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Design and Implementation of Aid System for Physically Impaired People.

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ABSTRACT

Touch sense based aid system for physical impaired people is targeted at people who are restricted to move from congested place and people who are dumb. Here the system is built which will enable to control the lighting or other electrical devices in the room and to monitor the pulse rate of a patient. The projected aid system is touch sense technology used as an aid for bodily impaired people. When a finger is tapped on a surface the motion of a finger is detected and same is used as a trigger signal to turn an electrical device switch ON or switch OFF. The need for touch sense is that it requires only slight touch to activate and no pressure is required. In this system IR sensor is used for measuring the heartbeat of a patient. Heart beat level will be changed automatically announced low heart beat or abnormal heart beat. The advantage of using IR sensor is that low cost circuitry, low power requirements and high immunity. The entire transmission and reception process is done in a 2.45GHZ Zigbee protocol.

Keywords: Physically Impaired people**,** Heart beat monitoring, Touch sense module, IR sensor, Zigbee protocol, Voice processor (APR9600)

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INTRODUCTION

Previously, alarm system was used as an aid for bodily impaired people. This system uses piezoceramic sensor for measuring the pulse rate. The device which is set at the foot gives band pass filtered signal around 10millivolts for which the signal to noise ratio is 40dB. This output signal from the piezoceramic includes the low frequency component. Therefore care must be taken in the design of piezoceramic sensing circuitry. Filtering, averaging and differential sensing must be done to reduce band specific noise, random noise on periodic signal and common mode noise. The drawbacks of this system includes the time delay in getting the actual need from the person the one who looks after the patient and also requires pressure to actuate an alarm.

The touch sense technology targets the people who are restricted to move from the congested place. For example people who are partially impaired or cannot walk and also who are unable to speak. In this aid system is built which will enable them to control the most frequently required things which could be devices like the lighting in the room or other electrical devices and also a voice processor is used in which programmed voice response can be stored. The responses from the fingers of the person can be used to play any of these preprogrammed voice response. And also those people without finger can use touch sense. Thus a dumb person can also produce voice response using this system. When a finger is tapped on a surface the motion of the finger is detected and same is used as trigger signal to turn an electrical device switched ON or switched OFF. A microcontroller unit and a drive circuit are used for controlling the devices.

Experimental Implementation of Aid System [1-6]

In projected aid system, touch sense technology is used as an aid. The need of touch sensor is that it requires only a slight touch to activate and no pressure is necessary. So this can be used by the most handicapped people who does not have finger. IR sensor is used for measuring the pulse rate. The implementation of Aid system can be briefly classified into two modules 1. Patient aid and Pulse rate Transmitting module and 2. Receiver module of Patient aid system

Patient Aid and Pulse Rate Transmitting Module

This transmitting module explains how the signals are transmitted from the system built for aid as well as the pulse rate monitoring device to the receiving module. The receiving module is kept at some other room like the living room where the person who takes care of the patient most often stays. This is in case when this aid system is being used at home. When this system is used in hospitals to provide complete aid to the patient, the transmitting module is kept near by the patient whereas the receiving module can be installed anywhere in the range of 100 meters from patient side (since 2.45 GHz Zigbee wireless communication is used) so as to monitor by the nurse or doctor. The block diagram representation of the transmitting section is shown in Figure1. When the finger is placed over the touch pad, the touch sense is detected and sent to the micro-controller through UART (meant for serial communication).

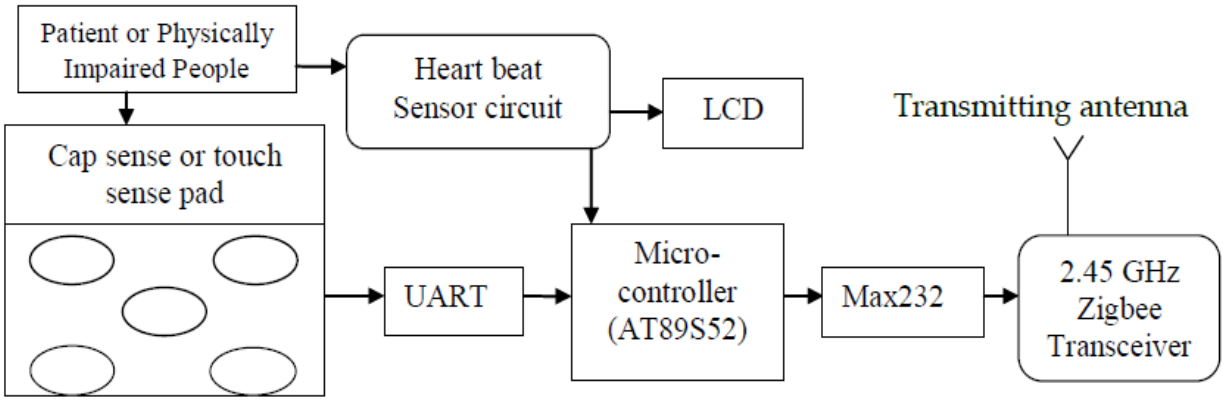
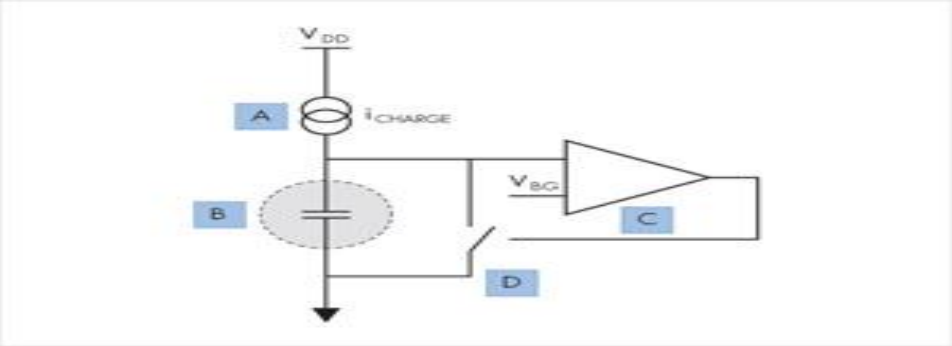


Figure 1: Transmitting Module of Patient Aid System

A program to this effect is written using embedded C and it is stored inside the ATMEL 89S52 micro-controller. For example, when the finger is placed on the key for "emergency", the signal is passed through controller to the receiver by means of wireless communication (Zigbee protocol). The controller makes sure that a voice message "emergency" is delivered by a speaker from the receiver module. This is similar in case of pulse rate monitoring. The pulse rate is continuously sensed by the IR sensor and its output is sent to micro-controller. If the rate being monitored deviates from the normal rate, a voice alarm "Abnormal pulse rate" is raised by the receiver module and that message is displayed on the LCD kept at the transmitting section.

Touch Sense Module

The Touch sense module is used as an aid for the patient. This module makes use of the cap sense technology. One of the most unique features available in PSOC is capacitive sensing. PSOC supports relaxation oscillator is shown in figure 2.



A - Current source; B - Sensor capacitor; C – Comparator; D - Discharge switch

Figure 2: PSOC supports relaxation oscillator

The sensor capacitor is charged by the current source. When the voltage across the capacitor reaches the threshold, the comparator is tripped. The discharge switch closes and so the sensor capacitor starts to discharge. This creates a saw tooth waveform across the capacitor. This saw tooth waveform is used to clock a pulse-width modulator which in turn enables a 16 bit timer. This creates a relaxation oscillator capacitive sensing circuit as shown figure 3. As the finger approaches the sensor, the capacitance of the sensor increases. A large capacitor takes more time to charge given a constant current. Since the pulse-width modulator is clocked by this signal and enables the timer, a longer charge time on the sensor capacitor yields a longer high-time on the pulse-width modulator and large value from the 16-bit timer. If the difference in counts from one scan to next exceeds a pre-determined threshold, the presence of conductive object is detected. Conductive object here is finger. This detected signal is sent to the micro-controller through UART. Why UART is used here is that it takes bytes of data and transmits the individual bits in a sequential fashion and hence there will not be loss of data. Also when it is compared to parallel communication many wires are not required here.

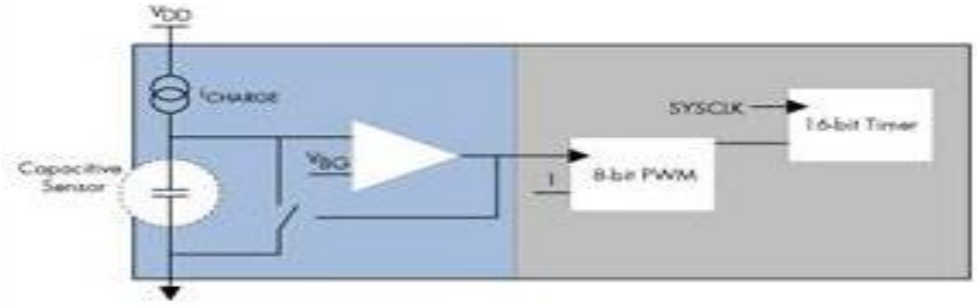


Figure 3: Capacitive Sensing Circuit

An added advantage of using UART is that the chip has a built-in buffer of anywhere from 16 to 64 Kbytes. This buffer permits the chip to store data (here touch sense signal) coming in from the system bus while it is processing data going out to the serial port (here to the micro-controller). The micro-controller will

have a pre-programmed set of coding. These coding are in embedded C language. As the controller receives data from UART it starts checking which condition satisfies. After a particular condition satisfies, its corresponding output is given as a signal to the next section i.e. the Zigbee protocol (wireless communication). For example if the patient touches the key for switching ON/OFF the fan the cap sense produces a signal. This signal is accepted in bytes fashion by UART and transmits in bit fashion to micro-controller. The controller does execution work and corresponding function to be carried out is transmitted to the receiver module by Zigbee communication protocol. Zigbee protocol allows transferring data upto 100 meters while it consumes less power. It is highly reliable, low cost and provides security at the network layer.

Heart Beat Monitoring Module

Heart beat rate is monitored continually with the help of IR sensor. The IR sensor consists of emitter and a detector which is wrapped around the finger. The heart beat is a pulsating one. So when the heart beats, the amount of oxygenation in the finger will cause the IR light to reflect off the skin and to the photo diode close by. This will produce a voltage difference across the lead of this photo diode and this voltage is used to switch a photo transistor so as to find the number of times oxygenation takes place (pulse rate).The circuit diagram of IR sensor is module in figure 4.

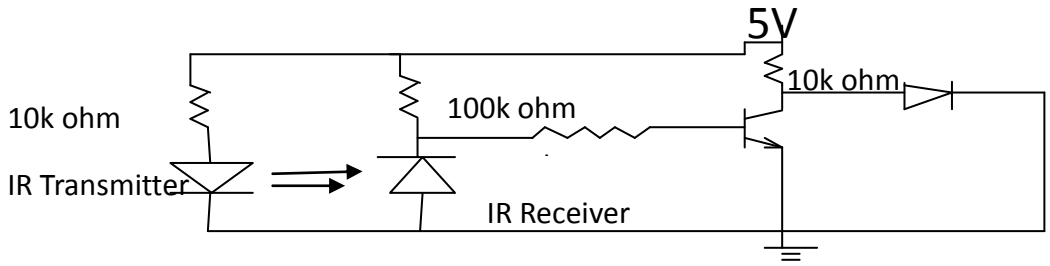


Figure 4: Heart Beat Monitoring IR Sensor module

The normal heart beat rate is 72beats/minute. So it is necessary that the monitoring has to be carried out for every minute. For this purpose the system has to pre-program with micro-controller as follows. Micro-controller has two 16 bit timers/counters. One of these is made as counter for counting the number of heart beats and another is made as timer for counting the heart beat for every minute (60sec). The hexadecimal value has to be assigned in micro-controller to do the counting and running timer operations. This value can be found as follows:

Heart Beat Rate Calculation

1 machine cycle = 12 clock pulses
For 1 pulse = 11.0592 MHz / 12 = 0.9216 MHz
Time period = $1/f = 1/ (0.9216*10^6) = 1.085$ µs

For 1 instruction T = 1.085 µs
For 16 bit = 2^{16} = 65536
T for 16 bit (0000 to FFFF) = 65536 * 1.085 = 71106.56 µs = 71.106 ms
1 minute = 60s = 60*1s
1 s = 20*50ms

Therefore consider 50ms

0 ms ⟶ 0000
71.106ms ⟶ FFFF
For 50ms ⟶ = 50ms/1.085 µs = 46083

Should always use the series from last

So 50ms = 65536 – 46083 = 19453 = 4BFD H
Thus 1 minute = 60*20*50ms = 1200*50ms

4BFD is used by multiplying it for 1200 times to get 1 minute.

4B is assigned to high bit timer register and FD to low bit timer register.

The normal heart beat rate is stored in an address. The heart beat which is sensed using IR sensor and stored in counter register is compared with the normal rate. When the deviation occurs i.e. the sensed rate becomes abnormal, an alarm is raised to the receiver end. There may be chances where the heart beat rate becomes abnormal when the person who takes care is near the patient. In such cases he/she may not come to know that emergency situation has arisen. So this can be solved by identifying the abnormality in the heart beat rate through the LCD fitted at the transmitting end (near the patient).

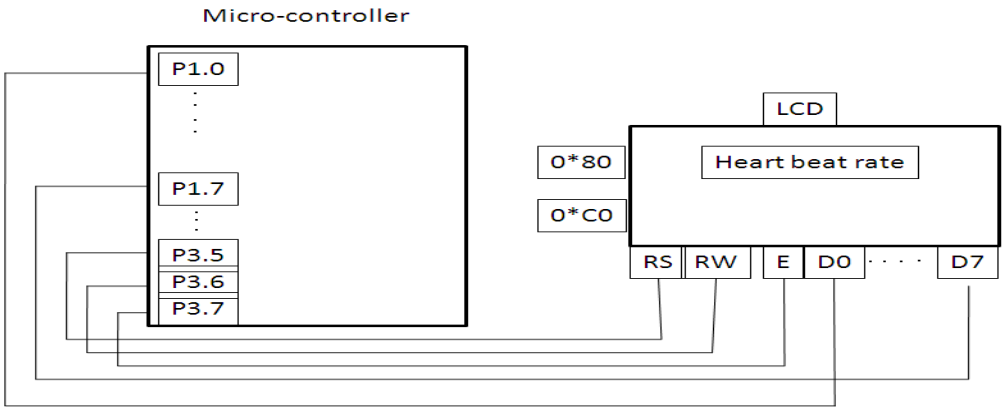


Figure 5: Interface circuitry for Heart beat rate display on LCD with Microcontroller

Interface circuitry for Heart beat rate display on LCD with Microcontroller is shown in figure 5. The port 1 of micro-controller containing 8 bits from P1.0 to P1.7 has been assigned to data bit addresses of LCD (D0 to D7). Port 3 which acts as a special function register has been to assigned to LCD in such a manner that RS=P3.5, RW=P3.6, E=P3.7. In LCD 0*80 denotes starting address, 0*C0 denotes 2nd line and 0*01 will clear the display contents.

Receiver Module of Patient Aid System

The receiver module discusses how the signals are received from the transmitting module so as to fulfill the requirements of the patient. There are two different actions that can be performed in this aid system. One is to raise a voice alarm with the help of a voice processor and other is to switch an electrical device to ON state or OFF state using a relay driver. The receiver module can be placed at a distance of about 100 meters away from the transmitter module since that range can be covered by the Zigbee wireless communication protocol used here. Hence this aid system is well suited for home application as well as for hospital use. Block diagram of sequence of operation receiver module is shown in Figure 6.

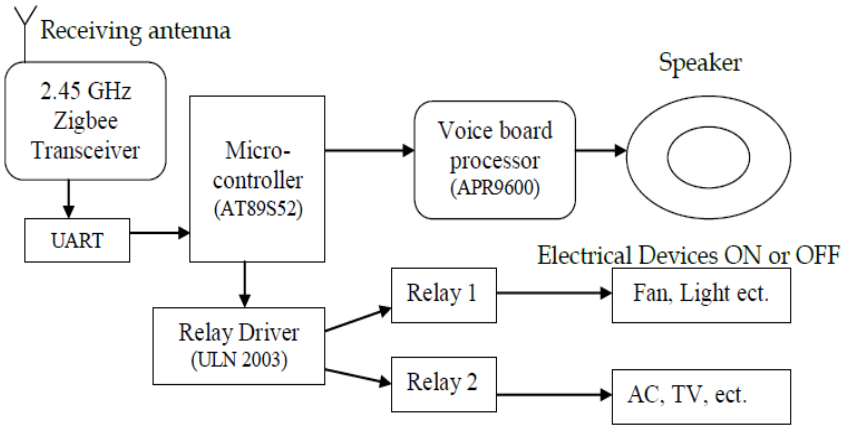


Figure 6: Sequence of operation of Receiving Module

The signal from the transmitting module is received at this end through receiving antenna of Zigbee transceiver. From the transceiver signal is given to the UART for further communication in a bit wise fashion to the micro-controller and relay driver. Depending upon the condition satisfied in the micro-controller programming at the time of transmission, their corresponding function is triggered over here.

Aid through Voice Processor

The touch pad used here consists of around 5 keys. Each one can be used for different purposes as how the pre-programming is done. For example if there is a key assigned for "water", then when this key is touched, a signal is received from the transmitting section by Zigbee transceiver. This is followed by UART which is then fed to the micro-controller. The micro-controller identifies the function to be carried out and hence gives the triggering signal to the voice processor APR9600 in order to deliver the voice message "water needed" through a speaker. The voice processor APR9600 IC can store a maximum of 8 voice messages. The processor gives a playback time of 40 seconds to 60 seconds. This aid system needs totally 4 voices – a voice for delivering "water required", for "food required", for "emergency/call doctor" and the last is to give out "abnormal heart beat rate". It is to be ensured that the voice processor IC is configured so as to record different voice messages and store them in different addresses which denote a particular pin. This allows referring voices for each function while programming is done in the micro-controller.

Aid through Relay

Out of the five keys used in this system, 3 keys are meant for functions like to leave a voice message "water required", "food required", "emergency/call doctor" respectively. The rest 2 keys are used to control the electrical devices like fan, lighting, TV, AC, room heater, etc. This control action is possible with the help of a relay and relay driver. A relay is an electrically operated switch which can supply voltage range from 5V to 24V. As the touch key for corresponding switching action is touched, the signal is received from transmitter block and stored in micro-controller for further action. It verifies the conditions and actuates relay for that particular switching action to take place. It is to be noted that relay a driver ULN 2003 is used to prevent back Emf. The need to prevent back Emf is that the micro-controller can tolerate a maximum value of 5V. So it is necessary to avoid the back flow of the voltage which was used to switch an electrical device through relay.

For example if the key for fan control is touched, the receiver modules gets a signal from the transmitter through the receiving antenna of Zigbee transceiver. This signal is sent to micro-controller. The controller executes the program to take necessary action that satisfies the condition. So the relay which is connected with the fan gets enabled and hence the fan can be put from ON state to OFF state or vice versa.

Future Advancements

The aid system can be used in home as well as in hospitals. But the home application should ensure that a family member is present at home all the time to look after the person. So this member will not be able to go out for emergency purposes as they may not know the status of the person's health condition. An advancement that can be made is the use of GSM technology. If the heart beat rate deviates from the preset value or in the case of emergency, a message can be transmitted to a pre-defined phone number in the form of SMS using a GSM module. Also by using a 3G mobile phone, the message can be visualize or monitor the person's health condition on the phone's screen. Hence this system allows the doctor to monitor the patient from outside of the hospital.

Zigbee wireless communication can be replaced by RF communication so as to transmit the signal to a wider range. If this is done, then a central monitoring system can be located anywhere within the hospital.

CONCLUSION

This system is done with the intention to provide a helping hand for the physically impaired people. To achieve this study of the existing system was carried and hence the difficulties with it were found out. An improved system was made practically possible. The technology implemented allows this aid system to be used even by people who do not have finger or by a dumb person. Further, it eliminates the time delay in getting their need. The heart beat rate monitoring process has been done in such a manner that the

abnormality occurrence can be known even at the time of sleep by raising a voice alarm. Also those future advancements have been suggested to utilize the technology in a useful and effective manner.

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