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Low cost colour sensing by the implementation of Sigma Delta ADC

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Abstract— 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 using an 8 bit microcontroller at low cost. High performance ADC's collectively referred to as sigma delta converters "SIGMA-DELTA CONVERTERS" has been implemented at the first stage which is highly significant recent commercial communications. The microcontroller used (PIC16F877A) has an in-built ADC which is a conventional Nyquist converter which possesses analog components that are highly precise and very much immune to noise. To avoid these effects, we implemented an oversampling converter which requires simple and tolerant analog components. By this method, we can improve the resolution of the ADC from 10 bits to 16 bits. The importance of sigma delta ADC is that they can be used in many applications where the minute variations in the sensing quantity (light,temperature,voltage,etc..) should be measured. As the next stage, objects with different colours are sensed by the implemented sigma delta ADC with greater accuracy at low cost.

Index Terms— Sigma Delta ADC, Resolution, Colour Sensing, PIC16F877A, LDR Sensor, LED, Over sampling

1 INTRODUCTION

Colour detection is a very important process in modern applications. 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 using an 8 bit microcontroller at low cost. Analog to digital conversion is an important process in the field of electronics which is done by analog to digital converters(ADC). The important parameter regarding an ADC is its resolution which indicates how many divisions can be made between the input voltage range. Thus the increase in the resolution of an ADC indicates how much minute variations in the voltage range can be detected by the ADC. High performance ADC's collectively referred to as sigma delta converters "SIGMA-DELTA CONVERTERS" has been implemented at the first stage which is highly significant in recent commercial communications[1]. The microcontroller used (PIC16F877A) has an in-built ADC which is a conventional Nyquist converter which possesses analog components that are highly precise and very much immune to noise. To avoid these effects, we implemented an oversampling converter which requires simple and tolerant analog components. By this method, we can improve the resolution of the ADC from 10 bits to 16 bits[2]. The importance of sigma delta ADC is that they can be used in many applications where the minute variations in the sensing quantity (light,temperature,voltage,etc..) should be measured. As the next stage, objects with different colours are sensed by the implemented sigma delta ADC with greater accuracy at low cost[1].

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2 PROPOSED METHODOLOGY

The importance of the analog to digital conversion is very high in present world. Almost in all electronic system there will be an ADC. The importent parameter regarding an ADC is its resolution. That is, It is a parameter which gives idea about the range of ADC. If the resolution of ADC is 10 bits it means that ADC can make 2^{10} (1024) divisions within the input voltage range. So the resolution is higher, it means the number of divisions will be higher and hence the output will be more accurate. That is we can detect even a minute variation in the analog input signal[3].

PIC16F877A micro controller has an inbuilt ADC with resolution of 10 bits. We can increase its resolution by implementing a sigma delta ADC within it. Sigma delta ADC is an advanced over sampling ADC by which we can get more resolution. We can implement sigma delta ADC within the micro controller by coding. The sigma delta ADC can be used in many applications where ever we should detect even minute variations in the converting analog signal[9]. That is the main important aspect of this ADC.

Colour sensing has become much more important in present world.We can sense colours using PIC16F877A microcontroller with its inbuilt ADC. But it is limited to primary colours. That is by using its inbuilt ADC we can detect RED,BLUE and GREEN colours.

If we increase resolution of ADC in 16 bits using sigma delta ADC implementation we can detect secondary colours also.We can detect colours by using other methods like MATLAB Coding. But they are highly expensive methods. We can reduce this expense into comparatively less expense by the implementation of sigma delta ADC[4]. That is here important is for the implementation of sigma delta converter inside the micro controller through coding.

Colour detection is showing just as an application. We can Extend the application of sigma delta ADC into many fields such as temperature sensing, light sensing, and can apply in any field

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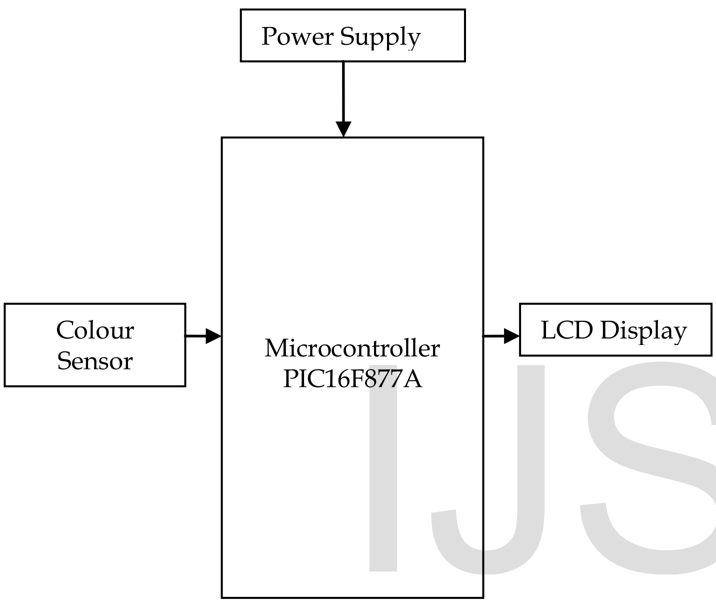
where we need a minute variations in the field of sensing[6].

Colour detection is also done by coding in the micro controller. It is done by using the theory of Colours.Every colour is a combination of primary colours. That is RED BLUE and GREEN. So if we consider a colour, there will be a certain amount of RED BLUE and GREEN in it[4].

By using this logic ,we are detecting the colours.

3 BLOCK DIAGRAM



3.1 Microcontroller- PIC16F877A

PIC16F877A microcontroller is used here. PIC16F877A is used because of some reasons. According to the datasheet of PIC16F877A, it is suitable for scaling of ADC resolution. Also, our aim is to develop a low cost high resolution ADC. So, we choose PIC16F877A since it is comparatively cheep and easily available. PIC16F877A has in in-built ADC with a resolution of 10 bits by which we can detect only primary colours. By the introduced method, we can increase or improve the resolution of the ADC from 10 bits to 16 bits. By which we can have a higher resolution ADC. The implementation of Sigma Delta ADC inside microcontroller is done by coding. The colour detection process is also done through coding in the microcontroller.

3.2 Colour Sensor

Colour sensing method used here is RGB colour detection method which consists of RED, BLUE and GREEN LED's and a Light Dependent Resistor. When an object is placed in front of the colour sensor, RED, BLUE and GREEN LED's will glow. Each colour LED will give a particular reflection which depend on the colour of the object. The LDR sensor will sense the light and produce a corresponding voltage value which depends on the reflected light intensity.this voltage value will be analog which will be given to the high resolution analog to digital converter which is implemented inside the microcontroller unit.

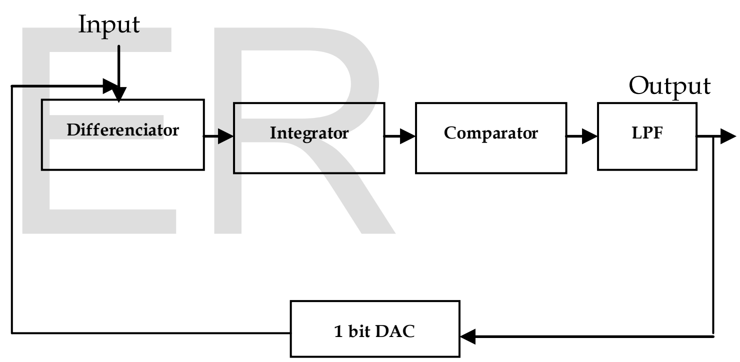
3.3 LCD Display

LCD display is used here for displaying the colour of the object. 16*2 alpha numeric display is used here in which we can display alphabets and numerics in two lines of 16 bits.

4 IMPLEMENTATION

4.1 Sigma Delta ADC

The Sigma Delta ADC has two main parts; Sigma Delta modulator and comparator. The Sigma Delta modulator converts the analog value into corresponding bitstream. The function of lowpass filter is filter out the corresponding data blocks of 16 bits width from the data bitstram. The block diagram f Sigma Delta ADC is shown below.



Differenciator finds the difference between the input analog value and the output of 1 bit ADC. Initially, the output of 1 bity ADC is zero. The difference signal output is given to the integrator which adds the previous output of the integrator and the present input to integrator. Next stage is a comparator. One input to the comparator is grounded. So, the comparator will compare the output of integrator and zero. If the integrator output is greater than zero, it will produce output 1 and if it is lesser than zero, it will give the output 0. The one bit latch will manage the output generation with respect to the input clock. The final output (current bit of the bitstream) is fed back to input after converting the digital value into analog form for further comparison with analog input signal. Hence, the Sigma Delta modulator gives the corresponding bitstream output. The bitstream is the output of Sigma Delta modulator and this output is given to the low pass filter. The function of this filter is to filter out the corresponding digital output as blocks of width of 16 bits. This is the final digital output of the corresponding inputanalog value.

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4.2 Color detection method

From the theory of lights, each colour can be defined as a combination of RED, BLUE and GREEN colours in a particular ratio. Also, when a coloured light is incident on an object, the intensity of the reflected light will depend on the colour of the object. That is, if the colour of object and light is same, then the reflection intensity will be high. So, if we incident RED, BLUE and GREEN lights on objects serially, then each coloured objects will give a specific amount of reflection for each coloured LED's. So, we use 3 LED's of colours RED, BLUE and GREEN. The intensity of reflected light can be sensed by LDR sensor which give output voltage proportional to the input light intensity. So, for every coloured objects, there will be a specific value for LDR output voltage for each LED outputs.

The LDR output will be in analog form. This value will be difer from the value for another colour for a minute difference. This minute difference will not be detectable for the in-built ADC of PIC16F877A. for overcoming this limitation, we are using high resolution Sigma Delta ADC by which we can detect the small variations. The values for many colours will be checked and fed to the program code. After coding, the sensorwill be ready to use.

When an object is placed infront of the sensor, the RED, BLUE and GREEN LED's will glow serially and the reflection value will be detected by the LDR sensor and saved in the microcontroller. The microcontroller wil compare these values and detect the colour in the predefined manner.

5 SOFTWARE OVERVIEW

5.1 Coding

Coding is the most important part of this method. The implementation of Sigma Delta ADC and the colour detection method are written in the PIC16F877A microcontroller. The coding is done in Mplab in embedded C. High level languages such as C, Java or assembly language are used for coding and debugging. Here, the coding is done in Mplab using embedded C language.

5.2 Compiling

The microcontroller understands only the machine level language. Since C is a high level language, it should be converted into the machine level language. A compiler for a high level language helps to minimize the production time . The compilation converts C program into machine level language .

5.3 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 done in Proteus 7.6. [1]

5.4 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 Programmer has been used. [1]

6 RESULTS AND DISCUSSIONS

The sigma delta ADC was implemented inside the microcontroller at the first stage by coding. By implementing this, the resolution of the ADC was upgraded to 16 bits from 10 bits. Since the maximum input voltage to the microcontroller is 5 Volts, we can only give 0 to 5 volts as the input voltage range. By improving the resolution, we could make 2^{16} divisions within 0V and 5V. 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.

When the coloured object which is to be detected is placed infront of the LDR sensor, three coloured LEDs will blink and the corresponding voltage reading from the LDR sensor will be given to the microcontroller. We could make 2^{16} divisions within that voltage range and detect minute variations in that voltge range. The values for reflections from each LED is saved in the microcontroller. When the object is placed, the obtained values will be compared and the colour will be detected in that manner.

7 CONCLUSION

The technique is aimed at the development of an efficient method for the detection of colored objects by the implementation of the high resolution analog to digital converter into the microcontroller. Color is the most common feature to distinguish between objects. We can implement a colour detection method at very low cost by using PIC16F877A microcontroller. Here, colour detection is shown just as an example. We can extend the applications of this methods into various fields where even the minute variations in thesensing quantity should be detected.

8 FUTURE SCOPE

This method of increasing the resolution of the in-built ADC of a microcontroller will give rise to so many applications. By doing this, we can use this wherever we should detect even minute variations in the sensing quantity. This can be used in many areas and applications in future at low cost.

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