Abstract

To construct a device that is able to sense, identify and reproduce the colours that it is shown.

Specifications:

Circuit Components:

- LED's of Red Green and Blue colour, two each.(RGB because they are primary colours)
- An LDR to detect the changes in light (reflected light).
- Necessary resistances and switches

Working:

Concept:

The concept behind the colour sensor is very basic. It is well known that the colour we see of any object around is due to the light reflected from the object. Hence a red object reflect red light, blue reflects blue and green reflects green. These are the primary colours. Other colours can be made from various combinations of red, green and blue and hence reflect more than one primary colour. For instance, yellow should give both green and red. White should give back all the colours while black should reflect none. The proportion of colour should be related to the intensity of that wavelength reflected. We use this basic physics to design our portable colour sensor.

Circuit:

The circuit consists of 6 LEDs, two of each colour and a LDR. There are two LED's of each colour and they are arranged hexagonally and in a symmetric way around the LDR, the same collared LED are diametrically opposite. We also include a switch to give the interrupts to sense the colour.

When the switch is pressed, the LEDs go on one at a time in sequence and stay on for half a second each. After the LED is lit for 100milliseconds, we take the reading of the LDR to measure the resistance across it and hence the intensity of the reflected light.

We also place a cylindrical cover all around the LDR top protect it from the surrounding ambient light which will otherwise cause noise and hence interfere with the measurements. When this is not done, we get similar readings for all the colours hence proving that the noise is higher than the signal and needs to be taken care of. The colour sample to be detected is placed over the LDR covering it completely and hence protecting it from the surrounding light coming from top.

Calibration:

This is the most important part. We need to calibrate our circuit to sense the colour. Also, we need to take care of the errors. There are two potential sources of errors even after removing the background noise (which we did using hardware as mentioned above). All the LEDs do not give the same intensity of light and hence one of the LED can be dominant and give a higher reading as compared to other even if it should not theoretically be present. Moreover, the LDR can be sensitive to one of the wavelengths.

To overcome these we do the following:

The device is calibrated using a black (completely absorbing all wavelengths, intensity dependent) and white (completely reflecting). As these surfaces are wavelength independent, they should theoretically give the same readings for all the colours.Also, if the intensity of all LEDs is same, we should again get the same readings. Hence any difference in the readings can be attributed to these two factors. If we normalize all the subsequent readings using these values, we will essentially be nullifying these errors. Hence we take the average of the black and white reading for all 3 LEDs and divide the subsequent readings of that LED with their corresponding average.

Once this is done, we are left with the task of guessing the colour. For this, we need to calibrate the device. There are many ways in which this can be done-

1. We can directly feed in the expected values we should get from LDR for a given colour. We can then set some error margin and check if the readout value lies within this margin of the expected, the colour is guessed. This is a very crude method with many error sources. For instance, it is very sensitive to the reflecting nature of the object because we want exact same readings. A good reflector will give higher reflection for all and hence will not be guessed correctly. Moreover, any change in background noise or configuration can disrupt the calibration. Hence we abandon this approach after running in these troubles.

2. We make our approach more dynamic. The circuit should set the standards for the colours at the time of functioning and not beforehand. It is obvious that we should see the colour which is in the largest component. Hence we find the average of the readings of RGB and if there is only one colour whose value is more than this average, then this should be the colour. We use this as a method to detect the primary colours.

3. If the colour is not a primary colour, then we run into trouble. The composite colour depends on the proportions of various primary colours. Hence we need to find the percentages of the individual colours. By brute force and repeating the experiment again and again (obviously, we made some intelligent guesses while starting like for a secondary colour, two of the percentage should be greater than third, and keeping a margin of some x% i.e. say both Blue and Green should be at least 15% more than Red) we arrive at the calibration or the conditions to be imposed on the percentage of individual colours.

Results:

We were successfully able to detect all the primary and secondary colours i.e. red, blue, green, cyan, magenta, yellow. We were also able to detect black and white. We tried working the algorithm for other colours, say orange but we need to know the exact percentages of various primary and secondary colours and the device is not that sensitive. We were also able to reproduce our results. Though we did the calibration using a paper sheet, we were able to detect colour on a plastic object and clothes as well until the object had very low reflectivity.

Reproduction:

The values found across the LDR for every particular light are passed on to the analogy output of the Adriano. These values are used to light up a tri RGD LED, which when covered by surface will show the colour that it is sensing.

Flowchart