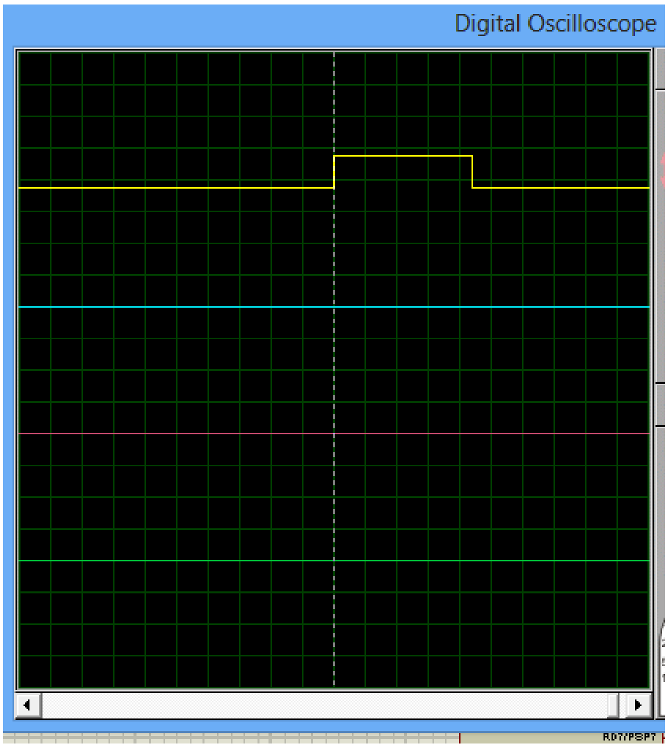

Fig 7. . Sigma Delta Modulator Output

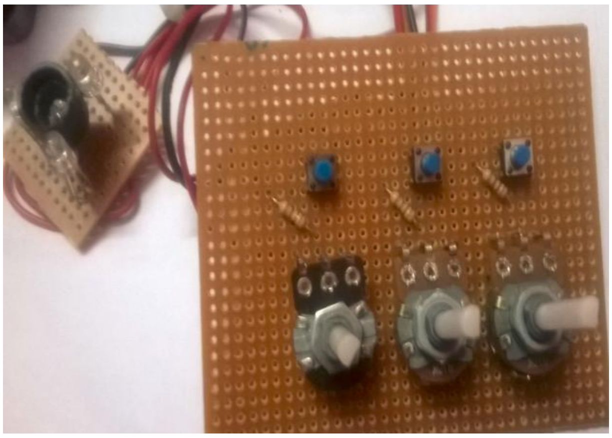

Fig .8. Design of the colour sensor

The colour sensor that has been designed which has been interfaced with the PIC 16F877A which possess an inbuilt ADC which is a nyquist converter that has been disabled and implemented a oversampling converter into the microcontroller that then drives the stepper motor in accordance with the colour detected. The implementation of the colour detection method in Proteus as shown in Fig 9.

request color printing. **Do not use color unless it is necessary for the proper interpretation of your figures.** There is an additional charge for color printing.

Figure axis labels are often a source of confusion. Use words rather than symbols. As an example, write the quantity "Magnetization," or "Magnetization *M*," not just "*M*." Put units in parentheses. Do not label axes only with units. As in Fig. 1, for example, write "Magnetization (A/m)" or "Magnetization ($A \cdot m^{-1}$)," not just "A/m." Do not label axes

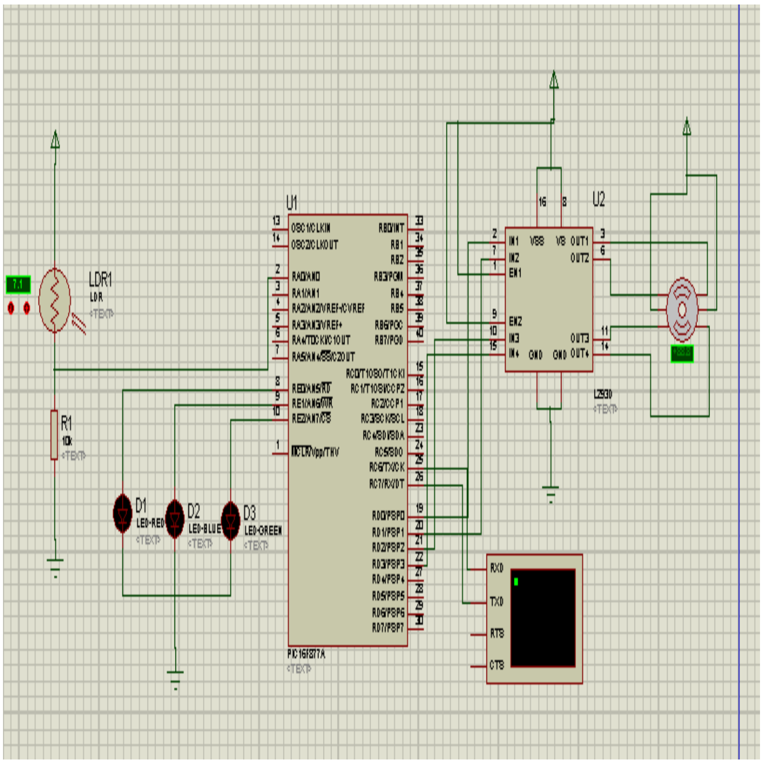

Fig 9.Hardware implementation of the proposed Method

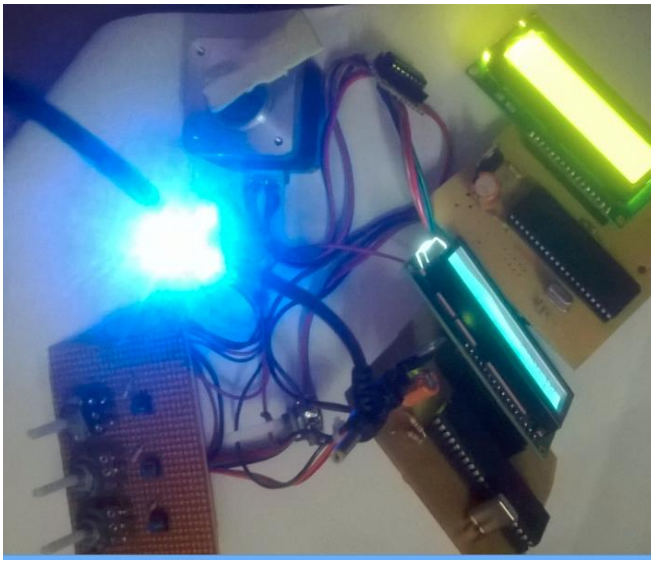

Fig10. Final Hardware for colour Detection

VI. EXPERIMENTAL OBSERVATIONS

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Table I. Colour Detection

S.No	Colour Detection	Angle rotated by stepper motor(in degree)
1.	red	9
2.	blue	18
3.	green	27
4.	yellow	36
5.	cyan	45
6.	magenta	54
7.	No colour	0

VII. CONCLUSION

The method is aimed at the development of an efficient method for the detection of colored objects by the implementation of the oversampling converter into the microcontroller. Color is the most common feature to distinguish between objects. Colour as a means of assessing quality is also gaining popularity amongst researchers. Thus the performance of the method has extended to secondary colored objects with greater precision than that of Nyquist converter that are highly immune to noise effects. This work can be extended by placing the Speech IC that can mention the object that has been detected and can be for sorting of objects .The implemented Sigma Delta ADC are mainly used in avionic applications.

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REFERENCES

[1] I.Mazumdar,R.Mondal,S.Pal, "Design and Development of low costcolour sensor and its application in angular position control systems ",*International Journal Of Electronics and Computer Science Engineering*, vol. 2, no. 4,pp.1241-1251,

[2] D. Peter,B. C. Baker,D. Butler, H.Darmawaskita, " Theory Of Implementation of Delta sigma Data Converter, " *Microchip Technology Inc*.

[3] E. Joo, L. I. Gab, J. Y.Woo, P. Y. Ho, H. G. C. Lee, "Colour enhancement of TV picture using RGB sensor," *IEEE 1996*, Vol. 42, Issue 2, pp. 182 191.

[4] J. Mcdowell, Inc. Aline, B. Redondo,"Low cost colour sensors for monitoring plant growth in a laboratory , *IEEE 2011*, pp. 1 6.

[5] S.Sahu, P.Lenka, S. Kumari, K.B.Sahu and B.Mallick, "Design a colour sensor: Application to robot handling radiation work , *IEEE* 2010, pp. 77 78.

[6] N.Nasrudin, N.M.Ilis, T.P.Juin, T.T.K.Chun, L.W.Zhe, F.Z. Rokhani,"Analysis of the light dependent resistor configuration for line tracking robot application, *IEEE 2011*, pp. 500 - 502.

[7] L. Lwin Oo and N.K. Hlaing, " Microcontroller Based Two-Axis Solar Tracking System" , IEEE 2010, pp. 436 440.

[8] M.A Sid Ahmed," Selective color tone adjustment for advanced television system *",,IEEE Transaction on consumer electronics*,vol.40.,no.4,pp.938- 943,November-1994

[9] V. Devalla,A. Kumar Mondal,Dr. R. Singh,V. Kaundal "Design and Development of Object Recognition and Sorting Robot for Material Handling in Packaging and Logistic Industries*" International Journal of Science and Advanced Technology* ,Volume 2 ,No. 9 ,September 2012

[10] M. Sharma, A. Grover, P. Bande, "Low Cost Sensors for General Applications," *International Journal of Recent Trends in Engineering*, Vol. 1, No. 5, May 2009

[11] Peatmann, J. B. 1998.,"Design with PIC Microcontrollers ",*Printice-Hall*.

[12] Smith , D. W. 2002.,"PIC in Practice ", *Newnes, Malta by Gutenberg Press Ltd.*

[13] D.F. Silva, D.A. Avalos, "Light Dependent Resistance as a Sensor in Spectroscopy Setups Using Pulsed Light and Compared with Electret Microphones," *MDPI 2006*, ISSN 1424-8220

[14] By N. J. Joh,L. K. Boon,K. Y. Leong"Color Sensors for Precise Measurement", *Optoelectronic Products Division,Avago Technologies.*

[15] D. L. Gilblom, S. K. Yoo, P. Ventura" Operation and performance of a color sensor with layered photodiodes ",*The Proceedings of the SPIE*, Volume 5074.

[16] Technical Information, "Characteristics and use of Avalanche Photodiode ".

[17] G. Kulpa,"Theory of Color Sensor "

[18] "Pic Microcontroller for Digital filter implementation "

[20] " LDR and ULN 2003 datasheet ,"*Contek Microelectronics Co.,Ltd.*

[21] Digital Image Processing, R.C. Gonzalez and R.E.Woods, 2nd edition

[22] W. Kester, "ADC Architectures : Sigma-Delta ADC Basics "

[23] P. Miller, "Aspects of data acquisition system design ", Data Converters

[24] B. Baker " How delta-sigma ADCs work, Part 1 " ,*Data Acquisition,*

[25] S.i Rongrong, "Stepper Motor Drive Control Based on MCU , IEEE International Conference On Control, Automation and System Engineering (CASE),2011, pp.1-3.

[26] A. Kumar and Mrs. M. Valarmathi, " High Precision Stepper Motor Controller Implementation on FPGA with GUI on LABVIEW , *I*nternational Journal of Advanced Resear*ch in Electrical, Electronics and Instrumentation Engineering,2013,* Vol.2,pp.1197-1202.

[27] " Stepper Motor interfacing with the microcontroller tutorial "

[28]Wikipedia,LightDepenedentResistor,March2015,http://en.wikipedia.org/wiki/Photoresistor

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