A NOVEL ALERT SYSTEM FOR SUDDEN INFANT DEATH SYNDROME MONITORING ENHANCED WITH WIFI TECHNOLOGY

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Abstract—**One of the most vulnerable diseases in infants is the Sudden Infant Death Syndrome Monitoring(SIDS).The SIDS is a type of disease that can quickly take out the life of the infant.It is therefore important to monitor the infant continuously so that this disease can be detected and avoided.In this regard we are developing a smart alert system.This Smart Alert System (SAS), developed under the context of the European Texas Instruments Innovation Challenge (TIIC) 2015, is composed by the following elements:wearabledevices,smarttextiles,embeddedsystems,wirelesscommunications,web interfaces and mobile applications aimed to monitor the infants during their sleep.The main goal of the smart alert system is to reduce the response time in an SIDS scenario. The Wearable IoT Device is embedded with many sensors that are capable of measuring the body position,heart beat rate,breathing rate and temperature of the infant. After a minimal data processing, this set of information is sent to the MySQL server, via WIFI technology, and it is accessible to the user through the normal connection of internet. If any critical event occurs the buzzer that is present in the system will trigger an alarm and it will also send the message to the mobile. This smart alert system for infants is found to be a very useful tool in the detection of SIDS aas the disease could be life threatening to the infant.**
Keywords—Sudden Infant Death Syndrome;Smart Alert System.

1.Introduction

The main reason for the design of this smart alert system was because SIDS could be a very dangerous disease among new borns.The smart alert system is a combination of various technologies that are embeeded together such as wearable devices,pressuresensor,temperaturesensor,heart beat sensor,breathing rate sensor,buzzer and a WIFI module.The various sensors measure each of these respective parameters and with the information obtained from each of these readings the future course of action is determined.If all the parts of the body are functioning normally then there is no problem.But if there is any abnormal behavior in any one of the parameters then the information is collected by the MySQL server and then it is conveyed immediately to the parent via message and also the buzzer will be triggered on.Continuous monitoring of vital parameters allows for immediate intervention by enabling quick detection of dangerous situations like cessation of breathing,irregularities in heart beats or slowing of heart rate.[1].It has also been shown that continuous cardiac monitoring can reduce mortality risks especially for low birth weightinfants.Such monitoring thus helps in improving survival rates and provides support for the infants developmental growth.
Doctors say that the infants should sleep on their back and on their stomach, as sleeping in this position would mean that they are more vulnerable to SIDS due to asphyxiation [2]. Therefore we have developed an algorithm that monitors the position of the infant during sleep. This algorithm is based on the data retrieved from a MEME sensor and it can identify all the four possible positions of the body such as lying on the back,lying on the stomach,and lying on the sides.But more than the body position,it is the abnormal change in the breathing rate and heart beat rate that remains to be the major cause of SIDS. For a newborn baby the

breathing rate is 30 to 60 breaths per minute, 40 breaths per minute for an infant, and it becomes 24-30 breaths per minute after one year[3]. For the detecting the breathing rate, we used the accelerometer sensor(ADXL335), and we have developed a low complexity algorithm with low overhead. This sensor can well be used near the infant in such a way so that the breaths taken by the infant is recorded. The normal heart beat rate for an infant is generally above 100 beats per minute[4].We use an ECG sensor for measuring the heart rate.For measuring the body temperature we use a temperature sensor namely LM35.

The main goal of this smart alert system is to reduce the response time in SIDS. This SAS can send different types of alarms such as sound, light and, distress messages to smartphones thus increasing the reliability of the system.The software used in this project are CCS(CutomComputerService)compiler,Eclipse(Android APP) and Microsoft visual studio(Server).The languages used are embedded C,Java,.XML,Asp.net.In SAS main cause of energy consumption are the wireless communications, corresponding to more than 60% of the total of energy consumption [5]. Therefore,we use a Regulated Power Supply(RPS) in order to maintain smooth flow of electricity.[6].Also a real time clock(RTC) is used to record the time in which the abnormality may have occurred.

The research community and scientists have given a lot of importance to the concept of the smart alert system.The smart alert system has been designed for various applications such as: Evaluating the sleeping poattern of a person for a certain period,assessment of an athlete's performance etc. [7]– [9].The smart alert system is generally used to monitor multiple parts of the body and is used to determine whether the user is in an emergency situation or not.The parameters that can be monitored by a SAS are: electrocardiogram signals (ECG); electroencephalogram (EEG); electromyogram (EMG); heart rate; breathing rate; blood pressure; blood glucose; blood oxygen; perspiration (sweating) or skin conductivity; and body or skin temperature [7]–[9].Many methods have been suggested to make the SAS more wearable like wristwatches [10], shirts [11], jackets [12] , gloves [13], socks [14], chest bands [15], [16], or pajamas [16], [17]. But cables and wires, make those SAS not truly wearable and in some cases uncomfortable for the user [10], [11], [13]. The use of textile electrodes [12] is more comfortable to the user,but these technologies are still a type of prototype [12]. Several types of wireless communications technologies (Bluetooth [10], [11], [14], [15],
[17], [18], ZigBee [13], 3G [16] and WIFI) are used in SAS for off- body communications with the Base Station [10], [13], [16], [17], Smartphones [14]–[18] and/or Graphic User Interface [11], [13].Even though there are multiple technologies to prevent SIDS none of those are capable of measuring all the required parameters. Along with the prevention this can be used as a continuous tool to determine what may have actually caused this syndrome. Storing the information of any variation of patterns may be helpful to understand this syndrome. After the introduction in Section I, Section II describes the details of the existing system. In Section III, the proposed system details are given and in Section IV the references and conclusion is given.

2. Existing System.

In this section we will discuss about the existing system that was used before in the smart alert system.

System Overview:

This system is enhanced with Zigbeetechnology.The infant has to be watched continuously day and night it is a tedious process.TheZigbee technology could not cover large distances.thers it is not possible to receive information about the infant from long distances.Also the timing is not accurate. Therefore there may be some issues regarding the timing to give tablets etc.

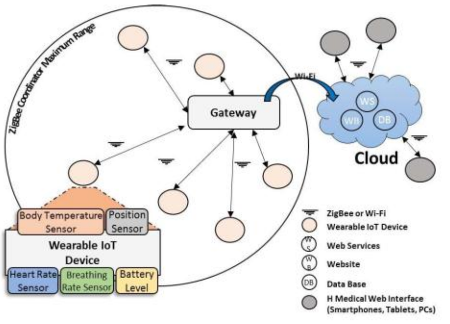


Fig.1.Overview of the existing system.

3. Proposed System:

A.System Overview:

Here the system is enhanced with WIFI technology.The accelerometer sensor is used to sense the posture as well as the activites of the infant.It is able to identify all the four possible positions of the infant during sleep such as lying on his back,lying on his sides and lying on his stomach.The pressure sensor is used to determine the breath rate of the infant.The temperature and heart beat sensors are used to determine the temperature and heart beat of the infant respectively.The above measured parameters will be updated in the server through WIFI.In case of any abnormalities found in the body position or temperature or heart rate or breathing rate. The device will alert the buzzer and it will also send the distress message to the parent via message.The alert message will also play as a voice alert to the parent.The doctor can view the web page and measure the health condition of the baby.Also the doctor can send the health care information,feeding time to the user through wearable device via WIFI.

By using this system we can reduce the death rate of the infants due to SIDS.Avoid the inconvenience of the parents to take care of the children at night.

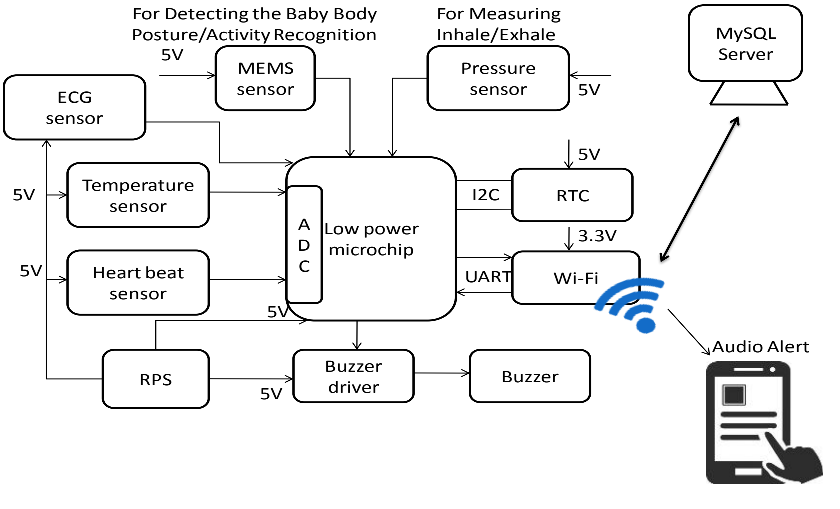


Fig 2:Overview of the proposed system.

The hardware used in this system are PIC controller (18f4520), temperaturesensor(LM35),accelerometersensor(ADXL335),pressuresensor(MPS20N0040D-S),RTC(DS1307),heart beat sensor, WIFI(ESP8266), Buzzer. The software used in this syatemare: CCS(Custom Computer Service) compiler, Eclipse(Android APP),Microsoft visual studio(Server).The languages used are: Embedded C,Java,.XML,asp.net.

B.Pic Controller:

PIC microcontroller is widely used for experimental and modern applications because of its low price, wide range of applications, high quality and ease of availability. It is ideal for machine control applications, measurement devices, and study purpose and so on.It is also called as “Computer on a Chip”.PIC was developed as Peripheral controller.PIC Microcontrollers are designed with a separate 14 bit program memory bus to carry instructions.A Separate 8bit data memory bus to carry data.This Design is commonly called hardvard architecture, and So PIC Microcontroller is based on Harvard architecture.Every instruction is coded as a single 14 bit word and fetched simultaneously with the corresponding data variable for that instruction.

The Harvard architecture speeds up the Process by its design.The instruction set for the PIC Microcontroller consist of 35 instructions .Each Occupying a single 14 bit program memory word and a two stage Pipelining .It consists of Flash Memory which make the programming cost and time less.

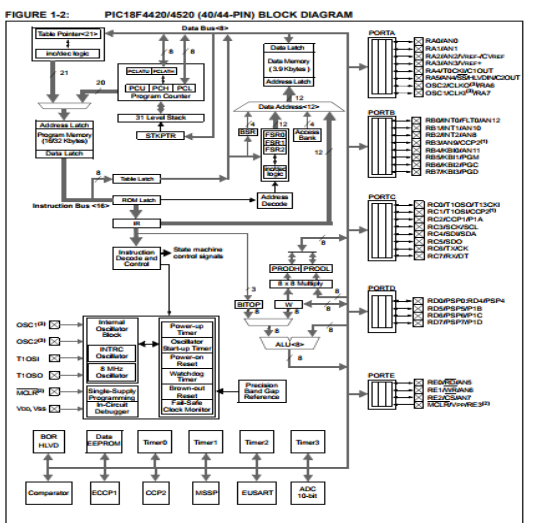


Fig 3:block diagram of PIC microcontroller.

C:UART*:*

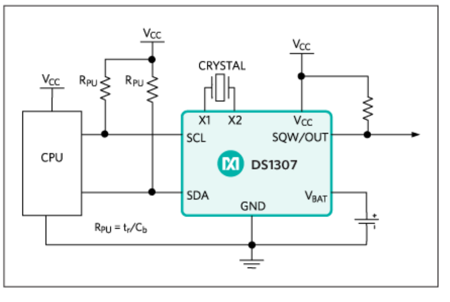
A Universal asynchronous receiver/transmitter, abbreviated UART is a piece of computer hardware that translates data between parallel and serial forms. UARTs are commonly used in conjunction with communication standards .The universal designation indicates that the data format and transmission speeds are configurable. The electric signaling levels and methods (such as differential signaling etc.) are handled by a driver circuit external to the UART.

A UART is usually an individual (or part of an) integrated circuit used for serial communications over a computer or peripheral device serial port. UARTs are now commonly included in microcontrollers. A dual UART, or DUART, combines two UARTs into a single chip. An octal UART or OCTART combines eight UARTs into one package, an example

being the NXP. Many modern ICs now come with a UART that can also communicate synchronously; these devices are called USARTs (universal synchronous/asynchronous receiver/transmitter).
The Universal Asynchronous Receiver/Transmitter (UART) takes bytes of data and transmits the individual bits in a sequential fashion. At the destination, a second UART re-assembles the bits into complete bytes. Each UART contains a shift register, which is the fundamental method of conversion between serial and parallel forms. Serial transmission of digital information (bits) through a single wire or other medium is less costly than parallel transmission through multiple wires.

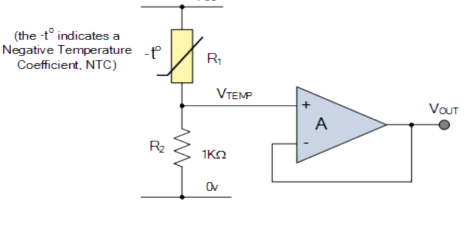
The UART usually does not directly generate or receive the external signals used between different items of equipment. Separate interface devices are used to convert the logic level signals of the UART to and from the external signaling levels. External signals may be of many different forms. Examples of standards for voltage signaling are RS-232, RS-422 andRS-485 from the EIA. Historically, current (in current loops) was used in telegraph circuits. Some signaling schemes do not use electrical wires. Examples of such are optical fiber, IrDA (infrared), and (wireless) Bluetooth in its Serial Port Profile (SPP). Some signaling schemes use modulation of a carrier signal (with or without wires). Communication may be simplex (in one direction only, with no provision for the receiving device to send information back to the transmitting device), full duplex (both devices send and receive at the same time) or half duplex (devices take turns transmitting and receiving).

D:RTC-DS1307:



The DS1307 operates as a slave device on the serial bus. Access is obtained by implementing a START condition and providing a device identification code followed by a register address. Subsequent registers can be accessed sequentially until a STOP condition is executed. When VCC falls below 1.25 x VBAT the device terminates an access in progress and resets the device address counter. Inputs to the device will not be recognized at this time to prevent erroneous data from being written to the device from an out of tolerance system. When VCC falls below VBAT the device switches into a low-current battery backup mode. Upon power-up, the device switches from battery to VCC when VCC is greater than VBAT + 0.2V and recognizes inputs when VCC is greater than 1.25 x VBAT.

E:Temperature Sensor:



The LM35 series are precision integrated-circuit temperature devices with an output voltage linearly proportional to the Centigrade temperature. The LM35 device has an advantage over linear temperature sensors calibrated in Kelvin, as the user is not required to subtract a large constant voltage from the output to obtain convenient Centigrade scaling. The LM35 device does not require any external calibration or trimming to provide typical accuracies of ±¼°C at room temperature and ±¾°C over a full −55°C to 150°C temperature range. Lower cost is assured by trimming and calibration at the wafer level. The low-output impedance, linear output and precise inherent calibration of the LM35 device makes interfacing to readout or control circuitry especially easy. The device is used with single power supplies, or with plus and minus supplies. As the LM35 device draws only 60 µA from the supply, it has very low self-heating of less than 0.1°C in still air. The LM35 device is rated to operate over a −55°C to 150°C temperature range, while the LM35C device is rated for a −40°C to 110°C range (−10° with improved accuracy). The LM35-series devices are available packaged in hermetic TO transistor packages, while the LM35C, LM35CA, and LM35D devices are available in the plastic TO-92 transistor package. The LM35D device is available in an 8-lead surface-mount small-outline package and a plastic TO-220 package.

In order to understand the working principle of lm35 temperature sensor we have to understand the linear scale factor. In the features of lm35 it is given to be **+10 mills volt per degree centigrade**. It means that with increase in output of 10 mills volt by the sensor Vout pin the temperature value increases by one. For example if the sensor is outputting 100 mills volt at Vout pin the temperature in centigrade will be 10 degree centigrade. The same goes for the negative temperature reading. If the sensor is outputting -100 mills volt the temperature will be -10 degree Celsius.

The formula to convert voltage to centigrade temperature for Lm35 is Centigrade **Temperature = Voltage Read by ADC / 10 mV(mills Volt).**

At 25”C:

$$Vout=\frac{R_2}{R_1+R_2}xV=\frac{1000}{10000+1000}x12v=1.09v$$

At 100;C:

$$Vout=\frac{R_2}{R_1+R_2}xV=\frac{1000}{100+1000}x12v=10.9v$$

F:Accelerometer Sensor:

FUNCTIONAL BLOCK DIAGRAM

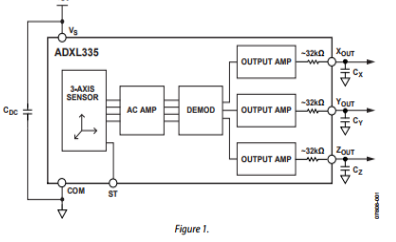


Figure 1.

The ADXL335 is a complete 3-axis acceleration measurement system. The ADXL335 has a measurement range of ±3 g minimum. It contains a polysilicon surface-micromachined sensor and signal conditioning circuitry to implement open-loop acceleration measurement architecture. The output signals are analog voltages that are proportional to acceleration. The accelerometer can measure the static acceleration of gravity in tilt-sensing applications as well as dynamic acceleration resulting from motion, shock, or vibration. The sensor is a polysilicon surface-micromachined structure built on top of a silicon wafer. Polysilicon springs suspend the structure over the surface of the wafer and provide a resistance against acceleration forces. Deflection of the structure is measured using a differential capacitor that consists of independent fixed plates and plates attached to the moving mass.

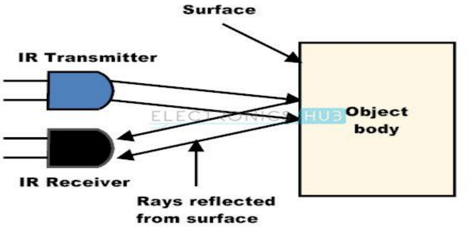
The fixed plates are driven by 180° out-of-phase square waves. Acceleration deflects the moving mass and unbalances the differential capacitor resulting in a sensor output whose amplitude is proportional to acceleration. Phase-sensitive demodulation techniques are then used to determine the magnitude and direction of the acceleration. The demodulator output is amplified and brought off-chip through a 32 kΩ resistor. The user then sets the signal bandwidth of the device by adding a capacitor.

This filtering improves measurement resolution and helps prevent aliasing. MECHANICAL SENSOR The ADXL335 uses a single structure for sensing the X, Y, and Z axes. As a result, the three axes' sense directions are highly orthogonal and have little cross-axis sensitivity.

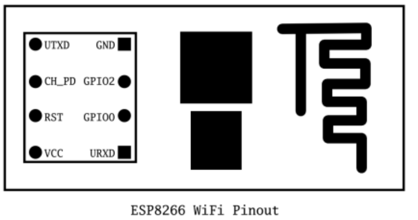
Mechanical misalignment of the sensor die to the package is the chief source of cross-axis sensitivity. Mechanical misalignment can, of course, be calibrated out at the system level. PERFORMANCE Rather than using additional temperature compensation circuitry, innovative design techniques ensure that high performance is built in to the ADXL335. As a result, there is no quantization error or no monotonic behavior, and temperature hysteresis is very low (typically less than 3 mg over the −25°C to +70°C temperature range).

G:Heart Beat Sensor:

The sensor emits IR light and gives a signal when it detects the reflected light. The emitter is simply an IR LED (Light Emitting Diode) and the detector is simply an IR photodiode which is sensitive to IR light of the same wavelength as that emitted by the IR LED.



H:ESP8266 WIFI MODULE:



ESP8266 WiFi Pinout
Top View (Not to scale)

Wi-Fi technology may be used to provide Internet access to devices that are within the range of a wireless network that is connected to the Internet. The coverage of one or more interconnected access points (hotspots) can extend from an area as small as a few rooms to as large as many square kilometers. Coverage in the larger area may require a group of access points with overlapping coverage.

I:Software Used:

CSS:

This integrated C development environment gives developers the capability to quickly produce very efficient code from an easily maintainable high level language. The compiler includes built-in functions to access the PIC microcontroller hardware such as READ_ADC to read a value from the A/D converter. Discrete I/O is handled by describing the port characteristics in a PROGRAM. Functions such as INPUT and OUTPUT_HIGH will properly maintain the tri-state registers. Variables including structures may be directly mapped to memory such as I/O ports to best represent the hardware structure in C.

**Proteus 7.0 Simulation Tool:*

Proteus 7.0 is a Virtual System Modeling (VSM) that combines circuit simulation, animated components and microprocessor models to co-simulate the complete microcontroller based designs. This is the perfect tool for engineers to test their microcontroller designs before constructing a physical prototype in real time.

This program allows users to interact with the design using on-screen indicators and/or LED and LCD displays and, if attached to the PC, switches and buttons. One of the main components of Proteus 7.0 is the Circuit Simulation -- a product that uses a SPICE3f5 analogue simulator kernel combined with an event-driven digital simulator that allow users to utilize any SPICE model by any manufacturer. Proteus VSM comes with extensive debugging features, including breakpoints, single stepping and variable display for a neat design prior to hardware prototyping. In summary, Proteus 7.0 is the program to use when we want to simulate the interaction between software running on a microcontroller and any analog or digital electronic device connected to it.

CONCLUSION

The Baby Night Watch is capable of detecting unexpected events and registering several physiological parameters, making it a powerful medical tool to understand SIDS, and a reliable real-time monitor of infants. The project proved that with a small amount of hardware a huge number of parameters can be measured, improving the users experience and safety of the infant. The data are produced by IoT Device via Wi-Fi.

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