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Microcontroller Based Colour Identification System

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Abstract: *A microcontroller based system using P89V51RD2 microcontroller for colour identification system is designed and developed. It is based on the principle that the analog voltages of the sensor converted to RGB colours. The sensor OPT 301 is an opto-electronic integrated circuit containing a photodiode and transimpedance amplifier on a single dielectrically isolated chip. This sensor provides an analog input depending upon the colour sensed by it. This analog voltage may then convert into digital form using ADC (analog to digital converter) interfaced with the microcontroller. Digital output varies depending upon the variation in the colours sensed. The P89V51RD2 is a low-power, high-performance CMOS 8-bit microcontroller used in the present study. Further, an LCD module is interfaced with the microcontroller in 4-bit mode, which reduces the hardware complexity. Software is developed in C using Keil's C-cross compiler. The data stored in the microcontroller along with the name of the colour. The paper deals with the hardware and software details.*

Keywords*: Opt 301 Sensor, ADC, LCD, P89V51RD2 microcontroller, Keil's C-cross compiler and colour identification system.*

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I. Introduction

The appearance of objects in the real world is related to the complex ways they reflect the light impinging on them from the light source present. Different materials reflect light in various ways, but one thing common to most materials is the fact that they are neither totally matte nor totally mirror-like; it is a combination of these two modes of reflection that governs the appearance of most objects. In short, it is the sum of diffuse and specular reflections that determines the total reflection of light off surfaces. Based on this statement, we observe that a shift in colour occurs under some conditions, which leads to the development of an identification system designed to identify the colour changes, which are due to specular reflection [1-3]. Colour plays a vital role in human daily life for communication as well as for recognition. Blind people are expected to be interested in the colour of their cloths, the colour of toys and the colour of pictures [4]. Colour can be described as an attribute of visual perception consisting of any combination of chromatic and achromatic content. This attribute can be expressed by chromatic colour names such as red, green, blue etc., or by achromatic colour names such as white, grey, black, etc. Achromatic colour is perceived colour devoid of hue and chromatic colour is perceived colour possessing a hue [5]. For sight-able people, basic colour related tasks such as colour coordination of clothing are taken for granted. For the vision impaired, these tasks can be difficult and frustrating. Colour identification system would be of much aid for their independence. Nowadays, the popularity of microcontrollers is increasing, due to the fact that they are being used in all types of instruments and in embedded environments. In the present study, the technique utilizes analog voltages of the sensor are converted into colours using the microcontroller as a tool.

II. Instrumentation

A. Hardware design

The block diagram and the schematic diagram of the microcontroller based colour identification system are shown in Figs. 1 and 2 respectively. It consists of the functional units: (i) Colour sensor (ii) Analog to digital converter (iii) Microcontroller (iv) Liquid crystal display (v) serial communication and (vi) Personal computer.

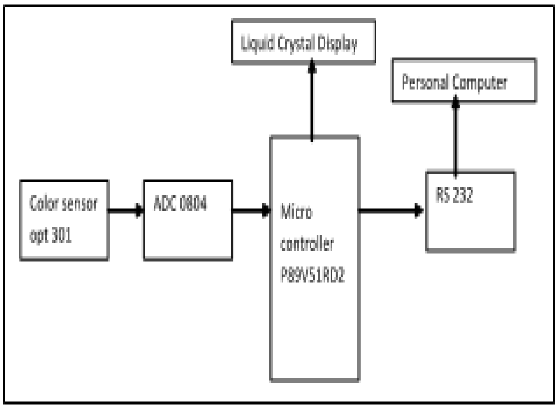

Figure 1: Block diagram for microcontroller based colour identification system.

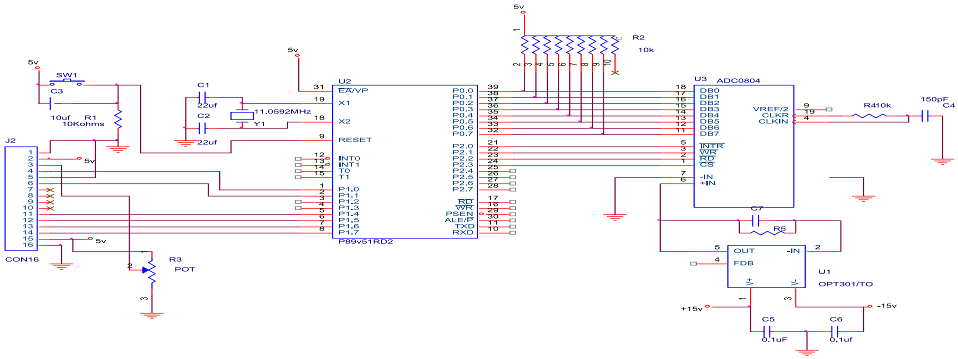

Figure 2: Schematic diagram for microcontroller based colour identification system.

Sensor: A photodiode [6] is a type of photo detector capable of converting light into either current or voltage, depending upon the mode of operation. Transimpedance amplifier is an amplifier that converts current to voltage. Its input ideally has zero impedance, and the input signal is a current. Its output may have low impedance and is measured as a voltage. Transimpedance amplifiers are commonly used in receivers for optical communications to convert the current generated by a photo detector into a voltage signal for further amplification. In the present study, we selected such type of sensor that has both above features that is OPT 301. The OPT301 [7] is an opto-electronic integrated circuit containing a photodiode and transimpedance amplifier on a single dielectrically isolated chip.

Analog to digital converter

Analog to digital converter used as an intermediate device to convert the signals from analog to digital form. These digital signals are used for further processing by the digital processors. Various sensors like temperature, pressure, force, light etc. convert the physical characteristics into electrical signals that are analog in nature. ADC0804 [8] is a very commonly used 8-bit analog to digital convertor. It is a single channel IC, *i.e.*, it can take only one analog signal as input. The digital outputs vary from 0 to a maximum of 255. ADC0804 has 8 bit Resolution and its conversion time is 100 µs.

Microcontroller

The P89V51RD2 [9] is a low-power, high-performance CMOS 8-bit microcontroller. The device is manufactured using Philip's high density nonvolatile memory technology and is compatible with standard 80C51 instruction set and pin out. The on-chip Downloadable Flash allows the program memory to be reprogrammed in-system through serial interface. By combining a versatile 8-bit CPU with Downloadable Flash on a monolithic chip, the P89V51RD2 is a powerful microcomputer which provides a highly flexible and cost effective solution to many embedded applications. The P89V51RD2 provides 64k bytes of Downloadable Flash, 1024bytes of RAM, 32 I/O lines, programmable watchdog timer, Data Pointers, three 16-bit timer/counters, eight interrupt sources, a full duplex serial port, on-chip oscillator, and clock circuitry. The Downloadable Flash can be changed a single byte at a time and is accessible through the SPI serial interface. Holding RESET active forces the SPI bus into a serial programming interface and allows the program memory to be written. The microcontroller having advantages less power consumption, low cost, less space required and High speed execution.

Liquid crystal display

Liquid Crystal Display (LCD) is an electronic display module and find a wide range of applications. A 16x2 LCD display is very basic module and is very commonly used in various devices and circuits. LCD's are preferred over seven segments and other multi segment LEDs because of low cost, easily programmable, have no limitation of displaying special & even custom characters (unlike in seven segments), animations and so on. In the present study, we used lampex LCD [10].

Serial communication

RS-232 (Recommended Standard 232) is a standard for serial binary data signals connecting between a DTE (Data Terminal Equipment) and a DCE (Data Circuit-terminating Equipment). It is commonly used in computer serial ports. In the present study we used MAX 232 (RS-232) for serial communication in between microcontroller and personal computer [11].

Working

The heart of the system is OPT301, which is an opto-electronic integrated circuit containing a photodiode and transimpedance amplifier on a single chip. Photodiode current, I_D, is proportional to the radiant power or flux (in watts) falling on the photodiode. At a wavelength of 650nm (visible red) the photodiode Responsively, R_I, is approximately 0.45A/W. The OPT301's voltage output is the product of the photodiode current times the feedback resistor, (I_D X R_F). The internal feedback resistor is laser trimmed to 1MW ±2%. Using this feed resistor, the output voltage R, is approximately 0.45V/mW at 650nm wavelength. The output of the Photodiode is given to the ADC-0804 which converts the analog voltage into digital format. The photo diode output voltage is applied to pin 6 $+V_{in}$ of ADC0804, Connect pin 7 $-V_{in}$ to ground. The ADC0804 includes an internal oscillator which requires an external capacitor and resistor to operate. The CS, WR, RD, INTR is connected to Port 2 of Microcontroller. ADC conversion will be start by making CS high ,WR signal low the conversion start and wait for INTR pin to go low i.e., means conversion ends. Once the conversion in ADC is done, the data is available in the output latch of the ADC. Data of the new conversion is only available for reading after ADC0804 made INTR pin low. The Read the data from port where ADC is connected, make RD signal high, the result is available at pins 11 through 18 which read from Port 0. The microcontroller is interfaced with 16x2 LCD using Port1. The RS is connected to P1.0, En is connected to P1.1 and data lines DB4-DB7 are connected to P1.4-P1.7. The sensor converts the optical signal reflected from the sample into analog voltages. Then the microcontroller converts the analog voltages into digital data using analog to digital converter. The digital data send is utilized to determine R, G and B values.

SOFTWARE

Software is developed in C using Keil's C-cross compiler [12] to measure the light intensities of LDRs with the help of ADC. The converted ADC values are compared with the lookup table 2 and corresponding colour displayed on the LCD. The flow chart of the program is presented Figures 3 and 3 (a).

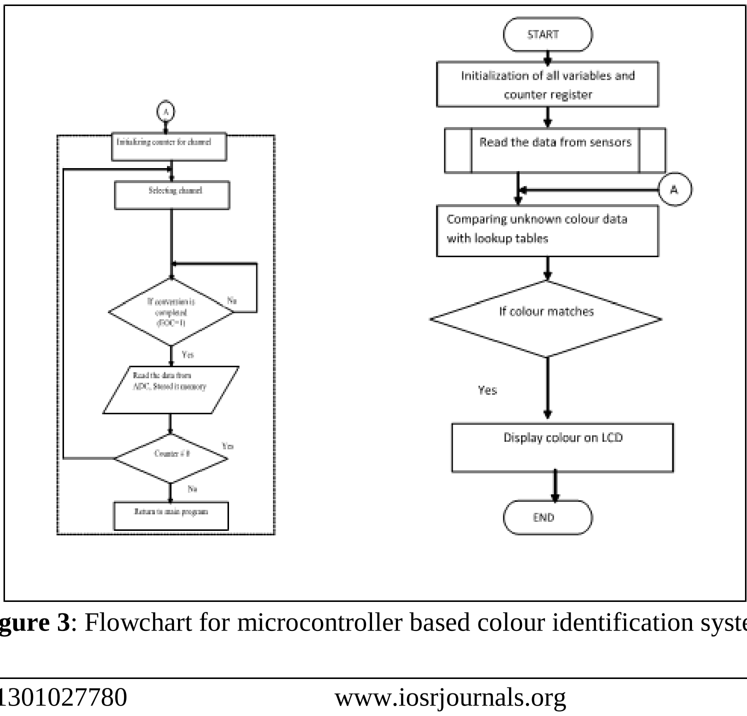

Figure 3: Flowchart for microcontroller based colour identification system.

III. Results And Discussion

The colour identification system is identifying colours. The typical sensor readout in terms of analog voltage depending on RGB contents of the sample is shown in Table 1. This instrument is successfully differentiate 8 colours which are three primary colours Red, Green, Blue and secondary colours Yellow, Magenta, Cyan, White and Black. The standard values of the 8 colours prepared for the present system is given in Table 2.

S.No	**Colour**	**Sensor output**	**RGB contents**		
			R	**G**	**B**
1	Black	0.158	0	0	0
2	White	3.62	255	255	255

Table 1: Typical sensor readout in terms of analog voltage depending on RGB

Colour of the object	**Lookup table values for this system in Hex**		
	Red	Green	Blue
Red	FF	26	19
Green	26	FF	19
Blue	19	26	FF
Yellow	FF	FF	19
Magenta	FF	26	FF
Cyan	19	FF	FF
White	FF	FF	FF
Black	00	00	00

Table 2: Standard values of the 8 colours prepared for this system

IV. Conclusion

The hardware and software features of microcontroller based colour identification system using P89V51RD2 microcontroller is designed and developed. The necessary software is developed in ‘C’ using Keil’s C- cross compiler. The data stored in the microcontroller along with the name of the colour. The colour is identified and displayed on LCD.

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