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Doctor Assistive System Using Augmented Reality for Critical analysis

[1] G.Jayanthi, [2]V.Dhaarni, [3]P.M.Nivethitha, [4]S.Subashini
[1] Assistant Professor, [2][3][4] UG Scholar
[1][2][3][4] Sri Sairam Engineering College, Chennai, Tamil Nadu, India

***Abstract* – Surgeons are regularly on the lookout for technologies that will enhance their operating environment. They face difficulties in monitoring the vital parameters while doing surgery continuously. So, in this project, the system for assisting the doctors while performing surgery using Augmented Reality commonly called as AR is developed. Augmented reality (AR) is rapidly becoming available, accessible and importantly affordable, so that their application into healthcare to enhance the medical field is certain. The Vital Parameters such as Heart Rate, respiratory rate and Temperature of Patients are measured using suitable sensors. The sensors used in our work are KY039 for measuring Heart rate, X2M200 for Measuring Respiratory rate, LM35 IC temperature Sensor. The Peripheral Interface Controller (PIC) is used for processing the sensor values and is programmed using Embedded C. The surgeon is provided with an alert signal, whenever the sensor output exceeds a normal threshold Value. The alert signal is displayed on the AR glass through the wireless transceiver. Thus, this prototype helps the doctors to monitor the patients continuously during Surgery.**

Keywords- Augmented reality (AR), Heart rate, Respiratory rate, Peripheral Interface Controller (PIC)

1. INTRODUCTION

Surgeons have great interest in adopting the newer technologies that provide them a better surgical environment. The main need of medical augmented reality came from the need of visualizing medical data and patient within the same medical space. Augmented reality (AR) supplements the real world with virtual objects, such that virtual objects appear to coexist in the same space as the real world[1]. The main reason for using AR is that it improves the quality of care. Developing this method really helps doctors during surgery and reduces the medical errors. It continuously monitors the patient's health condition during surgery. AR technology lets users to provide digital information onto the existing environment. AR innovations can help enhance doctors and surgeons ability to diagnose, treat, and perform surgery on their patients more accurately by giving them access to real-time data and patient information faster, and more precisely than ever before. In the existing system, the doctors should take care of any parameters during surgery manually. It will be difficult to monitor the parameters of the patients undergoing surgery continuously for the doctors and it may cause some serious case. So, there is a need for the system to monitor the parameters continuously. Hence we proposed the doctor assistive system using Augmented Reality. The main objective is

To implement the AR technology and to monitor the patient health.
To select biomedical sensor to maintain the patient health condition.
To process the sensor output value using PIC controller.
To generate alerts under abnormal conditions in the AR glass and headset.

II. LITERATURE REVIEW

In 2014, a review[1] made by Egui Zhu, Arash Hadadgar, Italo Masiello and Nabil Zary tells that Augmented reality (AR) amounts to the real world with virtual objects, such that virtual objects appear to coexist in the same space as the real world. AR is used in Clinical care as it provides with an internal view of the patients without any invasive procedures. AR implemented in several healthcare areas and aimed at all level of learners. But, this paper has a Lack of learning theories to guide the design of AR. It did not clearly describe which kind of learning theory was used to guide design or application of AR in healthcare education. So, in this project we provide a clear idea for the use of augmented reality in surgeries by providing the surgeons the semi transparent glass where they will be alerted if any parameters go above the threshold ranges.

A paper published in 2016 by Nikola Popovic, Ognjen Djekic, Marko Kovacevic, and Tomislav Maruna

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Vol 6, Issue 7, July 2019

[2] gives the software architecture responsible for processing of the data received from ultrasonic sensors in vehicle, preparing and providing the data to higher layers of the system. Inputs in our algorithm are raw data from ultrasonic sensors. Problem with this solution can be computational bottleneck, especially when lots of data from different type of sensors comes to one place and needs to be processed in rational amount of time. From that reason we suggest a certain level of optimization. Here, only one sensor value is taken into account and there
can be a problem when more sensors come to one place. So, we provide a distributed architecture in order to read values from different kinds of sensors such as respiratory sensor, heart beat sensor, temperature sensor. In 2018, Filip Malwski[3] developed the Augmented reality for car assistive system. Based on this paper we got the idea of developing the same system for assisting doctors. The AR technology [4]can be used in Handheld Devices, Stationary AR Systems, Spatial Augmented Reality (SAR), Systems Head-mounted Displays (HMDs), Smart Glasses, Smart Lenses. Major medical applications deals on robot-assisted surgery and image guided surgery. Because of this, substantial research is going on to implement AR in instruments which incorporate the surgeon's intuitive capabilities[5].

III. BLOCK DIAGRAM

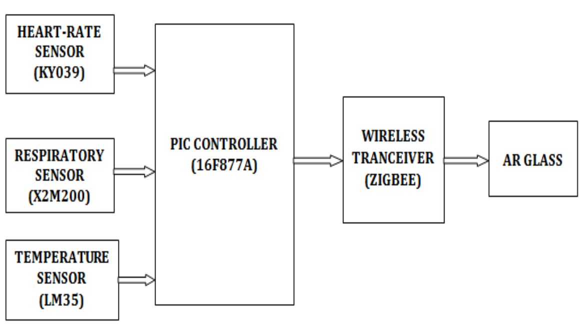

Fig 3.0 Generalised Block Diagram

The Generalised block diagram is shown in the Fig 3.0. In this project, the real time data of the patient's during surgery is displayed in the AR glass through wireless transceiver i.e. Zigbee transceiver. The parameters are sensed using the sensors such as heart rate sensor, respiratory sensor and temperature sensor. The Heart rate sensor is used to measure the heart rate of the patients. The respiratory sensor is used to measure the respiratory rate of the patients. The temperature sensor is used to measure the temperature of the patients. These measured values are processed using the PIC controller. The PIC controller is programmed using the Embedded C programming. The processed values are sent to the Doctor's augmented reality glass through the wireless mean only when these values reach above the threshold values.

A) Heartbeat sensor

This sensor shown in Fig 3.1 is used to measure the heartrate of the patient during surgery. Here, we are KY039 heartbeat sensor.This sensor is based on the principle of photo phlethysmography.

Specification:
16 x 116 x 3mm (l x w x h)
IR Emitter and Receiver
3 - 5V DC Input
M2 Mounting holes (centres 10mm apart)
Designed to be compatible with standard 2.54mm socket.

Fig 3.1 Heartbeat sensor

B) Respiratory sensor

This sensor is used to measure the respiratory rate of the patient. Here X2M200 respiratory sensor is used for the measurement of respiratory rate of the patient during surgery.
The respiratory rate is the number of breaths a person per minute. The rate is usually measured when the patient is at rest. Respiration rates may increase with fever, illness and other medical conditions. The X2M200 sensor module shown in Fig 3.2 is designed for respiration monitoring of people of all ages for health and well being purpose.

Fig 3.2 Respiratory sensor

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C)Temperature Sensor

This sensor is used to measure the body temperature of the patient during surgery.LM35 temperature sensor shown in Fig 3.3 is used to measure the patient body temperature. The LM35 has an advantage over linear temperature sensor and it does not require any external calibration.LM35 is widely used temperature sensor because of its low cost and high accuracy. The measured temperature value is given to the output devices.

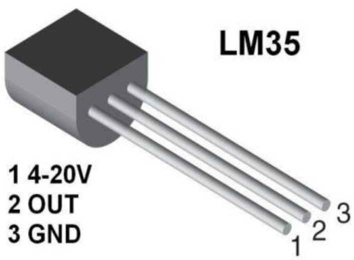

Fig 3.3 Temperature sensor

D) PIC Microcontroller

Pic controller used is PIC16F877A shown in Fig 3.4.The PIC microcontroller is based on the flash technology where the data is remained even when the power is switched off[6]. Easy programming and erasing are the other features of PIC16F877A. Here the PIC microcontroller is programmed with embedded C programming. The sensor senses the input and the values are processed and are checked with the threshold values using PIC microcontroller. The Pin diagram of PIC controller is shown in Fig 3.5

Fig 3.4 PIC Microcontroller

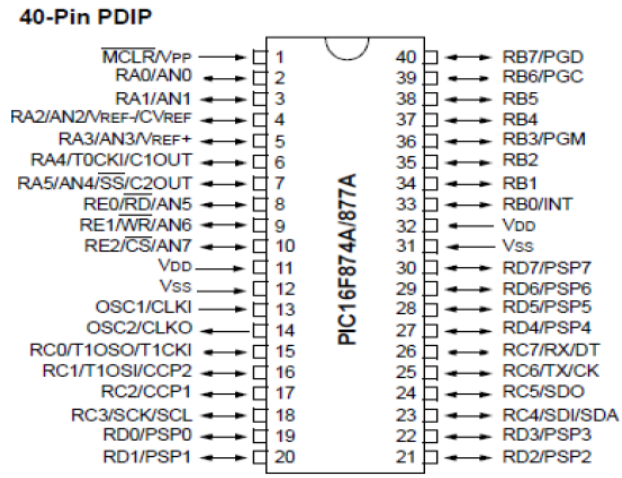

Fig 3.5 Pin diagram of PIC controller

Core Features:

High-performance RISC CPU
Only 35 single word instructions to learn
All single cycle instructions except for program branches which are two cycle
Operating speed: DC - 20 MHz clock input, DC - 200 ns 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

E) Zigbee wireless transceiver

Zigbee shown in Fig 3.6 is an IEEE 802.15.4 based, low power, low data rate supporting wireless networking standard, which is basically used for two-way communication between sensors and control system. It is a short-range communication standard like Bluetooth and Wi-Fi, covering range of 10 to 100 meters. Bluetooth and Wi-Fi are high data rate communications standard supporting transfer of complex structure like media, software etc.

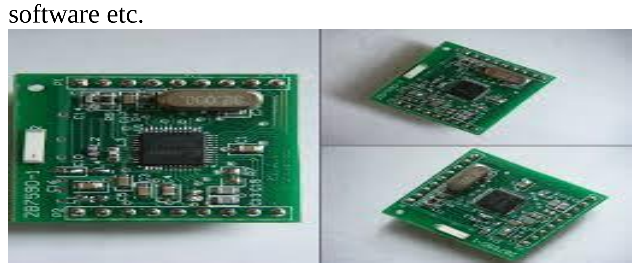

Fig 3.6 Zigbee Transceiver

In this method Zigbee protocol is used for wireless communication. Zigbee protocol transmitter is connected to pic microcontroller and the Zigbee protocol receiver is mounted on the AR glass. It supports low data rate of about 250 kbps. The operating frequencies are 868 MHz, 902 to 928 MHz and 2.4 GHz. Zigbee Technology is used mainly for applications requiring low power, low cost, low data rate and long battery life. Zigbee transmitter receives signal from PIC controller and it transmits signal to the Zigbee protocol receiver which is mounted on the AR glass and the final output is displayed on the AR glass which is provided to the surgeons.

F) Connection Pin diagram

The connection PIN diagram is shown in Fig 3.7

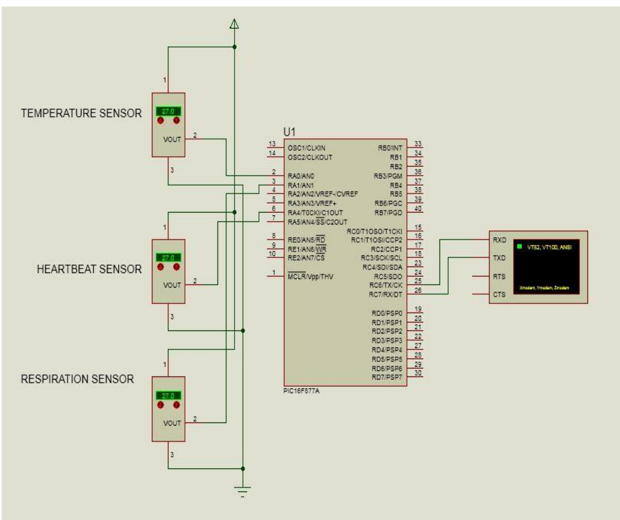

Fig 3.7 Connection Pin diagram

IV. SOFTWARE DESCRIPTION

A) Embedded C software

Any programming language can be used for writing program in PIC controller.Here embedded C programming is used to program in pic microcontroller. Embedded systems programming is different from developing applications on a desktop computers.

Embedded C is a set of language extensions for the C Programming the C standards committee to address commonality issues that exist between C extensions for different embedded systems[7]. Historically, embedded C programming requires nonstandard extensions to the C language in order to support exotic features such as fixed point arithmetic, multiple distinct memory banks and basic input output operations. Key characteristics of an embedded system, when compared to PCs, are as follows:

Embedded devices have resource constraints(limited ROM, limited RAM, limited stack space, less processing power)

Components used in embedded system and PCs are different; embedded systems typically uses smaller, less power consuming components.

Embedded systems are more tied to the hardware.

Two salient features of Embedded Programming are code speed and code size. Code speed is governed by the processing power, timing constraints, whereas code size is governed by available program memory and use of programming language. Goal of embedded system programming is to get maximum features in minimum space and minimum time. Embedded systems are programmed using different type of languages:

Machine Code

Low level language, i.e., assembly

High level language like C, C++, Java, Ada, etc.

B) MPLAB IDE

Microchip has a large suite of software and hardware development tools integrated within one software package called MPLAB Integrated Development Environment (IDE). MPLAB IDE is a free, integrated toolset for the development of embedded applications on Microchip's PIC and dsPIC microcontrollers. It is called an Integrated Development Environment, or IDE, because it provides a single integrated environment to develop code for embedded microcontrollers.

MPLAB IDE runs as a 32-bit application on MS Windows, is easy to use and includes a host of free software components for fast application development and super-charged debugging. MPLAB IDE also serves as a single, unified graphical user interface for additional Microchip and third party software and hardware development tools. Moving between tools is a snap, and upgrading from the free software simulator to hardware debug and programming tools is done in a flash because MPLAB IDE has the same user interface for all tools.

Load the Code to PIC Controller

The code loading process of microcontroller is called dumping. The microcontrollers understand only the machine level language, which contains '0 or 1s'. So we need to load the hex code into the microcontroller. There are many software's available in the market for loading the code to the microcontroller. Here we have used 'PICFLSH' programmer software to dump the code to the PIC microcontroller. The programmer kit comes with the hardware kit along with the software. This software needs to be installed into the computer. The microcontroller

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International Journal of Engineering Research in Computer Science and Engineering (IJERCSE)

Vol 6, Issue 7, July 2019

placed in the hardware kit, which comes with the socket shown in Fig 4.2. Here are the steps to load the code onto the microcontroller.

Interface the hardware (programmer kit) to the computer through a serial cable

Place the microcontroller in the socket of the hardware kit. Press the lock button to ensure the microcontroller is connected to the board.

Open the software installed in the computer. This shows the menu bar with file, functions, open, save and setting options.

Select the 'open' option from the drop-down menu and select the 'load file'.

Click on the 'load' button so that the hex file is loaded into the microcontroller.

Fig 4.2 Loading Program to PIC controller

V. PROGRAM CODE

```
#include <htc.h>
#include "lcd16.h"
#include <stdlib.h>
voidtxs(unsigned char val)
{
inti;
while(!TXIF)
continue;
TXREG=val;
for(i=0;i<1200;i++);
}
unsigned char rxs(void)
{
int c=0;
while(!RCIF)
{
c++;
if(c>5000)
break;
}
return RCREG;
}
voidsendtx(unsigned char val[],unsigned char length)
{
inti;
for(i=0;i<length;i++)
{
txs(val[i]);
}
}
void delay2()
{
longi;
for(i=0;i<10000;i++);
}
void Delay()
{
Long i;
for(i=0;i<5000;i++);
}
void Delay2()
{
longi;
for(i=0;i<100000;i++);
}
void delay3(unsigned int val)


inti;
for(i=0;i<val;i++);
}
void init_a2d(void)
{
ADCON0=0;       // select Fosc/2
ADCON1=2;       // select left justify result. A/D port configuration 0
ADON=1;         // turn on the A2D conversion module
}
unsigned char read_a2d(unsigned char channel)
{
channel&=0x07;  // truncate channel to 3 bits
ADCON0&=0xC5;           // clear current channel select
ADCON0|=(channel<<3); // apply the new channel select
Delay();
GO=1;   // initiate conversion on the selected channel
while(GO)continue;
return(ADRESH);         // return 8 MSB of the result
}
unsigned char val[6],flagx=0,val1,val2,val3,val4,val5;
int j=0;
int x;
int sp,sp1,spt;
```

```
unsigned int d=0,e=0,f=0,flgg=0;
unsigned int m=0;
unsigned char rval=1,rvalt=1,cc,oc;
intc,fg,fgg;
unsigned char hb,hbt,hbtt;
void main()
{
CMCON=0x07;
RCSTA=0x90;
TXSTA =(0x24);
SPBRG = 64;
ADCON1=0x02;
ADCON0=0x81;
CVRCON=0x00;
TRISD=0x00;
TRISE=0x00;
Lcdinit();
init_a2d();
TRISB=0x00;
TRISC=0xF0;
TRISD=0x00;
TRISE=0x00;
nRBPU=0;
RB0=0;
RB1=0;
RB2=0;
RB3=0;
RB4=0;
while(1)
{
val1=read_a2d(0)+15;
Lcdcmd(0x80);
lcddata('T');
lcddata('=');
lcddata((val1/100)+0x30);
lcddata(((val1%100)/10)+0x30);
lcddata((val1%10)+0x30);
val2=read_a2d(1);
Lcdcmd(0x88);
lcddata('R');
lcddata('=');
lcddata((val2/100)+0x30);
lcddata(((val2%100)/10)+0x30);
lcddata((val2%10)+0x30);
val3=read_a2d(2);;
Lcdcmd(0xC0);
lcddata('H');
lcddata('=');
lcddata((val4/100)+0x30);
lcddata(((val4%100)/10)+0x30);
lcddata((val4%10)+0x30);
lcddata(' ');
lcddata((hb/100)+0x30);
lcddata(((hb%100)/10)+0x30);
lcddata((hb%10)+0x30);
lcddata(' ');
lcddata((cc/100)+0x30);
lcddata(((cc%100)/10)+0x30);
lcddata((cc%10)+0x30);
hbt++;
if(val3<100)
{
if(oc==0)
{
hb++;
oc=1;
}
}
else
{
oc=0;
}
if(hbt==60)
{
val4=62+(hb%20);
hb=0;
hbt=0;
}
if(cc==50)
{
txs('*');
sendtx("Temp= ",6);
txs((val1/100)+0x30);
txs(((val1%100)/10)+0x30);
txs((val1%10)+0x30);
sendtx("   ",3);
txs('#');
}
if(cc==100)
{
txs('*');
sendtx("Res=  ",6);
txs((val2/100)+0x30);
txs(((val2%100)/10)+0x30);
txs((val2%10)+0x30);
sendtx("   ",3);
txs('#');
}
if(cc==150)
{
cc=0;
txs('*');
```

```
sendtx("HB=   ",6);
txs((val4/100)+0x30);
txs(((val4%100)/10)+0x30);
txs((val4%10)+0x30);
sendtx("   ",3);
txs('#');
}
if(Val1>45)
{
txs('*');
sendtx("Alert",6);
txs('#');
}
if(Val2>100)
{
txs('*');
sendtx("Alert",6);
txs('#');
}
if(Val4>90)
{
txs('*');
sendtx("Alert",6);
txs('#');
}
cc++;
}
}
```

VI FLOWCHART

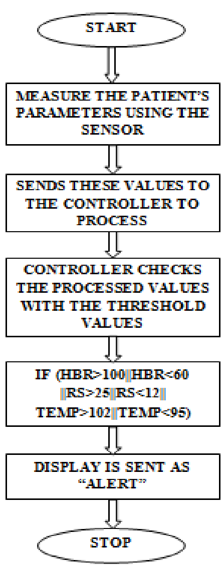

Fig 6.0 Flowchart

The detailed description of the flowchart shown in Fig 6.0 is given below.

STEP 1: The Parameters such as Heart rate, Respiratory rate and Temperature of the patient's are monitored using the biomedical sensors.

STEP 2: These measured values are sent to the PIC microcontroller for processing.

STEP 3: Controller checks these processed values with the given threshold Values.

STEP 4: If the heart rate goes above 100 bpm or below 60 bpm or the respiratory rate goes above 25 breathes per min or below 12 breathes per min or the temperature goes above 102 F or below 95 F, then the alert signal is sent to the doctor.

STEP 5: The display is given as "ALERT".

VII RESULT

In this project the doctor's assistive system is developed. It will be helpful for the doctor's to monitor the patient's vital parameters continuously. If this parameter goes above the threshold values, the alert message is send to the doctor through Zigbee communication to the AR glass. Here, a prototype shown in Fig 7.0 is only developed so the message is displayed only as "ALERT" given in Table 7.0 but when we go for real time the message along with the values of the abnormal parameters are displayed.

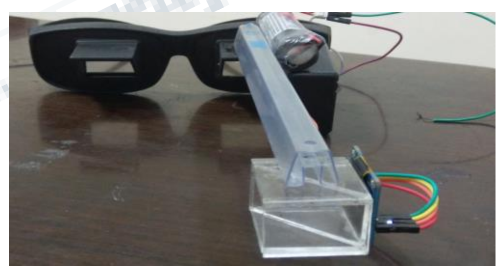

Fig 7.0 AR glass prototype

TABLE 7.0 RESULT

CONDITION	RESULT
HBR>100,HBR<60	ALERT
RS<12,RS>25	ALERT
TEMP>102,TEMP<95	ALERT

International Journal of Engineering Research in Computer Science and Engineering (IJERCSE)
Vol 6, Issue 7, July 2019

Advantages

- Low power consumption.
- Provide more efficiency.
- It reduces mistakes and move ahead to multitask.

VIII CONCLUSION

AR's potential ability to concurrently display imaging data and other patient information could save lives and decrease medical errors. The AR glass provides necessary parameter details to the surgeon in digital manner. It reduces the risk of invasive surgery, which can be avoided by keeping the most important information in front of the surgeon. It significantly improves the quality of treatment. The AR glass is used to clearly demonstrate and visualize the abnormality. AR innovations can help enhance doctors and surgeons ability to diagnose, treat, and perform surgery on their patients more accurately by giving them access to real-time data and patient information faster, and more precisely than ever before.

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