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RESEARCH ARTICLE

Intelligent Monitoring of Patients in Hospitals Using CAN Protocols and ARM7TDMI Processor

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Abstract
In a hospital the monitoring of multiple patients constantly is a major issue if patient is not in intensive care unit. This paper presents a monitoring system that has the capability to monitor physiological parameters from multiple patient bodies and alarm the doctors if the patient's physiological parameters go beyond critical values. In the proposed system, a Electronic Control Unit has attached near patient body to collect all the physiological parameters and sends them to the base station. The attached sensors on patient's body are able to sense the heart rate, blood pressure and so on. This system can detect the abnormal conditions, issue an alarm to the patient and send a SMS to the physician. The main advantage of this system in comparison to previous systems is to reduce the energy consumption to prolong the network lifetime, speed up and extend the communication coverage to increase the freedom for enhance patient quality of life. We have developed this system in multi-patient architecture for hospital healthcare.

1. INTRODUCTION

Body sensor network systems can help people by providing healthcare services such as medical monitoring, medical data access, and communication with the healthcare provider in emergency situations through the GSM. Continuous health monitoring with Wearable clothing-embedded transducers and implantable body sensor networks will increase detection of emergency conditions in risk patients. Not only the patient, but also their families will benefit from these.

Also, these systems provide useful methods to remotely acquire and monitor the physiological signals without the need of interruption of the patient's normal life, thus improving life quality.

1.1. ARM PROCESSOR

The ARM architecture (previously, the Advanced RISC Machine, and prior to that Acorn RISC Machine) is a 32-bit RISC processor architecture developed by ARM Limited that is widely used in embedded designs. Because of their power saving features, ARM CPUs are dominant in the mobile electronics market, where low power consumption is a critical design goal.

Today, the ARM family accounts for approximately 75% of all embedded 32-bit RISC CPUs, making it one of the most widely used 32-bit architectures. ARM CPUs are found in most corners of consumer electronics, from portable devices (PDAs, mobile phones, media players, handheld gaming units, and calculators) to computer peripherals (hard drives, desktop routers)

The 4^{th} version of ARM core is ARM7TDMI. The abbreviation of ARM7TDMI is Advance RISC Machine 7 Thumb Debugging Multiplier In circuit Emulation.

1.1.2 Features

- 32bit bit RISC architecture.
- Von Neumann load/store architecture.
- Very low power consumption (0.6mA/MHz @ 3V fabricated in .8µm CMOS)
- 3stage pipeline architecture.
- CPU has two instructions set.
  - ARM Instruction Set (32bit).
  - Thumb Instruction Set(16bit).
- CPU has 7 Operating modes.
- On chip JTAG debug and In Circuit Emulation.
- Virtual Memory System Support
- Excellent high-level language support
- Big and Little Endean operating modes

The ARM7TDMI embedded microcontroller core is a member of the Advanced RISC Machines (ARM) family of general purpose 32-bit microprocessors, which offer High performance and very lower power consumption. CPU has two instructions set. ARM instruction set – 32 bit wide and gives maximum performance. THUMB instruction set – 16bit wide and gives maximum code density and enhanced power saving.

1.1.3 Operating modes

ARM7TDMI supports seven modes of operation:

- User (usr): The normal ARM program execution state.
- FIQ (fiq): Designed to support data transfer or channel process.
- IRQ (irq): Used for general purpose interrupt handling.
- Supervisor (svr): Protected mode for operating system.
- Abort Mode (abt): Entered after data or instruction prefetch abort.
- System (sys): A privileged user mode for operating system.
- Undefined (und): Entered when undefined instruction is executed.

2. LPC2129 MICROCONTROLLER

The LPC2129 is based on a 32 bit ARM7TDMI-S CPU with real-time emulation and embedded trace support, together with 256 kilobytes (kB) of embedded high speed flash memory. The architecture enables 32-bit code execution at maximum clock rate. For critical code size applications, the alternative 16-bit Thumb Mode reduces code by more than 30% with minimal performance penalty. With their compact 64 pin package, low power consumption, various 32-bit timers, combination of 4-channel 10-bit ADC and 2 advanced CAN channels and up to 9 external interrupt pins these microcontrollers are particularly suitable for industrial control, medical systems, access control. Number of available GPIOs goes up to 46 in 64 pin package.

2.1. Features

• 32-bit ARM7TDMI microcontroller in a 64 pin package.

• 16 kB on-chip Static RAM

• 256 kB on-chip Flash Program Memory (at least 10,000 erate/write cycles over the whole temperature range).

• Two interconnected CAN interfaces with advanced acceptance filters.

• Four channel 10-bit A/D converter with conversion time as low as 2.44 ms.

• Two 32-bit timers (with 4 capture and 4 compare channels), PWM unit (6 outputs), Real Time Clock and Watchdog.

• Multiple serial interfaces including two UARTs (16C550), Fast I2C (400 kbits/s) and two SPIs.

• 60 MHz maximum CPU clock available from programmable on-chip Phase-Locked Loop.

• Vectored Interrupt Controller with configurable priorities and vector addresses.

• Up to forty-six, 5 V tolerant general purpose I/O pins.

• On-chip crystal oscillator with an operating range of 1 MHz to 30 MHz

• Two low power modes Idle and Power-down.

• Processor wake-up from Power-down mode via external interrupt.

• Individual enable/disable of peripheral functions for power optimization.

• CPU operating voltage range of 1.65V to 1.95V (1.8V +/- 8.3%).

• I/O power supply range of 3.0V to 3.6V (3.3V +/- 10%).

3. HARDWARE DESIGN

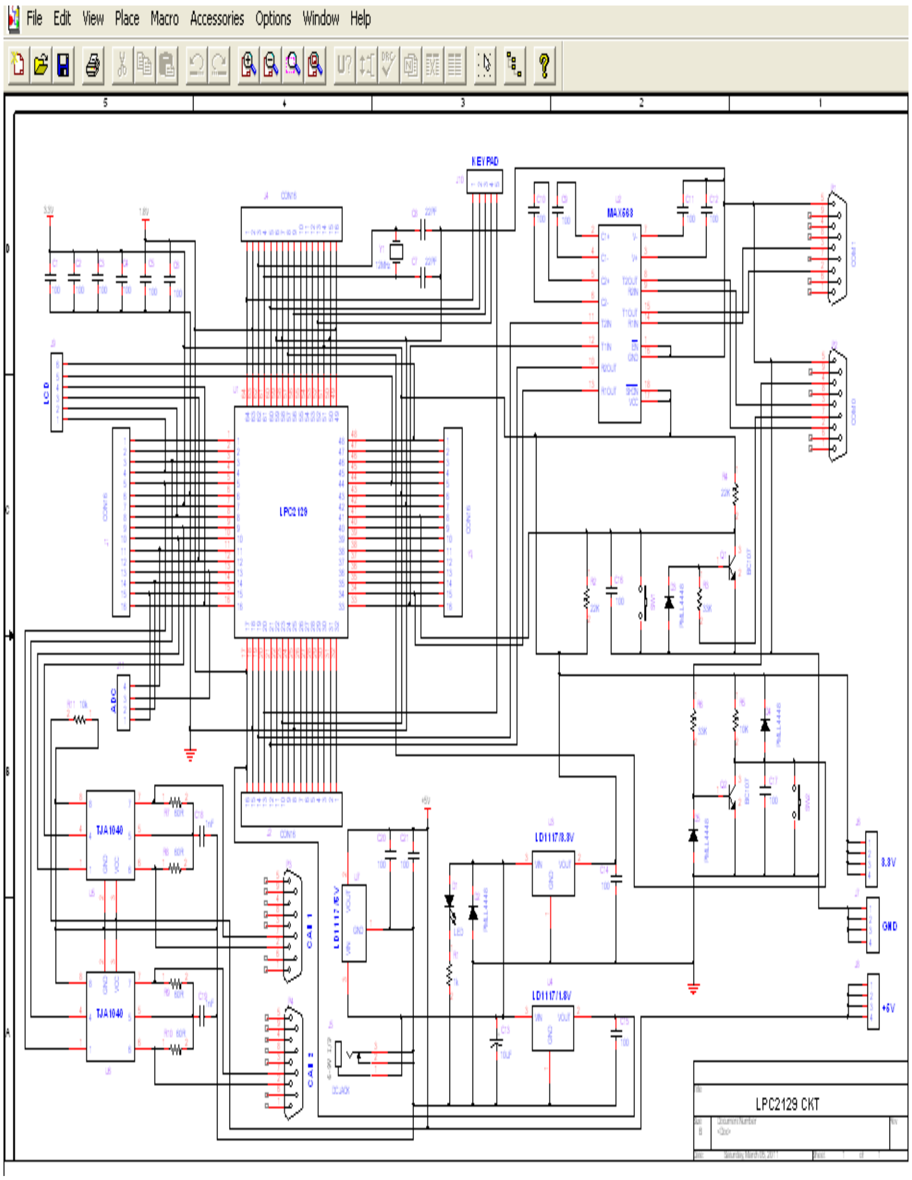


Fig . 2. Schematic Diagram of LPC 2129

4. CAN PROTOCOL

CAN or Controller Area Network is an advanced serial bus system that efficiently supports distributed control systems. It was initially developed for the use in motor vehicles by Robert Bosch GmbH, Germany, in the late 1980s, also holding the CAN license.

In the CAN protocol, the bus nodes do not have a specific address. Instead, the address information is contained in the identifiers of the transmitted messages, indicating the message content and the priority of the message. The number of nodes may be changed dynamically without disturbing the communication of the other nodes. Multicasting and Broadcasting is supported by CAN. CAN provides sophisticated error-detection and error handling mechanisms such as CRC check, and high immunity against electromagnetic interference. Erroneous messages are automatically retransmitted. Temporary errors are recovered. Permanent errors are followed by automatic switch-off of defective nodes. There is guaranteed system-wide data consistency.

The CAN protocol uses Non-Return-to-Zero or NRZ bit coding. For synchronization purposes, Bit Stuffing is used. There is a high data transfer rate of 1000 kilobits per second at a maximum bus length of 40 meters or 130 feet when using a twisted wire pair which is the most common bus medium used for CAN. Message length is short with a maximum of 8 data bytes per message and there is a low latency between transmission request and start of transmission. The bus access is handled via the advanced serial communications protocol Carrier Sense Multiple Access/Collision Detection with Non- Destructive Arbitration. This means that collision of messages is avoided by bitwise arbitration without loss of time.

4.1 CAN PROTOCOL VERSIONS

V2.0A (standard)-11 bit message ID

V2.0B (extended)-29 bit message ID

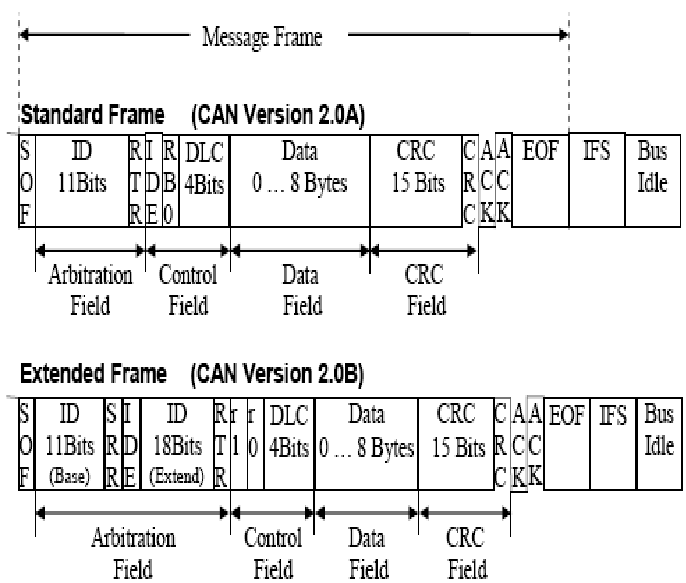


Fig. 3.3 CAN protocol versions

The original CAN specifications (Versions 1.0, 1.2 and 2.0A) specify an 11 bit message identifier. This is known as "Standard CAN". Those Data Frames and Remote Frames, which contain an 11-bit identifier, are therefore called Standard Frames. With these frames, 2^{11} (=2048) different messages can be identified (identifiers 0-2047).

4.2 CAN FRAMES

CAN having 5 types of frame formats

1. Data Frame

2. Remote Frame

3. Error Frame

4. Overload Frame

5. Interframe Space

4.3 ERROR DETECTION

The CAN protocol provides 5 sophisticated error detection mechanisms

1. CRC error

2. Acknowledge error

3. Form error

4. Bit error

5. Stuff error

4.4 Features

• Supports 1 Mb/s operation
• Implements ISO-11898 standard physical layer requirements
• Suitable for 12V and 24V systems
• Detection of ground fault (permanent dominant) on TXD input
• Power-on reset and voltage brown-out protection
• An unpowered node or brown-out event will not disturb the CAN bus
• Low current standby operation
• Protection against damage due to short-circuit conditions
• Protection against high-voltage transients
• Automatic thermal shutdown protection
• Up to 112 nodes can be connected
• High noise immunity due to differential bus implementation

• Temperature ranges:
- Industrial (I): -40°C to +85°C
- Extended (E): -40°C to +125°C

Pin Number	Pin Name	Pin Function
1	TXD	Transmit Data Input
2	VSS	Ground
3	VDD	Supply Voltage
4	RXD	Receive Data Output
5	VREF	Reference Output Voltage
6	CANL	CAN Low-Level Voltage I/O
7	CANH	CAN High-Level Voltage I/O
8	RS	Slope-Control Input

Table 3.1 CAN Transceiver

The RS pin is used to select High-speed, Slope-control or Standby modes via an external biasing resistor.

5. GSM

GSM (Global System for Mobile communications) is the technology that underpins most of the world's mobile phone networks. GSM is an open, digital cellular technology used for transmitting mobile voice and data services. GSM operates in the 900MHz and 1.8GHz bands GSM supports data transfer speeds of up to 9.6 kbps, allowing the transmission of basic data services such as SMS. The GSM standard is intended to address these problems. In the current work, SIM300 GSM module is used, it is shown in fig.2. The SIM300 module is a Triband GSM/GPRS solution in a compact plug in module featuring an industry-standard interface .

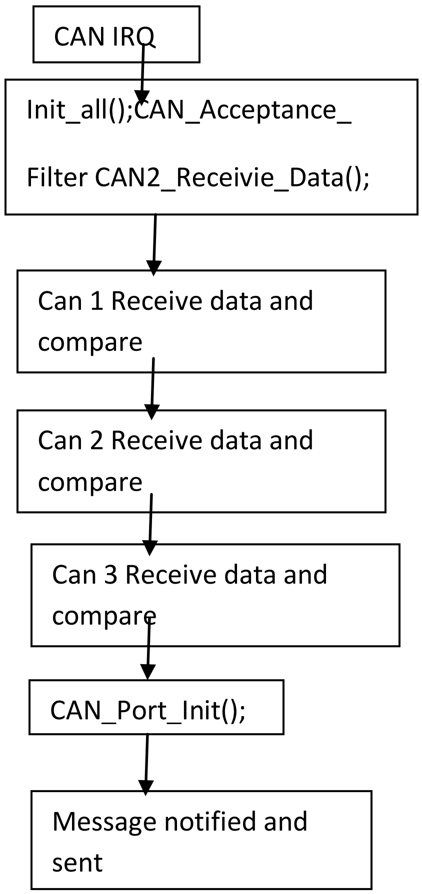
Features of GSM

- Single supply voltage 12v
- Typical power consumption in SLEEP Mode: 2.5mA.
- SIM300 tri-band MT,MO,CB, text and PDU mode, SMS storage: SIM Card.

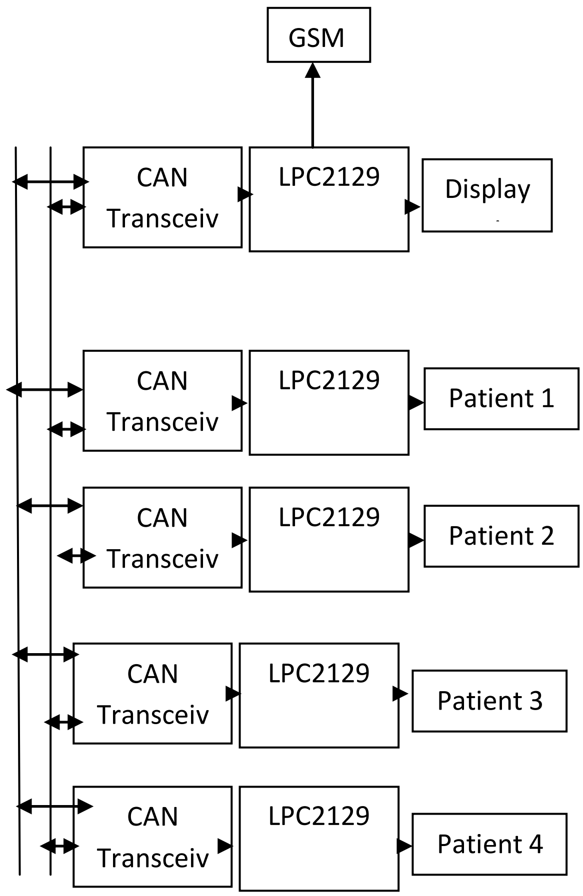
6. WORKING

The threshold value of pulse(heart rate),and other physiological values is set in each microcontroller ECU ,once patients physiological values surpasses the threshold value message consists of patients name and pulse rate or other physiological values is sent through CAN Bus to the main unit and main unit is continuously monitored by doctor and also this message sent to concerned doctor through gsm. so that doctor is notified of patients condition and he will take care of patient .

6.1.Flow Diagram:



6.2. BLOCK DIAGRAM:



7. ADVANTAGES

1. Easy to implement and extend.
2. Better then wireless technology because in wireless technology signals may interfere with x-rays.
3. Less expensive than other topologies (But in recent years has become less important due to devices like a switch)
4. Cost effective; only a single cable is used.
5. Easy identification of cable faults. The breakdown of a CAN station has no immediate impact on the CAN bus.
6. All the other stations can communicate unconstrained.

8. CONCLUSION

In this paper we proposed a mobile physiological monitoring system, which is able to continuously monitor the patient's heart beat, blood pressure and other critical parameters in the hospital. The entire system consists of a coordinator node to acquire the patient's physiological data, a CAN ECU to forward the data. The system is able to carry out a long-tem monitoring on patient's condition and is equipped with an emergency rescue mechanism using SMS/ E-mail.

This is the effective way than wireless system of patient monitoring in hospitals where less number of doctor's was there.

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