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Testing and Development of Bluetooth Based Cardiac Pacemaker Device with an RTOS Implementation

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Abstract

The aim of the project is to style a failure safe rate responsive pacemaker device that would be monitored and designed by a doctor employing a secured wireless communication. The convenience code depends on upon a tough consistent RTOS (Real-Time operative System) and hereafter the device helpfulness is secured and is predicted to limit dissatisfactions see able of programming breakdowns. A created vessel pacemaker may be a restorative device that usages electrical inspirations, passed on by cathodes obtaining the centre muscles, to regulate the throbbing of the center. The basic a part of a pacemaker is to stay pulse, either in light-weight of the actual fact that the heart's traditional pacemaker isn't adequately quick, or there's a bit within the heart's conduction structure. Exhibit day pacemaker's square measure remotely programmable and empower the heart specialist to choose the right pacing modes for individual patients. A number of them have completely different anodes strengthening unsteady positions within the center to boost synchronization of the lower chambers (ventricles) of the center.

Keywords — Electrocardiogram, Pacemaker, Pulse Rate, DSO and RTOS.

I. INTRODUCTION

Innovation has progressed improbably and there measure over an enormous range of transistors in today's implantable pacemaker system. A vessel pacemaker is used to treat brad cardiopathy (a pulse that's too moderate). During this paper, instead of utilizing a couple of straightforward ICs to observe the centre rate and convey electrical incitement, an awfully coordinated mingling flag interface single-chip-arrangement IC [1] is exhibited. The required purpose for pacemaker ICs has been alert on low-control computerised define systems [3], [2]. Victimisation some low-control set up systems and large live of straightforward and computerised hardware has been coordinated to administer new parts and capacities to future pacemakers. Low power utilization [4-5] is by an extended shot the foremost essential define requirement to fulfil the 10–12 years of single battery operation. Every nano ampere of current utilization has been exactly thought-about during this define.

II. WORKING PRINCIPLE

The necessary components and functionalities of the pacemaker structure can screen the electrical movements of the centre through the vessel customary electrocardiogram of the patient.

The device has electrodes to sense the electrocardiogram signal Associate in an ADC (Analog to Digital Converter) to convert the analog signal into the digital domain.

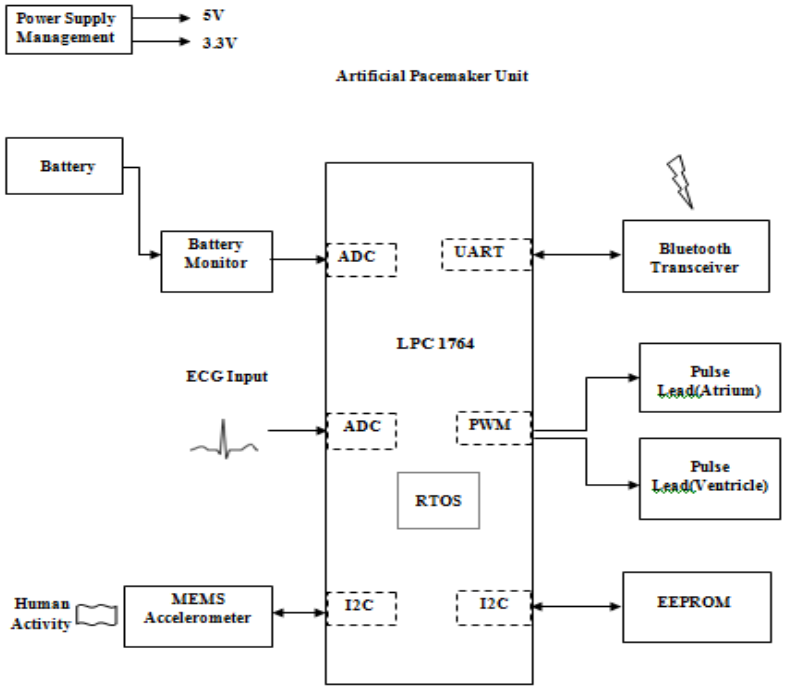

Figure 1: electronic device Unit

The yield may be a heartbeat with settled abundance and term. The device makes the chamber beat initial and it's trailed by the ventricle beat. The beat yield is brought out through the terminals Associate in often watched utilizing an oscilloscope/DSO. The device can communicate with external world through a correspondence channel. Bluetooth is used because the remote medium. The device standing and basic parameters are often examined and formed over this channel. A special reprogramming unit is made for this purpose. The reprogramming unit facilitates the doctor-pacemaker communication. The unit can communicate with PC/Laptop via USB [6]. To keep up a strategic distance from remote strikes and hacking of the convenience, Associate in exceptional crypto logical estimation (RC4 Stream Cipher) is employed to scramble and unscramble within the interior of any knowledge trade. The key for this calculation is gotten randomly from the electrocardiogram [7] data and so exceptionally secured. Figure 1 and 2 represents the electronic device unit and Monitoring Unit.

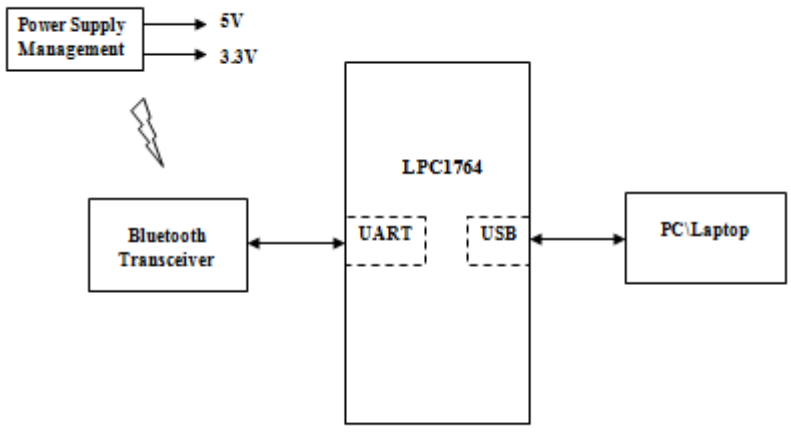

Figure 2: Monitoring Unit

Screens the standing of the battery employing a voltage screen circuit and reports it by ways for Bluetooth. Stores the patient careful data on a non-eccentric EEPROM chip integral into the device. Within the interior of show, the transcription of vessel banner should be varied to mirror heart calm. This is often sent by victimisation Associate in electrocardiogram generator unit. It's a Graphics alphanumeric display and Push Buttons as its UI. Associate in electrocardiogram wave shape is yield by ways for the DAC (Digital to Analog Converter) [8] outer boundary. The yield of this unit are often unbroken an eye fixed on Associate in scope. ARM Cortex-M3 based mostly LPC176x microcontroller is employed because the central microcontroller for this wanders for every one among the 3 units of the system. The applying code is formed victimisation Free RTOS that is that the progressing RTOS used as a bit of this device that confirmation its convenience beneath all conditions, therefore creating the convenience defend.

III. RESULTS AND DISCUSSIONS

The convenience are going to be rate responsive pacemaker type which will amendment its pacing rate as shown by the physical activities of a patient. The physical activity level of the patient is known employing a one among a sort development sensing element known as Tri-center MEMS measuring instrument. The device are going to be a complicated twofold chamber pacemaker type which will pace each chamber and ventricle and from this point forward works sort of a traditional heart.

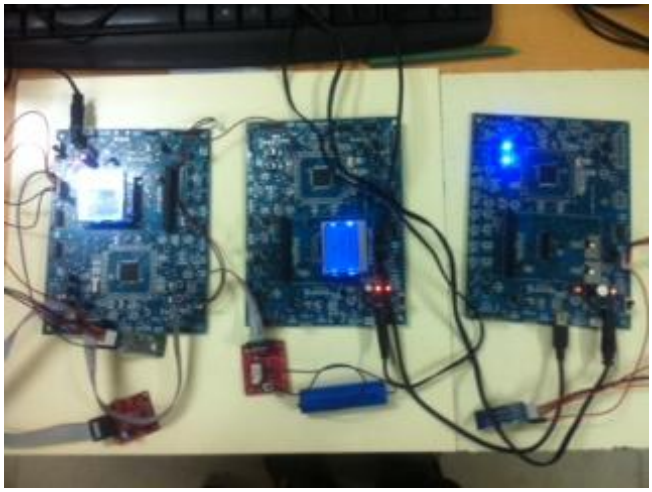

Figure 3: Hardware Implementation

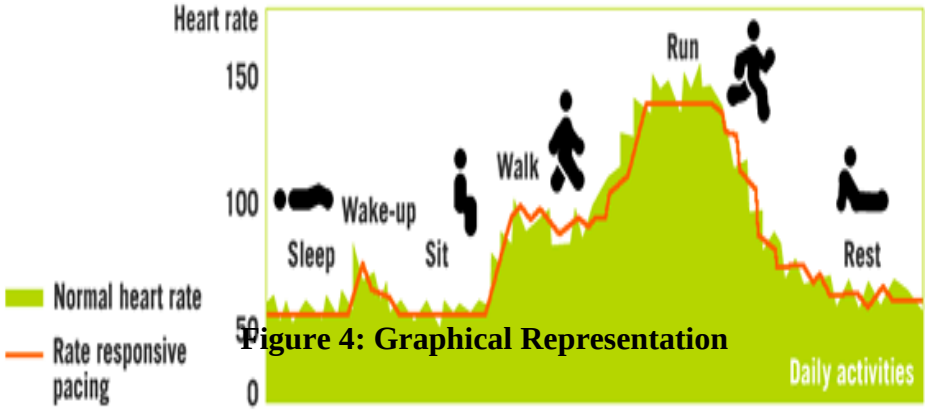

Figure 4: Graphical Representation

Project Demonstration Procedure

Figure 3 and 4 represents the hardware and graphical implementation.

1) Connect the one end of the USB cable in the LPC 1764 J40 connector and the other end of the USB cable in the USB port of the CPU

2) Connect 2 GLCD one in LPC1764 board(Pacemaker Unit) and another in LPC1766 board (ECG Generation unit)
3) For this project, no need to pair the Bluetooth. If you use any paired Bluetooth, it will not work in the project DEMO
4) You have to use two new Bluetooth HC05 for this project
5) Connect power adapter in LPC1764(Control Unit) and LPC1764(Pacemaker Unit)
6) Switch ON the power supply of the LPC1764 board(Pacemaker Unit) first
7) Switch ON the power supply of the LPC1764 board(Control Unit) first
8) After switching ON the both boards the Bluetooth will toggle faster and after the fraction of seconds, it will synchronize and toggle equally at a particular DELAY
9) The GLCD in the Pacemaker unit will display words like Mode, Rate and ECG generation unit will display like ECG generator, Pulse
10) After switching ON the both boards, Open FLASH MAGIC→Tools→Terminal
11) A window will appear and configure the below settings which is listed in the table

COM port	COM port is what you have noted after the installation of the LPC17xx USB DRIVER (Check the installation Procedure of the LPC17xx USB DRIVER)
Baud Rate	115200
New Lines	CR

12) A window will open, it consists of Input and Output window
13) In the Output window the Microcontroller will generate the Command List like Pacing Chamber, Pacing Rate and etc.,
14) Switch ON the DSO and Set the configuration (Amplitude = 1.00V and Time Period -=1.00s)
15) PROBE one end should be connected in CH1
16) The other end of the probe consists of Clip and a Pin
17) The clip of the PROBE should be connected with the GND of the LPC1764 board(Pacemaker Unit)
18) Type Pacing Chamber = 1 in the input window and then press ENTER, the output window will display OK
    a. Connect the PIN end of the probe in the P1.18 and notice the DSO monitor
    b. The pacemaker unit will generate the square waves
19) Type Pacing Chamber = 2 in the input window and then press ENTER, the output window will display OK
    a. Connect the PIN end of the probe in the P1.18 and notice the DSO monitor
    b. The pacemaker unit will generate the square waves
    c. Connect the PIN end of the probe in the P1.25 and notice the DSO monitor
    d. The pacemaker unit will generate the square waves
20) Type Pacing Mode = 0 in the input window and then press ENTER, the output window will display OK
    a. Connect the PIN end of the probe in the P1.18 and notice the DSO monitor
    b. The pacemaker unit will generate the square waves
    c. Increase the pulse in the ECG Generator unit by using SW1 as well as decrease the pulse in the ECG Generator unit by using SW2
    d. Notice the DSO monitor, there will not be any changes in the Time period of the waves
    e. It is called Non-Triggered Mode
21) Type Pacing Mode = 1 in the input window and then press ENTER, the output window will display OK

a. Connect the PIN end of the probe in the P1.18 and notice the DSO monitor
b. The pacemaker unit will generate the square waves
c. Increase the pulse in the ECG Generator unit by using SW1 as well as decrease the pulse in the ECG Generator unit by using SW2
d. Notice the DSO monitor, there will be a change in the Time period of the waves
e. It is called Triggered Mode

22) Type Pacing Rate = 0 in the input window and then press ENTER, the output window will display OK
    a. See GLCD in the Pacemaker unit, it will show Rest
    b. Connect the PIN end of the probe in the P1.18 and notice the DSO monitor
    c. The pacemaker unit will generate the square waves
    d. Click Measure, now see the right side bottom of the DSO
    e. It consists of Period and Frequency
    f. If you shake the MEMSACCELEROMETER, there will not be any changes in the waves and as well as period and the frequency
23) Type Pacing Rate = 1 in the input window and then press ENTER, the output window will display OK
    a. Connect the PIN end of the probe in the P1.18 and notice the DSO monitor
    b. The pacemaker unit will generate the square waves
    c. Click Measure, now see the right side bottom of the DSO
    d. It consists of Period and Frequency
    e. If you shake the MEMSACCELEROMETER, there will be a changes in the waves and as well as period and the frequency
    f. See GLCD in the Pacemaker unit, it will show Active
24) Type Device Status in the input window and then press ENTER, the output window will display OK
    a. The output window will show the Position of the Device Name Pacing Chamber, Pacing Rate and Pacing Mode
25) Type Battery Status in the input window and then press ENTER, the output window will display OK
    a. Lithium ion battery used as a power source during the “battery monitor status”
    b. The output window will show the energy stored in the lithium ion battery

Advantages:

- Software written under RTOS guarantees the operation of the device under all conditions and makes the patient life safer.
- Cryptographic security for wireless communication between doctor and pacemaker.
- Crypto key is picked from ECG data thus improving the randomness of the algorithm
- Adapts the pulsing according to the patient physical activity.
- Advanced dual chamber pulsing similar to the operation of a normal heart
- Intelligent battery monitoring circuit predicts end of device much earlier.
- ECG Generator unit to vary the timing of the cardiac signal according to the user request.
- A full speed USB interface to connect the Reprogramming unit with PC/Laptop.
- Low power is an important device characteristic. Thus software is written with extreme low power in mind to be able to run the device from battery for years.
- 32-bit ARM Cortex-M3 microcontroller enables high performance using very less power.

IV. CONCLUSION

Low power consumption is out and away the foremost necessary style demand for medicine implants. Each nanoampere of current consumption should be fastidiously thought-about and utilized in the IC. During this paper, an very low-power single-chip mixed-signal interface IC for pacemaker applications is bestowed. Most of the analog transistors square measure operative within the deep sub threshold region and switched-capacitor ways square measure typically accustomed construct new circuits at terribly low power utilization. Some new practicality has been introduced and also the complete device has Associate in calculable longevity of 5–10 years.

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