# An Application of Embedded System in Telemedicine Using Arm-7

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**Abstract-The people in India, particularly in rural and remote areas, are found struggling to receive timely medical treatment. The region of the country is characterized by densely populated communities spread over vast distances and there is a lack of expert physicians in certain sectors of the health service. Telemedicine originally emerged to serve rural populations or anyone who is geographically dispersed, where time and cost of travel make it difficult to receive the best medical care. Nowadays, telemedicine is forming a new structure in health-care services. By using information and communication technologies, the healthcare professionals in specialized fields, such as cardiology, urology, oncology, psychiatry, surgery and many others, can access or exchange information for diagnosis, treatment and prevention of disease. This new age concept also provides solutions for continuing education and research among health-care providers to improve the health of individuals and their communities. Thus, telemedicine facilitates the delivery of the right medical advice at the right place at the right time using new computer-based communication technologies for medical purposes.**
**This paper is based on ARM-7 processor which establishes an embedded telemedicine platform ground on LPC1768 and realizes some very popular embedded application technologies such as USB communication, embedded Internet communication, infrared communication, etc. Meanwhile the volume of the hardware is smaller; power consumption is lower; the functions are mightier and the expansibility is stronger. The whole running system is more stable and the program maintenance and update is more convenient. The telemedicine system based on this technology has been tested to be stable and efficient, and has obtained the results as expected.**

**Key Words– ARM-7 Processor, Telemedicine, ECG**

## I. INTRODUCTION

Telemedicine is the transfer of electronic medical data (i.e. high resolution images, sounds, sometimes video briefings, records of specific operations and patient records) from remote areas to centers where experts or well-equipped hospitals are available. Taking advantage of telecommunication, medical electronics and information technologies, telemedicine acts as a potential source to reduce health-care expense, improve health-care service in remote areas and support modern home health care and so on. Telemedicine can deliver health-care services to places where distance is the critical factor. Recent works in communication technologies have inspired the development of telemedicine to a large extent. There are many different disciplines in telemedicine, such as teleradiology, telepathology, telecardiology and so on. The common problem faced during the development of a telemedicine system is how to integrate the existing techniques to meet requirements for telemedicine applications.
The series of ARM7 processors are 32bit RISC processors with low power consumption, which suit to those products that are exigent to the price and power consumption. The characters of ARM7 are shown as below:

- The exceptionally low power consumption;
- Offer third grade pipeline architecture of 0.9MIPS/MHZ(fetching instruction, decoding and running);
- The maximum master frequency adds up to 130MIPS;
- The high coding density and supporting 16bit Thumb instruction set;
- Supporting OS that includes Windows CE, Linux, Palm OS and so on.

## II. The Introduction To ARM-7 Controllers LPC 1768

The LPC1769/68/67/66/65/64/63 are ARM Cortex-M3 based microcontrollers for embedded applications featuring a high level of integration and low power consumption. The ARM Cortex-M3 is a next generation core that offers system enhancements such as enhanced debug features and a higher level of support block integration. The LPC1768/67/66/65/64/63 operate at CPU frequencies of up to 100 MHz. The LPC1769 operates at CPU frequencies of up to 120 MHz. The ARM Cortex-M3 CPU incorporates a 3-stage pipeline and uses a Harvard architecture with separate local instruction and data buses as well as a third bus for peripherals. The ARM Cortex-M3 futures and benefits are

- ARM Cortex-M3 processor, running at frequencies of up to 100 MHz (LPC1768/67/66/65/64/63) or of up to 120 MHz (LPC1769). A Memory Protection Unit (MPU) supporting eight regions is included.
- ARM Cortex-M3 built-in Nested Vectored Interrupt Controller (NVIC).
- Up to 512 kB on-chip flash programming memory. Enhanced flash memory accelerator enables high-speed 120 MHz operation with zero wait states.
- In-System Programming (ISP) and In-Application Programming (IAP) via on-chip bootloader software.
- On-chip SRAM includes:
  - 32/16 kB of SRAM on the CPU with local code/data bus for high-performance CPU access.
  - Two/one 16 kB SRAM blocks with separate access paths for higher throughput. These SRAM blocks may be used for Ethernet, USB, and DMA memory, as well as for general purpose CPU instruction and data storage.
- Eight channel General Purpose DMA controller (GPDMA) on the AHB multilayer matrix that can be used with SSP, I2S-bus, UART, Analog-to-Digital and Digital-to-Analog converter peripherals, timer match signals, and for memory-to-memory transfers.
- Multilayer AHB matrix interconnect provides a separate bus for each AHB master. AHB masters include the CPU, General Purpose DMA controller, Ethernet MAC, and the USB interface. This interconnect provides communication with no arbitration delays.
- Split APB bus allows high throughput with few stalls between the CPU and DMA.

## III. Telemedicine System Hardware Design

The system adopts framework design thought of modularization, which divides the equipment into main module and other function modules. There is a uniform or special interface form between the main module and other modules. The user can select different function modules according to their own needs.

Different kinds of data can transmit synchronously but not interrupt each other. Meanwhile, some other functional modules can be expanded depending on the market demand, for example the photo electricity communication module, fetal heart rate monitoring etc. The design structure is convenient not only to use but also to update. The main control module is mainly up to human computer interaction, communication with functional modules, data storage, data transmission, etc. Through controlling the main functional module, the user may operate the functional module as well as other system functions and the data will be saved in the main control module. Then the main control module can send data to the server.

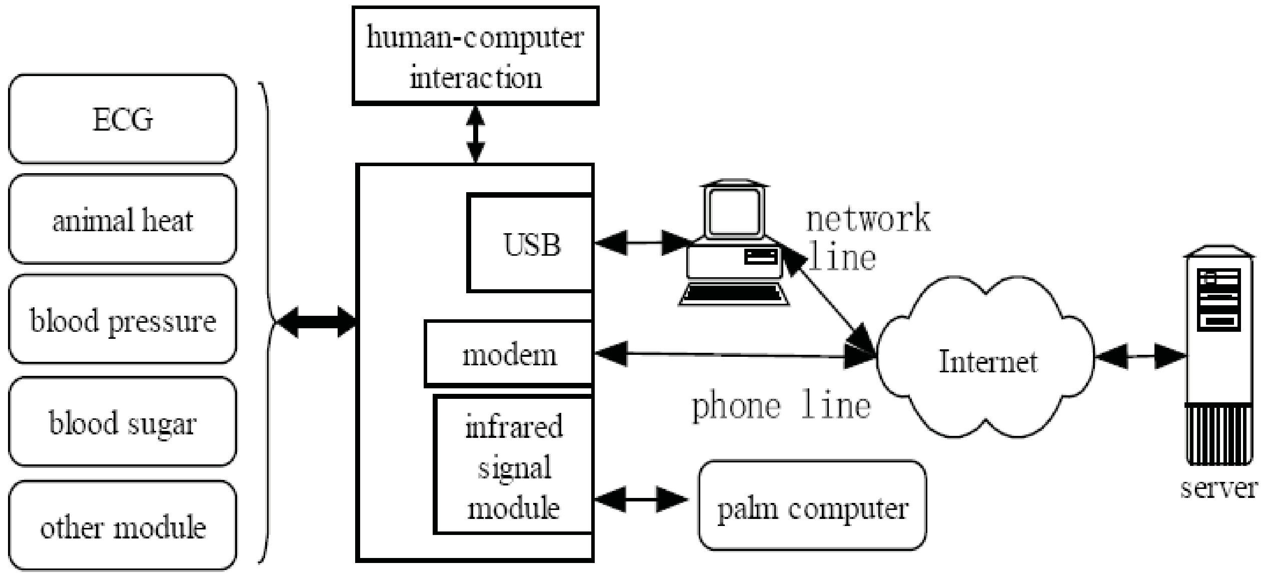


Figure 1. Embedded Data Acquisition system module

## IV. Circuit Operation

*4.1 Temperature Sensor–*

For temp measure we have used temperature sensor LM34 .This sensor increases 1 mill volt output per degree centigrade. Output of this sensor is directly connected to analog-to-digital converter (ADC) pin of ARM7 controller LPC1768 will do the job.

*4.2 Heart bit sensor–*

Less well known, but very usable is method to measure heart beat is the optical measurement. The translucence of human tissue changes with each heart beat when the heart pumps blood through the arteries, the tissue becomes less translucent. (Shine a torch at one of your fingertips and look at the tip from the opposite site from the torch). This phenomenon is not, or hardly, noticeable with the naked eye but can easily be made so by electronic means. The light source in the present meter is an infra-red (IR) LED, while the detector consists of an infrared sensitive phototransistor. These two devices may form a hybrid light barrier (when they are in parallel with one another). Figure 5 shows explains it.

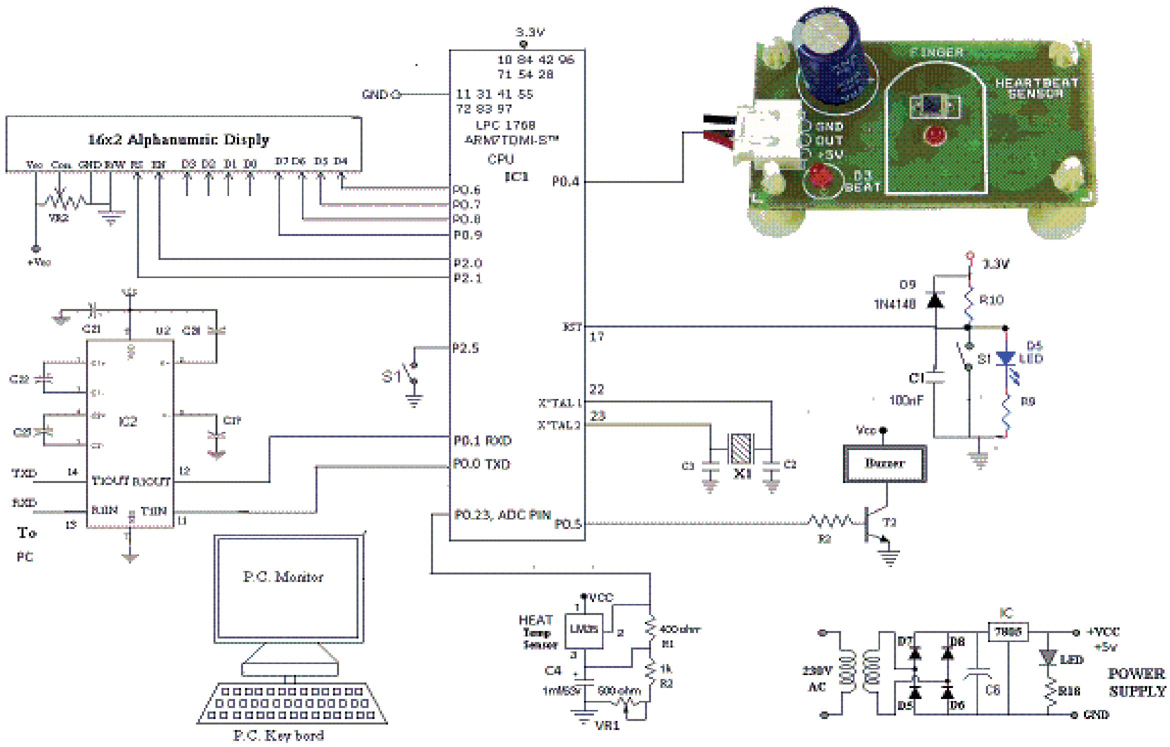


Figure 2. Circuit diagram of system

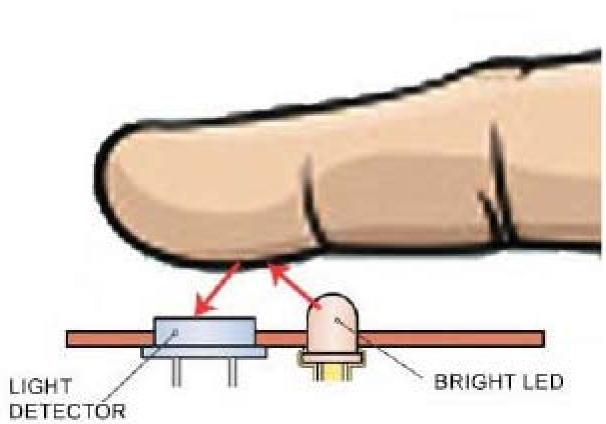


Figure 3. Heat beat indication by LED

*4.3 Temperature sensor–*

To measure human body temperature, we use LM34 temperature sensor. This sensor is precious integrated circuit temperature sensor whose output voltage is linearly proportional to Celsius. The LM35 requires no external calibration since it is inherently calibrated it output 10mv for each degree of centigrade.

*4.4 Serial Port Communication on PC–*

- Max 232-

This is the level shifting phase to interface ARM7 controller with the pc. since the Rs-232 is not compatible with ARM7 we need a line driver to convert the Rs-232's signals to TTL voltage levels that will be acceptable to ARM7 ICs TXD and RXD. As the logic for pc is +12 to -12 volts the MAX 232 converts this voltage level to +5 to

0 volts which is acceptable by ARM7 controller IC LPC1768 and vice versa. There are two sets of line drivers for transmitting and receiving data the line drivers for TXD are called T1 and T2 while that for RXD are R1 and R2 . Here only T1 and R1 are used for TXD and RXD of ARM7 controller. T1 and R1 line drivers has a designation of T1in,T1out and R1in,R1out respectively. T1in pin is the TTL side and is connected to the TXD of the micro controller while T1out is the RS232 side that is connected to the RXD pin of the RS232 DB connector, similarly R1in pin is on the RS232 side that is connected to the TXD pin of the RS232 DB connector and R1out is the TTL side that is connected to the RXD pin of the ARM7 controller. The T2 and R2 ports are left NC.

- RS-232-

RS-232 communication is asynchronous. That is a clock signal is not sent with the data. Each word is synchronized using it's start bit, and an internal clock on each side, keeps tabs on the timing.

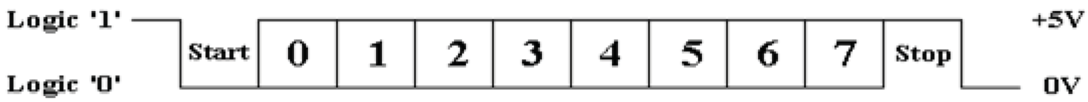


Figure 4. TTL/CMOS Serial Logic Waveform

Figure 4 shows the expected waveform from the UART when using the common 8N1 format. 8N1 signifies 8 data bits, No Parity and 1 Stop Bit. The RS-232 line, when idle is in the Mark State (Logic 1). A transmission starts with a start bit which is (Logic 0). Then each bit is sent down the line, one at a time. The LSB (Least Significant Bit) is sent first. A Stop Bit (Logic 1) is then appended to the signal to make up the transmission.
Figure, shows the next bit after the Stop Bit to be Logic 0. This must mean another word is following, and this is it's Start Bit. If there is no more data coming then the receive line will stay in it's idle state(logic 1). We have encountered something called a "Break" Signal. This is when the data line is held in a Logic 0 state for a time long enough to send an entire word. Therefore if we don't put the line back into an idle state, then the receiving end will interpret this as a break signal. The data sent using this method, is said to be *framed*. That is the data is *framed* between a Start and Stop Bit. Should the Stop Bit be received as a Logic 0, then a framing error will occur. This is common, when both sides are communicating at different speeds.
Figure 4 is only relevant for the signal immediately at the UART. RS-232 logic levels uses +3 to +25 volts to signify a "Space" (Logic 0) and -3 to -25 volts for a "Mark" (logic 1). Any voltage in between these regions (ie between +3 and -3 Volts) is undefined. Therefore this signal is put through a "RS-232 Level Converter". This is the signal present on the RS-232 Port of our computer, shown in figure 5

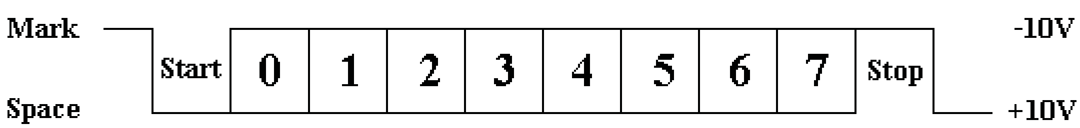


Figure 5. Signal present on RS-232 Port

### *4.5 Internet as a medium of communication –*

Due to the all-pervading nature of the Internet, a web-based appliance control provides a lucid, user-friendly and cost-efficient system for home automation with long distance control. As there is a direct link between two computers, it is more reliable to transfer data and text files. However, it has the disadvantage that a modem is necessary for establishing a link between the two computers. Secondly, certain pre-transmission conversion needs to take place in order to avoid error in transmission.

12 MHz quartz ceramic crystal is connected between pin XTAL1, and XTAL2 of LPC1768 ARM Based 32-Bit micro controller to produce machine cycle for fetch and execution of instruction. And at pin57, RST pins we connect R.C network to provide reset pulse when power is turn on so that programmed execution start from memory location 0000H.

## V CONCLUSION

The system explained in this paper is based on the embedded technology of ARM processor in the development and research of data collection. The main goal of designing hardware is to meet the demand of low cost, low power consumption, small volume and real-time. It adopts LPC1768 micro-processor, sets up an embedded platform based on LPC1768 and realizes some applications such as USB communication, embedded Internet communication, infrared communication, etc. So the whole system performance increases greatly. The processor software is based on the embedded real-time OS and utilizes the multitask structure. The software system is more canonical and meanwhile, it is far more efficient and reliable in real running according to the demand of embedded OS and module design.

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