

# COL.Diesis: Interactive Colour Perception Device

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**Abstract**— This device was developed with the primary aim of helping blind and colour blind people perceive colours. It comprises of a colour sensor in a bracelet configuration which is used to detect the colour. The colour information is transmitted to the receiver which will then play the associated music.

**Keywords**— Colour, ZIGBEE, Synesthesia

## I. INTRODUCTION

Colour represents one of the most important and conditioning aspects of the reality that surrounds us. It has the great capability of moving us, impressing us and of creating meanings and symbolic values which, consequently, play a part in the culture and traditions of each one of us.[1]

In general colour isn't perceived uniquely through our eyes but also thanks to other aspects of a cultural type, through our conscience and subconscious. Aspects like primordial images, symbolism, cultural influences and traditions as well as personal experiences all form part of our singular and personal way of perceiving colour.[4] Colour is associated to feelings and basic life concepts such as romance, tranquility, hate, happiness, sadness, etc. as concluded by the many studies that have been made on the subject: the symbolism which belongs to colour walks hand in hand with common imagination. Colour, associated with either hearing or touch, represents one of the most common combinations in this field. Colour is connected to other senses besides sight. Blind people create concepts based on their personal experience and according to their point of view and imagination. They associate descriptive words and every day conversation to feelings, things they read, tactile experiences, hearing, taste and smell. Just because a blind person cannot 'see' colour, this does not take away from the fact that they can interpret it in their own personal way. COL.diesis is a device capable of detecting colours and transforming them into musical notes or melodies inspired by the concept of synesthesia which plays a fundamental role in the whole of the project [3]. COL.diesis represents an innovative study from a theoretical and technological point of view and it includes all the important ingredients in a proposal of social credibility as it encloses a wide range of problematic situations and disabilities. It counts on an important technological component, with the

programming of the software of the device and the modelling of an original colour/sound concept.

## II. MUSIC AND MUSIC THERAPY

On a sensorial level, music can help the blind develop to their auditory perception, teaching them to base it on a sequence of sounds. In addition, in physical exercises, music helps develop a sense of space. Musically, it is very important to allow a child who has visual difficulties or other psychological or physical conditions to discover as many sounds as possible [5]:

- Encouraging them to listen to sounds through different approaches (working with their imagination, concentrating on effects and barely perceivable changes in sound, etc.);
- It teaches to learn various positions and change in gestures in order to obtain distinct sounds;
- It allows them to create their own exercises and games so that they can appreciate personally chosen sounds, analyze them, learn to recognize them and differentiate them

	Internet, 700 people	25 children (9-13 yrs.)	Visually Impaired	Result
Flute	Green/ Yellow	Green/ Yellow	Green/ Blue	Green/ Yellow
Banjo	Orange	Not	Orange	Orange

	Internet, 700 people	25 children (9-13 yrs.)	Visually Impaired	Result
		Tested		
Cello	Purple/Blue	Purple/Red	Green/Purple/Red	Purple
Clarinet	Blue	Not Tested	Blue/Green/Red	Blue
Guitar	Red	Orange/Purple	Red/Orange	Red
Vibraphone	Yellow	Not Tested	Yellow	Yellow
Piano	Blue	Red/Purple	Blue/Yellow	Blue
Trumpet	Red/Blue	Not Tested	Purple/Blue	Blue

Table 1: synesthesia-joined perception statistics

It is a high performance RISC CPU. Only 35 single-word instructions to learn. It has all single-cycle instructions except for program branches, which are two-cycle. Operating speed is DC – 20 MHz clock input DC – 200ns instruction cycle. Up to 8K x 14 words of Flash Program Memory, Up to 368 x 8 bytes of Data Memory (RAM), Up to 256 x 8 bytes of EEPROM Data Memory. Pin compatible to other 28-pin or 40/44-pin PIC16CXXX and PIC16FXXX micro-controllers

**Peripheral Features:**

- Timer0: 8-bit timer/counter with 8-bit pre-scaler
- Timer1: 16-bit timer/counter with pre-scaler, can be incremented during Sleep via external crystal/clock
- Timer2: 8-bit timer/counter with 8-bit period register, pre-scaler and post scaler
- Two Capture (16-bit, max. resolution is 12.5ns), Compare (16-bit, max. resolution is 200ns), PWM (resolution is 10-bit)modules.
- Synchronous Serial Port (SSP) with SPI™ (Master mode) and I2C™ (Master/Slave)
- Universal Synchronous Asynchronous Receiver Transmitter (USART/SCI) with 9-bit address detection
- Parallel Slave Port (PSP) – 8 bits wide with external RD, WR and CS controls (40/44-pin only)
- Brown-out detection circuitry for Brown-out Reset (BOR)

**III.KEY COMPONENTS**

**A.PIC 16F877A MICROCONTROLLER:**

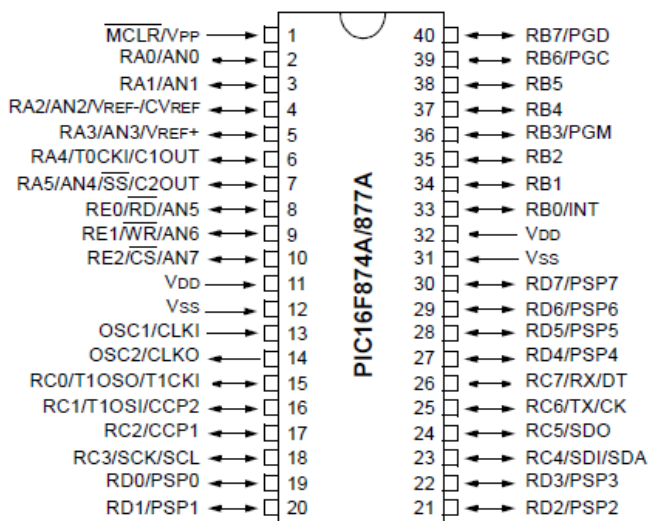


Fig1: Pin Description of PIC 16F877A microcontroller

**Analog features:**

- 10-bit, up to 8-channel Analog-to-Digital Converter (A/D)
- Brown-out Reset (BOR)
- Analog Comparator module with:
  - Two analog comparators
  - Programmable on-chip voltage reference (VREF) module
  - Programmable input multiplexing from device inputs and internal voltage reference
  - Comparator outputs are externally accessible.

**B.COLOUR SENSOR:**



Fig2:TCS3200 colourPAL sensor.

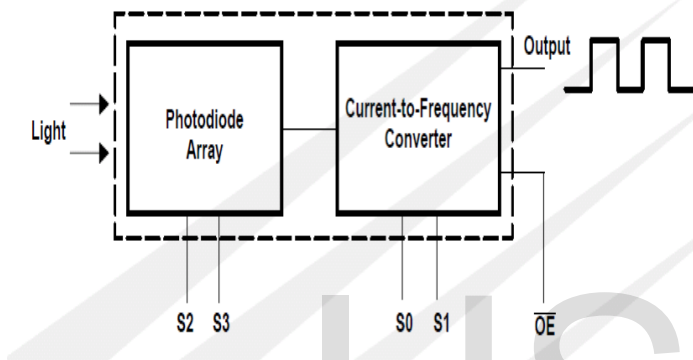


Fig 3:TCS3200 colourPAL sensor Block Description

The TCS230 programmable colour light-to-frequency converter combines configurable silicon photodiodes and a current-to-frequency converter on single monolithic CMOS integrated circuit. The output is a square wave (50% duty cycle) with frequency directly proportional to light intensity (irradiance). The full-scale output frequency can be scaled by one of three preset values via two control input pins. Digital inputs and digital output allow direct interface to a micro-controller or other logic circuitry. Output enable (OE) places the output in the high-impedance state for multiple-unit sharing of a micro-controller input line. The light-to-frequency converter reads an 8 x 8 array of photodiodes. Sixteen photodiodes have blue filters, 16 photodiodes have green filters, 16 photodiodes have red filters, and 16 photodiodes are clear with no filters.[2]

The four types (colours) of photodiodes are interdigitated to minimize the effect of non-uniformity of incident irradiance. All 16 photodiodes of the same colour are connected in parallel and which type of photodiode the device uses during operation is pin-selectable. When the light project to the

TCS3002D we can choose the different type of photodiode by different combinations of S2 and S3.

S2	S3	PHOTODIODE TYPE
L	L	Red
L	H	Blue
H	L	Clear (no filter)
H	H	Green

Table 2: Digital Filter selection on basis of photodiode type

The range of the typical output frequency is 2HZ~500KHZ. We can get different scaling factor by different combinations of S0 and S1.

Photodiodes are 120 mm x 120 mm in size and are on 144-mm centre.

S0	S1	OUTPUT FREQUENCY SCALING ( $f_o$ )
L	L	Power down
L	H	2%
H	L	20%
H	H	100%

Table 3: different scaling factor by different combinations of S0 and S1.

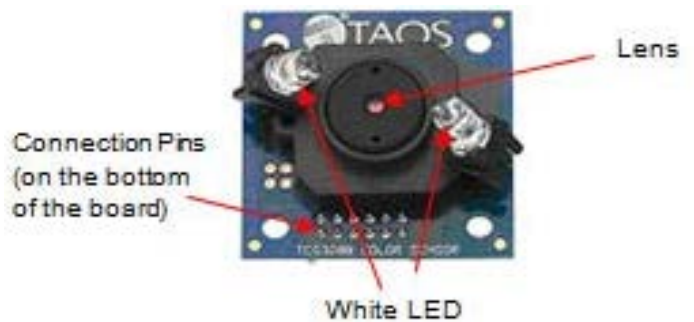


Fig4:TCS3200 colourPAL sensor layout

The TCS3200 colour sensor operates by illuminating the object with two white LEDs, while an array of photo detectors

(each with a red, green, blue and clear filter) interpret the colour being reflected by means of a square wave output whose frequency is proportional to the light reflected. As the two white LEDs are directed down at an angle, there is a point where the light intensity is the greatest. This position was 20 mm above the surface of the sample, as shown

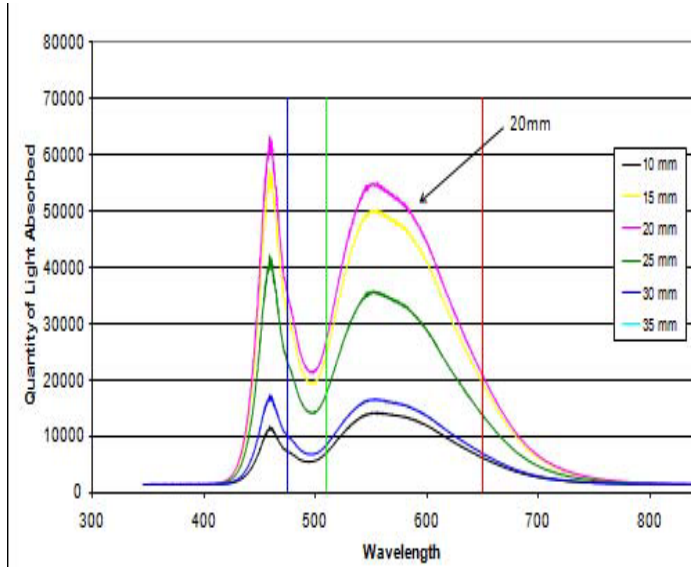


Fig 5: Light absorbed from TCS3200 across the white LED light spectrum when the sensor is positioned at 6 different heights.

### C. ZIGBEE MODULE:

ZigBee is a low-cost, low-power, wireless mesh networking standard. First, the low cost allows the technology to be widely deployed in wireless control and monitoring applications. Second, the low power-usage allows longer life with smaller batteries. Third, the mesh networking provides high reliability and more extensive range [6].

#### ZigBee Network Formation:

ZIGBEE networks are called personal area networks (PAN). Each network contains a 16-bit identifier called a PAN ID. ZigBee defines three different device types – coordinator, router, and end device.

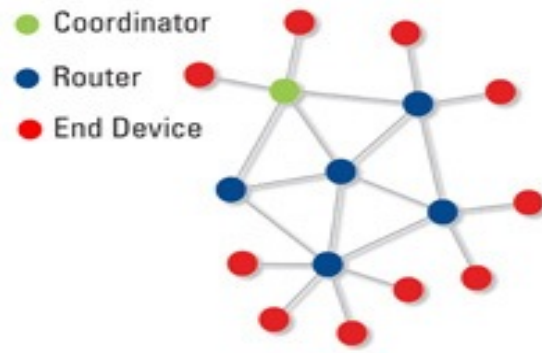


Fig 6: Coordinator, Router and End device

#### Coordinator :

The coordinator starts a new PAN. Once it has started a PAN, the coordinator can allow routers and end devices to join the PAN. The coordinator can transmit and receive RF data transmissions, and it can assist in routing data through the mesh network.

#### Router:

After joining a PAN, the router can allow other routers and end devices to join the PAN. The router can also transmit and receive RF data transmissions, and it can route data packets through the network.

#### End Device:

An end device must join a ZigBee PAN, similar to a router. The end device, however, cannot allow other devices to join the PAN, nor can it assist in routing data through the network. An end device can transmit or receive RF data transmissions. Since the end device may sleep, the router or coordinator that allows the end device to join must collect all data packets intended for the end device, and buffer them until the end device wakes and is able to receive them. The end device is considered a child of its parent (router).

#### ZigBee Module

This XBEE wireless device can be directly connected to the serial port (at 3.3V level) of your micro-controller.



Fig7: Zigbee Module

This module supports data rates of up to 115kbps. These modules use the IEEE 802.15.4 networking protocol for fast point-to-multipoint or peer-to-peer networking. They are designed for high-throughput applications requiring low latency and predictable communication timing.

#### D.VOICE PROCESSOR

The APR9600 device offers true single-chip voice recording, non-volatile storage, and playback capability for 40 to 60 seconds. A differential microphone amplifier, including integrated AGC, is included on-chip for applications requiring its use. The amplified microphone signal is fed into the device by connecting the Ana\_Out pin to the Ana\_In pin through an external DC blocking capacitor. Recording can be fed directly into the Ana\_In pin through a DC blocking capacitor, however, the connection between Ana\_In and Ana\_Out is still required for playback. The next block encountered by the input signal is internal anti-aliasing filter.

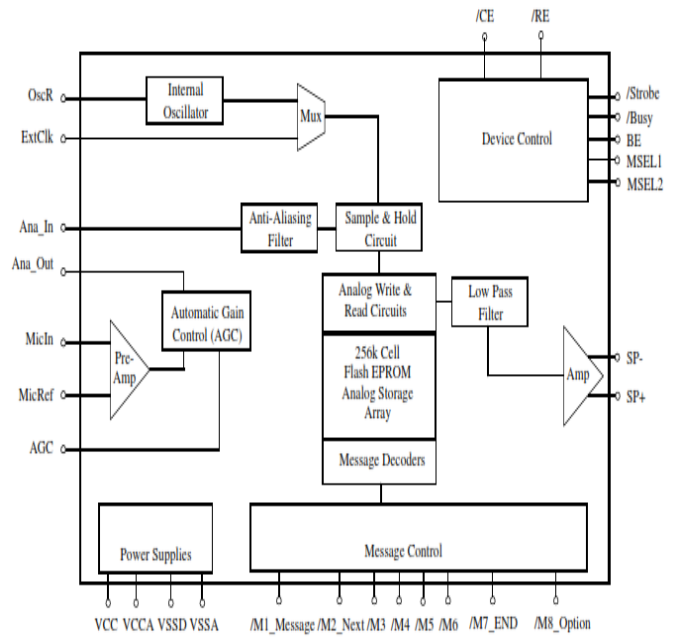


Fig8: APR9600 Voice Processor block diagram

The filter automatically adjusts its response according to the sampling frequency selected so Shannon's Sampling Theorem is satisfied. After anti-aliasing filtering is accomplished the signal is ready to be clocked into the memory array. This storage is accomplished through a combination of the Sample and Hold circuit and the Analog Write/Read circuit.

These circuits are clocked by either the Internal Oscillator or an external clock source. When playback is desired the previously stored recording is retrieved from memory, low pass filtered, and amplified as shown on the right hand side of the diagram. The signal can be heard by connecting a speaker to the SP+ and SP- pins. Chip-wide management is accomplished through the device control block shown in the upper right hand corner. Message management is controlled through the message control block represented in the lower centre of the block diagram. An important feature of the APR9600 message management capabilities is the ability to audibly prompt the user to changes in the device's status through the use of "beeps" superimposed on the device's output.

#### Features

- Single-chip, high-quality voice recording & playback solution
- Non-volatile Flash memory technology
- User-Selectable messaging options

- Random access of multiple fixed-duration messages
- Sequential access of multiple variable-duration messages
- Level-activated recording & edge-activated play back switches
- Low power consumption
- Operating current: 25 mA typical
- Standby current: 1mA typical
- Automatic power-down

**E.BLOCK DIAGRAM:**

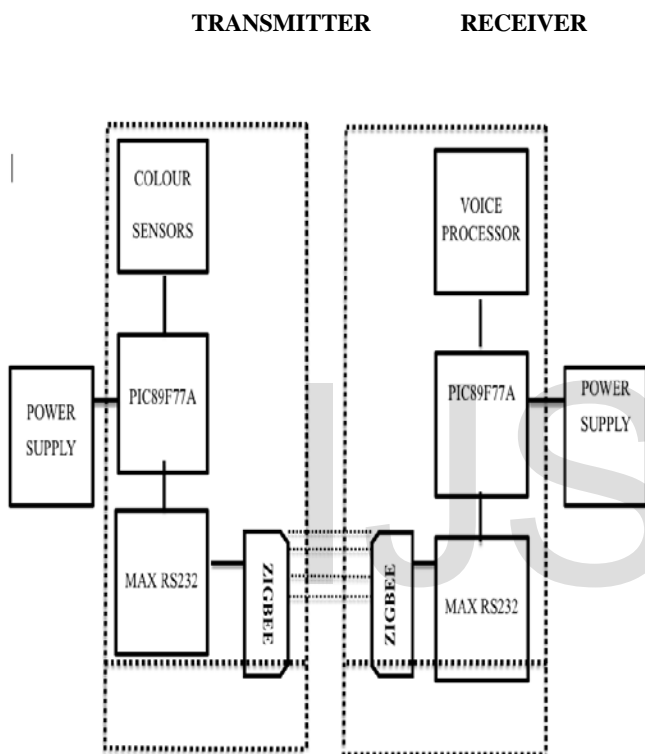


Fig9: COL.Diesis block diagram

Our aim is to incorporate all the components available to us and make a device which would help not only synesthetes but also colour blind people. Our team is now entering a phase of product diffusion in the hope to produce the COL.diesis bracelet with Zigbee communication which is not only a huge modification of the past projects [7] but also allows potential users to become acquainted with its possibilities and advantages.

- **Power supply** is the first and the most important part of our project. For our project we require +5V

regulated power supply with maximum current rating 500Ma.

- To step down the mains 230V A.C. step down transformer is required.
- Step down transformer gives out well regulated +5V output, output current capability of 100 mA
- **MAX RS232:** The Serial communication is used to transfer data between the mobile device and the micro-controller. MAX RS232 is used for this purpose
- **Zigbee Transmitter:** It transmits the signal which is connected to RS 232 interface. It works on 2.4 GHz frequency with the serial interface.
- **Zigbee Receiver:** It receives the signal which is connected to RS 232 interface. It works on 2.4 GHz

frequency with the serial interface

- **Micro-controller PIC16F877A:** It is the heart of the circuitry. It is the main block which takes the inputs and processes it and gives the output. All the other blocks work in accordance with the micro-controller.
- The **APR9600** device offers true single-chip voice recording, non-volatile storage, and playback capability for 40 to 60 seconds.

**IV.CONCLUSION**

COL.diesis is an innovative system thanks to its original approach to correspondence between music and colour

adapted to people with disability using a multi-disciplinary approach. [7]

The choices of correspondence between colour and music have proven to work in a high percentage of people although the subjectivity of colour interpretation has pushed the researchers to maintain an open fan of possibilities for the users. COL.diesis includes all the important ingredients in a proposal on a social and technological level with the objective to improve accessibility to information and knowledge. It fundamentally counts on potential user-groups on a national and European level. In addition COL.diesis can be extended to a wider range of problematic situations and disabilities. The team has developed a portable device capable of detecting colours through a colour sensor and reproducing them through music. The device can be programmed as to adapt itself to the needs of each user.

The future objective is to formalize the theory through mathematical-colour morphology and sound spaces in order to develop a more objective and formal correspondence between these spaces.

2009 Second International Conference in Visualisation 2009 IEEE DOI 10.1109/VIZ.2009.4930 transforming colour into melody and implementing the result in a colour sensor device-Jessica Rossi, Francisco Jose Perales, Javier Varona, Miquel Roca Computer Graphics, Vision and Artificial Intelligence Group Mathematics and Computers Science Department University of the Balearic Islands, Spain

## V.ACKNOWLEDGEMENT

We would like to thank our Principal, Dr.Alka Mahajan, our HOD, Dr.Atul Kemkar and our parents for their precious inputs. We would also like to thank our Project Guide, Prof.Swati Rane and all the relevant authors for their significant contributions in this field which provided an impetus to our paper.

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