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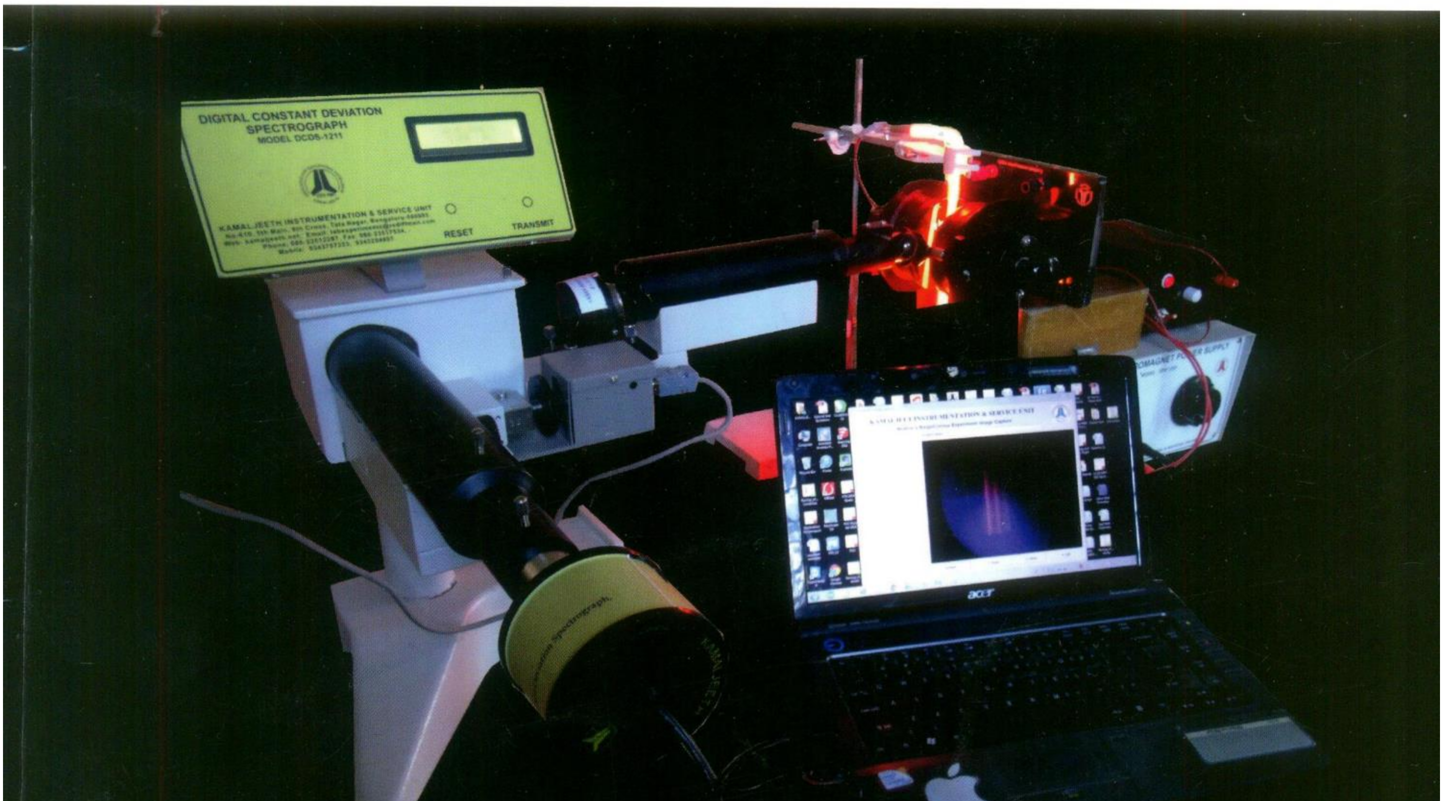

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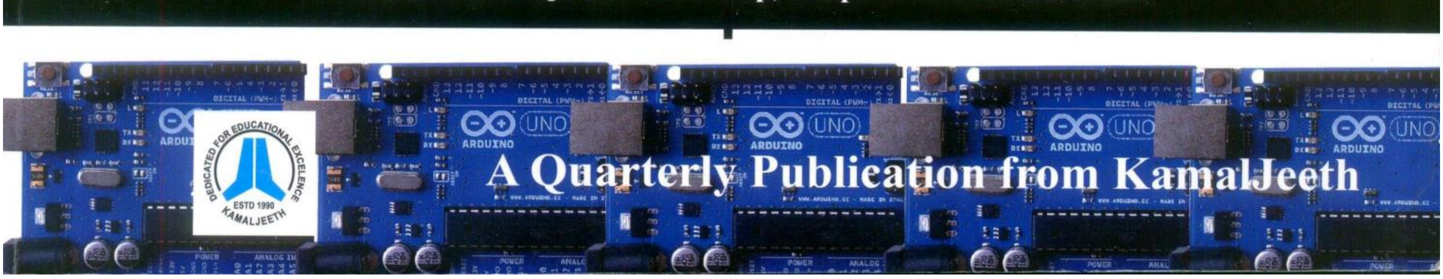

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Experiment-455 **A**

A COLLISION AVOIDANCE DEVICE TO ASSIST THE VISUALLY IMPAIRED

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Abstract

This work aims to assist visually challenged persons to walk safely avoiding collision with objects ahead on the course. The study hypothesizes a smart walking stick that alerts visually-impaired persons about the presence of obstacles on the course ahead that would assist them in walking without colliding with the obstacles. The main aim of the device is to provide a convenient and safe method for the blind to overcome their handicap thereby avoiding difficulties in daily life. This assistive collision avoidance device is an offspring of the assistive technology which is an emerging field in electronics. This is mainly based on ultrasound sensors which can acquire data about objects present around by estimating the time-of- travel of the ultrasound pulse. Using a sensor coverage area, one can detect obstacles on the course and determine which directions should be avoided by a visually challenged person while walking. The ultrasound sensors are used to detect if any obstacles are present in front of the visually impaired person. The feedback is given to the person in the form of voice commands. Our system comprises an embedded system, having an ultrasonic sensor, a voice circuit that provides vocal feedback (to give information on the proximity of the obstacle ahead). Ultrasound sensors are quite inexpensive (compared to other alternatives such as fiber optic sensors, laser range scanners etc.) and are harmless, making them ideally suited for this purpose.

Introduction

Assistive technology includes assistive, adaptive, and rehabilitative devices for visually challenged persons and also includes the process employed in selecting, locating and using them. Assistive technology enables enhancement of capabilities by enabling people to perform tasks that are normally difficult to accomplish. Figure-1 summarizes implementation of assistive technologies. Recently a lot of Electronic Travel Aids have been designed to help the blind navigate their course independently and safely. Technologically advanced and feasible solutions have been introduced to help blind persons navigate independently. Many of these systems use ultrasound because it is unaffected by the ambient noise. Another reason why ultrasonic technology is popular is that it is relatively inexpensive, and also ultrasound emitters and detectors are small enough in size to be carried without the need for having a complex circuit.

Measurement of distance of an obstacle

The "Timing diagram" of an ultrasound ranging module is shown in Figure-2. A short 10μS pulse is applied to the trigger input to start the ranging operation after which the module sends out an 8 cycle burst of ultrasound at 40 kHz frequency and produces an echo. The echo arises due to reflection of the ultrasound pulse by a distant object and has pulse width and range in proportion. One can calculate the range of an object from the time interval between the transmitted signal and the received echo from the object. Employing the relation: range = high level time * velocity of sound (340m/s)/2. It is advisable to use over 60ms measurement cycle in order to prevent interference between the transmitted signal and the echo.

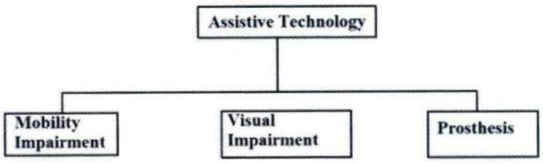

Figure- 1 : Types of Assistive technology

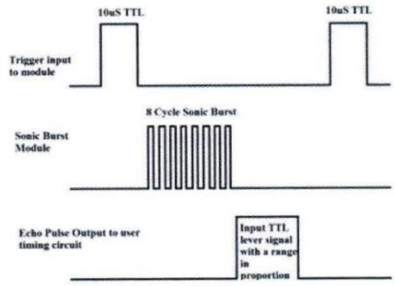

Figure- 2: Timing diagram of Ultrasound Ranging Module

Components used

Microcontroller ATMEL AT89S52, resistors, capcitors, 11.05MHz crystal, 16X2 LC display, Reset button, Uktrea sound senor HC-SR04, APLUS aPR33A3, Mic and Speaker

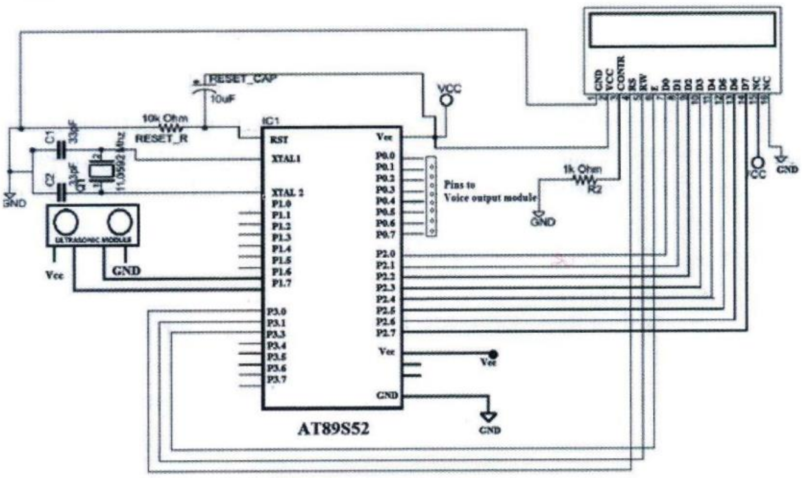

Figure- 3: Main circuit connections

Circuit layout

The circuit diagrams are shown in two parts. Figure-3 shows the main circuit connections and Figure-4 shows the voice output module connections.

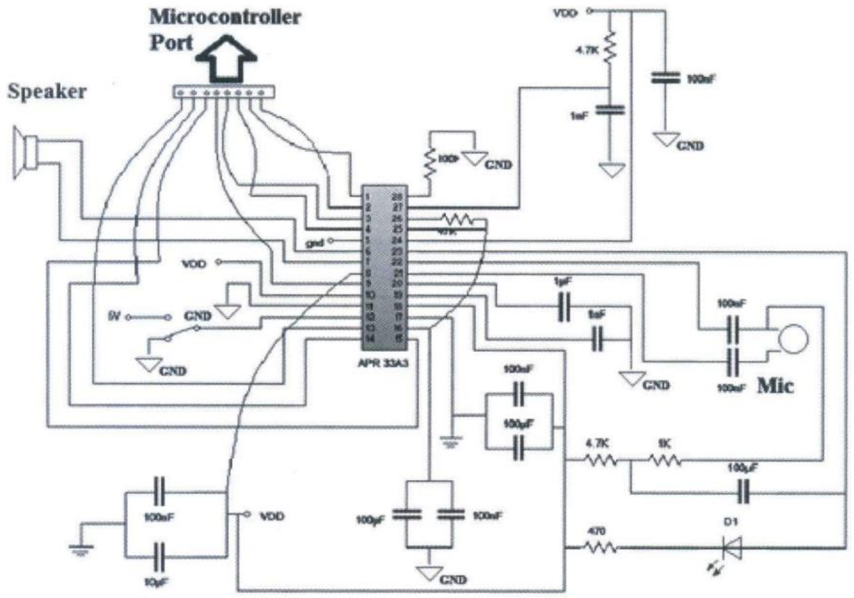

Figure-4: Voice output module connections

Experimental procedure

A 5V DC constant power source is used to supply power to the following modules:
Microcontroller ATMEL AT89S52, 16x2 LCD, Voice output module and Ultra Sound Ranging Module

All the devices are powered on and the same is indicated by glowing of the red LEDs present on each block. The functionality condition is verified by the LCD display which gets turned on and displays “OBSTACLE FINDER” as a verification message to show that it is functional, as shown in Figure-5.

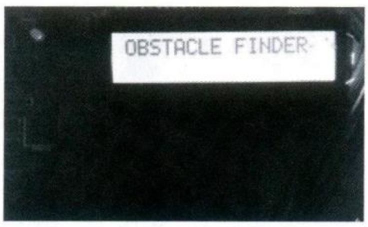

Figure-5: Verification message on the LCD

1. The Ultrasonic ranging module HC - SR04 starts functioning now as under:
   Using IO trigger for at least 10μs high level signal, the module automatically sends eight pulses of 40 kHz frequency and detects whether there is a pulse signal echo.

2. If the ultra sound receiver gets back the reflected signal from obstacle, the time take for the to and fro journey of the pulse is obtained. Then the distance at which obstacle is present may be calculated using relation

3. Test distance = (high level time velocity of sound (340m/s) / 2

4. Using this value of time for receiving the transmitted ultrasonic signal the Microcontroller ATMEL AT89S52 computes the distance and sends it to LCD and Voice Output Module.

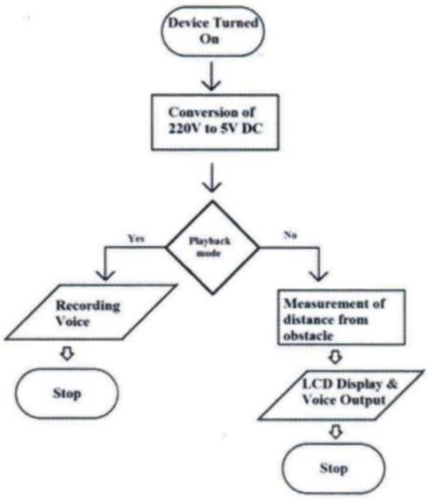

Figure-6: LCD initialization display

5. Microcontroller ATMEL AT89S52 displays the distance of the obstacle on the 16x2 LCD modules.

6. Microcontroller ATMEL AT89S52 selects an appropriate pre-recorded audio track for spoken feedback on the voice output module for the visually impaired.

7. The Voice Output Module which has pre-recorded audio tracks now plays an appropriate audio track according to the Microcontroller ATMEL AT89S52 selection. The above procedure is depicted in a flow chart shown in Figure-6.

Hardware details

This is mainly based on ultrasound sensors which can acquire range data from objects present in the vicinity by estimating the time-of-flight of the ultrasound signal. Using the sensor coverage area, we can detect obstacles and determine which directions should be avoided by a visually impaired person. The ultrasound sensors are used to detect whether obstacles are present in front of the person. The feedback is presented to the person in the form of voice commands. The system designed by us comprises a microcontroller, an ultrasonic sensor, a voice circuit to provide vocal feedback to the visually impaired person (to inform about the presence as well as distance of the obstacle ahead on the course).

Software details

The code is written in Keil μVision, verified for any programming errors and finally saved as a hex file, for burning a CD using the flash magic software.

Implementation

The aim is to calculate distance using the inputs from ultrasonic ranging module and select the particular pre-recorded audio track on the Voice Output Module for generating vocal feedback.

Program

```
/* distance_sensor_app.c        */
sbit echo=P2^1;
sbit pulser=P2^0;//trigger

sbit DIS_BLW_50CMS=P3^0;
sbit DIS_BLW_100CMS=P3^1;
sbit DIS_BLW_150CMS=P3^2;
sbit DIS_BLW_200CMS=P3^3;
sbit DIS_BLW_250CMS=P3^4;
sbit DIS_BLW_300CMS=P3^5;
sbit DIS_BLW_350CMS=P3^6;
sbit DIS_ABV_350CMS=P3^7;

bit f;
char flag;

Timer0_init();
Pulse_Delay(unsigned int);
Pulse();
Find_Distance();
Distance_Measure();
Voice_Alert();

Timer0_init()
{
        TMOD=0X11;
        TH0=0X00;
        TL0=0X00;
        IE=0X82;
}

Timer0()interrupt 1
{
        TR0=0;
        TF0=0;
        TH0=0X00;
        TL0=0X00;
```

```
        count=count+1;
        if(count>2)
        {
                Timer_flag=1;
        }
}

Distance_Measure()
{
        Pulse();
        while(echo!=1);
        TR0=1;
        while(echo!=0&&Timer_flag!=1);
        {
                if(Timer_flag==1)
                {
                        TR0=0;
                        TF0=0;
                        TH0=0X00;
                        TL0=0X00;
                        Timer_flag=0;
                }
                if(Timer_flag==0)
                {
                        Find_Distance();
                        echo=1;
                }
        }
}
Find_Distance()
{
        TR0=0;
        time=(TH0*256)+TL0;
        time_us=(time*1.0856);
        Distance_cm=time_us/58;
        if(Distance_cm<=351&&Distance_cm>1 && flag!=8)
        {
                flag=8;
                if(f==0)
                        lcd_str(1,1,"Obj at          ");
                lcd_chr(1,8,(Distance_cm/100)+48);
                lcd_data(((Distance_cm%100)/10)+48);
                lcd_data((Distance_cm%10)+48);
                if(f==0)
                        lcd_str(0,0,"Cm");
                Voice_Alert();
                TH0=0X00;
                TL0=0X00;
                f=1;
        }
```

```
        else
        {
                flag=0;
                TH0=0X00;
                TL0=0X00;
                f=0;
                lcd_str(1,1,"Obj Out of Range");
                DIS_ABV_350CMS=0;
                delay(50);
                DIS_ABV_350CMS=1;
                delay(400);
        }
}


Pulse()
{
        pulser=1;
        Pulse_Delay(10);
        pulser=0;
}

Pulse_Delay(unsigned int k)
{
        int j;
        for (j=0;j<=k;j++);
}

Voice_Alert()
{
        if(Distance_cm>=0&&Distance_cm<50 && flag!=1)
        {
                flag=1;
                DIS_BLW_50CMS=0;
                delay(50);
                DIS_BLW_50CMS=1;
                delay(400);
        }
        if(Distance_cm>=50&&Distance_cm<100 && flag!=2)
        {
                flag=2;
                DIS_BLW_100CMS=0;
                delay(50);
                DIS_BLW_100CMS=1;
                delay(400);
        }

        if(Distance_cm>=100&&Distance_cm<150 && flag!=3)
        {
                flag=3;
```

```
            DIS_BLW_150CMS=0;
            delay(50);
            DIS_BLW_150CMS=1;
            delay(400);
    }

    if(Distance_cm>=150&&Distance_cm<200 && flag!=4)
    {
            flag=4;
            DIS_BLW_200CMS=0;
            delay(50);
            DIS_BLW_200CMS=1;
            delay(400);
    }

    if(Distance_cm>=200&&Distance_cm<250 && flag!=5)
    {
            flag=5;
            DIS_BLW_250CMS=0;
            delay(50);
            DIS_BLW_250CMS=1;
            delay(400);
    }

    if(Distance_cm>=250&&Distance_cm<300 && flag!=6)
    {
            flag=6;
            DIS_BLW_300CMS=0;
            delay(50);
            DIS_BLW_300CMS=1;
            delay(400);
    }
    if(Distance_cm>=300&&Distance_cm<350 && flag!=7)
    {
            flag=7;
            DIS_BLW_350CMS=0;
            delay(50);
            DIS_BLW_350CMS=1;
            delay(400);
    }
}
```

Output

1. The magnitude of distance
2. Selection of the relevant pre-recorded audio track (Spoken Feedback)

Scope of the output of the device

This device is useful for determination of the position of the obstacle ahead at normal body height when an obstacle exists and reflects the ultra sound waves. However, it is not possible to detect hanging objects at or above the head level of a person.

Results

The results obtained for various test conditions are presented here. A summary of other possible results is presented at the end.

Obstacle within 50 cm distance

Condition: The distance of the obstacle from the Ultrasonic Ranging Module = 44 cm.
The LCD displays shows "Obj at 044 cm", as shown in Figure- 7

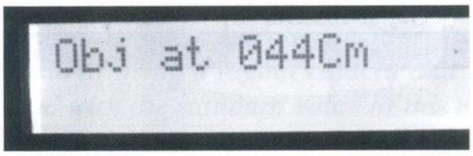

Figure-7: LCD output for an obstacle at 44 cm distance

Vocal Feedback

"Caution! Object under 50 centimeters"

Obstacle within 250 cm distance

Condition: The distance of the obstacle from the Ultrasonic Ranging Module = 218 cm.

The LCD displays shows "Obj at 218 Cm", as shown in Figure-8

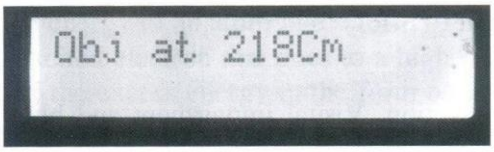

Figure-8: LCD output for an obstacle at 218 cm distance

Vocal Feedback

"Object under 250 centimeters"

Obstacle out of range of the device

Condition: The distance of the obstacle from the ultrasonic sound module= 500 cm
The LCD displays "Obj Out of Range", as shown in Figure- 9.

10.3.3 Vocal Feedback

"Obstacle is out of range"

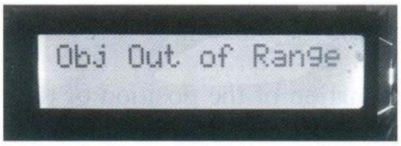

Figure-9: LCD output for an obstacle at 500 cm distance

A summary of other possible results is presented in Table-1.

Table-1: Summary of the results obtained under various test conditions

Distance	LCD Display	Vocal Feedback
44 Centimeters	Obj at 44 Cm	"Caution! Object under 50 centimetres"
83 Centimeters	Obj at 83 Cm	"Caution! Object under 100 centimetres"
129 Centimeters	Obj at 129 Cm	"Object under 150 centimetres"
181 Centimeters	Obj at 181 Cm	"Object under 200 centimetres"
218 Centimeters	Obj at 218 Cm	"Object under 250 centimetres"
284 Centimeters	Obj at 284 Cm	"Object under 300 centimetres"
322 Centimeters	Obj at 322 Cm	"Object under 350 centimetres"
353 Centimeters	Obj at 353 Cm	"Obstacle is out of range"
500 Centimeters	Obj at 500 Cm	"Obstacle is out of range"

Conclusion

We have implemented a system that enables visually impaired persons to know about the presence of obstacles and avoid colliding with them while walking around. In the near future devices of approximately the size of a normal button or clipper present on a common vest are expected to become available.

Acknowledgements

We are thankful to our managing director, Dr H S Saini, and G S S Kohli, vice-chairman of Guru Nanak Institutions for their co-operation and encouragement.

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Dr Prabhakar Sharma obtained his Ph.D. in 1977 from Gujarat University, Ahmedabad in the field of space sciences. Thereafter he shifted his research interests to Hydrology and Palaeoclimate. He has published over 70 papers in various national and international journals. He is also interested in science communication and has written several articles in popular science magazines and newspapers. He was associated with human resources development programme of PRL, Ahmedabad, for over a decade. He is a Fellow of Gujarat Science Academy.

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Dr. Jeethendra Kumar obtained his M.Sc. degree in Physics in 1980, with specialization in Electronics from Mysore University and Ph.D. degree in Physics in 1986 from Mangalore University. After working in the Physics Department of Mangalore University as a Lecturer for eight years, he founded KamalJeeth Instrumentation & Service Unit, a scientific instruments manufacturing company based in Bengaluru. At present it is one of largest manufacturers of Physics and Electronics lab instruments in South India.

In the year 2001, he started publication of Lab Experiments (LE), a journal which offers a platform to publish new experiments in Physics and Electronics. LE has now become a widely referred journal throughout the country for Physics and Electronics lab experiments.

A science museum dedicated to inventions and inventors in Physics and Electronics is coming up under his guidance at Manjeshwara village, Kasaragod district, Kerala State. As part of the activities of the museum, it is planned to hold regular lecture / demonstration programs for school children throughout the country.

Ajeya PadmaJeeth

Ajeya PadmaJeeth obtained his BE degree (2009) from BMSIT, Bengaluru and MS degree (2011) from Coventry University, London, UK. He has recently joined KJISU and has played a key role in establishing its Science Store. With his initiative KJISU is now poised to cater to other disciplines of science, such as Biology and Chemistry.

Prof. S V Ranganayakulu

Prof. S V Ranganayakulu has been working as Professor of Physics and Dean – Research & Development of Guru Nanak Institutions Technical Campus, Ibrahimpatnam, Hyderabad, since 2013. He obtained his M.Sc. and M.Phil. Degrees from Andhra University, Visakhapatnam and Ph.D in Physics from Osmania University, Hyderabad. He is a member of the Editorial board of Journal of Green and Sustainable Chemistry, American Journal of Engineering Technical Technology, and International Journal of Advanced Materials. He is a *Fellow* of Acoustical Society of India and Ultrasonic Society of India. He has authored 2 text books and is a reviewer for some national and international journals.

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