



Design of Embedded Device for Incubator for the Monitoring of Infants

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Abstract— An apparatus for maintaining an infant, especially one that is ill or born before the usual gestation period is called as Incubator. Baby Incubator is an enclosed apparatus providing a controlled environment for the care of premature babies. Until recently, there was just little attention for the care of newly born babies in developing countries. People are used to the fact that a low birth baby would easily die. Presumably, as a result of the great number of health workers out the western world who went to those countries; there is now also more attention for newborn care in the developing countries. Motivation for the said work is the demand of physicians for the development of monitoring and diagnostic systems which are easier to handle and less obtrusive than the commonly used medical systems. This research work provides design of embedded device for real time monitoring of infants. The Embedded device includes sensors for Door Security, Light Intensity, Voice detection of incubator for the continuous monitoring of infants under clinical and home conditions. It will allow the early detection of potential life threatening events. The device would involve DSPIC microcontroller (Part no: 330011 is used for transmitting the audio signals, from the incubator, the microcontroller will generate control signals for the given parameters. The system will monitor the 3 parameters Door, Light, Audio/ voice of the baby that he/she is ok or crying. The Door parameter provides an Intruder bell it will give alarm/Led indication if any person will come at the place /Room of baby by breaking the sensor. Light Intensity can be monitored by using LDR (Light dependent register). All these parameters are continuously monitored by system & will display the status on LEDs or give alarm.

Keywords— Incubator; DSPIC microcontroller (Part no: 330011); Door Security; Light Intensity; Voice Detection.

I. INTRODUCTION

The problem of premature and congenitally ill infants is not a new one. Before the industrial revolution, premature and ill infants were born and cared for at home and either lived or died without medical intervention. In the mid-nineteenth century, the infant incubator was first developed, based on the incubators used for chicken eggs. Dr. Stephane Tarnier is generally considered to be the father of the incubator (or isolate as it is now known), having developed it to attempt to keep premature infants in a Paris maternity ward warm. Other methods had been used before, but this was the first closed model; additionally, he helped convince other physicians that the treatment helped premature infants. France became a forerunner in assisting premature infants, in part due to its concerns about a falling birth rate.[28]

Healthcare cost is an urgent issue globally. The costs for infant care are high due to highly intensive labor. For healthy infants, Sudden Infant Death Syndrome (SIDS) is one of the most critical problems needed to be addressed and it requires a great deal of care labor. SIDS is defined as any sudden and unexplained death of an apparently healthy infant aged from One month to one year. The developed sensory baby vest for the monitoring of infants includes fully integrated sensors for the parameters respiration, heart rate, temperature and humidity, to detect excessive sweating, for the continuous monitoring of infants under clinical and home conditions. It allows the early alert for potential life threatening events as well as the recognition of the development or progression of diseases at an early stage. Health protection or even life-saving is enabled in time [1]. A variety of principles for the measurement of the parameters have been assessed for the integration into the garment. Prototypes have been manufactured incorporating the chosen sensing principles with textile and textile-compatible technologies. A non-invasive infant monitoring system includes CO₂ sensors to non-invasively monitor the exhaled air from an infant in order to reduce the potential risks for Sudden Infant Death Syndrome (SIDS) [2]. CO₂ sensors placed in the crib around an infant to non-invasively monitor the exhaled air concentration variation from him/her. By monitoring the outputs of CO₂ sensors, we can detect if there is anything unusual with the infant's respiration. The output data is sent wirelessly to activate an alarm or logged for further diagnoses.

The Developed Cot Death for Infants in Day Care system also worked on infant's respiration. There are some proposed infant monitoring systems, such as cardiopulmonary monitoring, vision monitoring, oxygen consumption monitoring and multi-purpose monitoring. Many of these approaches are invasive making both the infant and parents uncomfortable while some of the monitoring systems are not effective enough due to the unrecognized signs or low response of SIDS [3]. In many SIDS cases, the infants stop breathing without any signs of trauma. The aim of this work is to provide such a monitoring and diagnostic system which is easier to handle and less obstructive than the commonly used medical systems. Most previous approaches for the monitoring of infants provides parameters like respiration, heart rate, temperature and humidity, to detect excessive sweating, for the continuous monitoring of infants. Main goal of a

proposed system is to provide more security and more parameters for incubator for the continuous monitoring of infants under clinical and home conditions.

Main objective of a proposed system is To monitor the parameters Like Light, respiration, Audio/ voice of the baby that he/she is ok or crying.

Door parameter to provide Intruder bell so that it will gives alarm/Led indication if any personal will come at the place /Room of baby by breaking the sensor.

To monitor the temperature of the incubator.

All these parameters are continuously monitored by system & will display the status on LEDs.

II. PROPOSED METHODOLOGY

This proposed scheme aims to design an embedded device which supports mainly the following Features:

1. AUDIO monitoring.
2. Light sensing & Alarm/LED indication.
3. Door sensor to sense Intruder.
4. sense temperature of the incubator

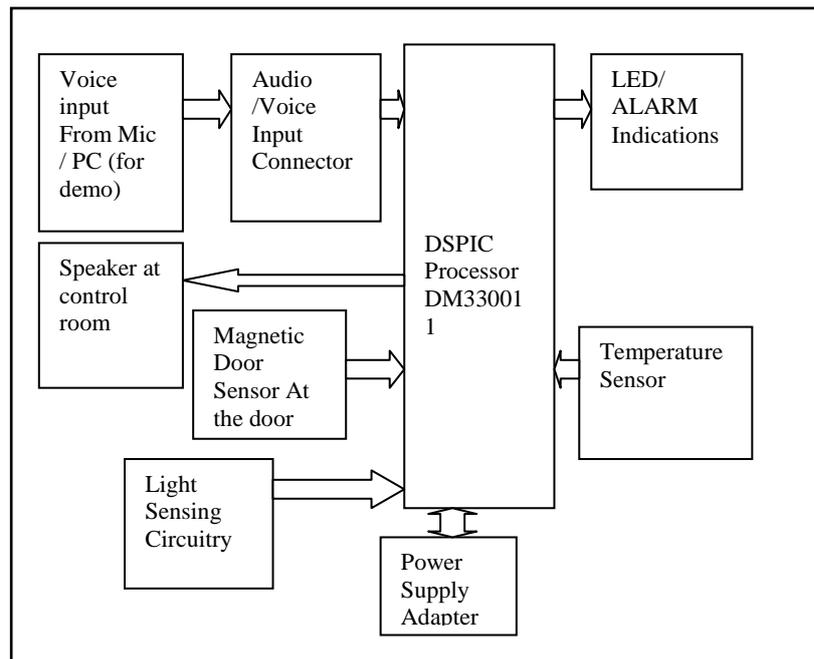


Fig 1: Block Diagram of Embedded Device for Incubator

The device involves DSPIC Part No. DM330011 and sensors which can be interfaced with PIC Controller. The system will monitor the 3 parameters Door, Light and Audio/ voice of the baby that he/she is ok or crying. The Door parameter provides a Led indication if any person will come at the place /Room of baby by breaking the sensor. Light Intensity can be monitored by using LDR (Light dependent register). All these parameters are continuously monitored by system & will display the status on LEDs or gives alarm. The WM8510 Codec Driver configures the WM8510 audio codec and provides an interface for reading and writing audio data to the codec. The driver is implemented in WM8510CodecDrv.c and the interface is defined in WM8510CodecDrv.h. The driver uses the DCI module on the dsPIC33F device module to process data and the I2C. Module as a codec control bus. The demo application configures the codec for a 8 KHz sampling rate.

A. DSPIC Microcontroller (Part no: 330011)

The MPLAB Starter Kit for dsPIC Digital Signal Controllers is a complete hardware and software tool suite for exploring applications based upon Microchip's dsPIC DSCs. With a built-in debugger on the board, simply install the software and connect the USB cable to the PC. Start up MPLAB IDE and you are in full control, able to run the sample programs, and to download and test your own applications. The board is designed with dsPIC DSC with 256 KB of flash memory, a high-fidelity audio codec, microphone input and headphone/speaker outputs, and is powered from the USB connection to the PC. Also on the board are reconfigurable switches, potentiometers, a temperature sensor and a 4 Mb serial EEPROM to store data such as audio samples [6].

Features of the DSPIC 330011 are

- Board includes integrated debugger / programmer
- USB powered
- dsPIC33FJ256GP506 DSC with 256 KB Flash and 16 KB RAM

- 16/24/32 bit codec with a maximum sampling frequency of 48KHz
- Low cost audio capture and play back circuitry using the 12 bit ADC and PWM Audio
- Microphone and line level inputs with adjustable input gain
- 100mW headphone amplifier with digital volume control
- 2 switches and 3 LEDs for user application purposes
- 4 Megabit serial flash memory for application use
- Temperature sensor
- CD contains MPLAB IDE with full editor, programmer and debugger; MPLAB C Compiler; code examples and user's guide
- All tools provided for developing and prototyping speech and audio application & algorithms

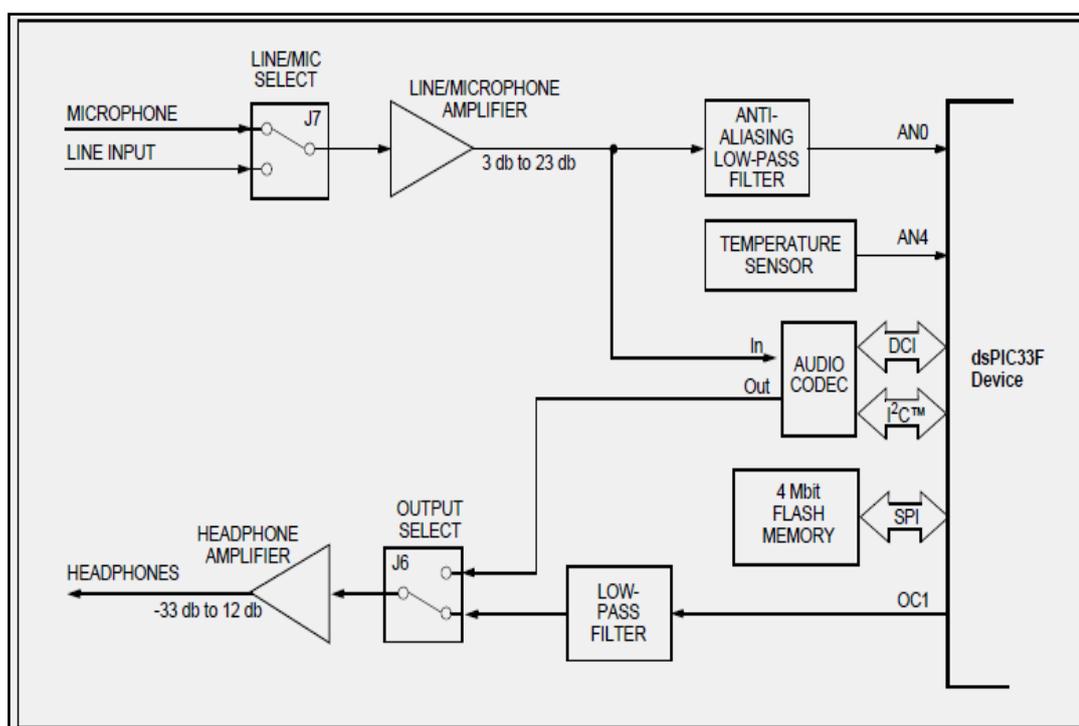


Fig 2: Starter Kit Block Diagram

The starter kit, with its built-in debugger/programmer, provides an all-in-one solution for debugging and programming applications using MPLAB IDE. Also, no additional external power supply is needed as power is supplied by the host PC's USB port. The starter kit's debugging/programming operations are controlled by a PIC18F67J50 MCU running at 48 MHz. The PIC18F67J50's built-in USB engine provides the communications interface between the starter kit and the host PC. Power to the starter kit is provided via USB whose nominal 5 volt unregulated supply is regulated by a Microchip MC1727 3.3 volt low-dropout (LDO) linear regulator. Proper starter kit main system power is indicated by the green LED .D1.. The PIC18F67J50 MCU accomplishes debugging or programming of the target dsPIC33FJ256GP506 by controlling the target's MCLR, PGC1/EMUC1, and PGD1/EMUD1 signals. Target power is switched on/off via a low VCE saturation PNP transistor configured as a high-side switch. Target clocking is also provided by the PIC18F67J50 MCU. A Microchip 25LC010A serial EEPROM is used to store the starter kit's serial number and debug control information. The MPLAB Starter Kit for dsPIC Digital Signal Controllers connects directly to the USB port on a computer. The PC USB connection supplies communications and power to the board. The starter kit includes debug and programmer circuitry that allows applications to be programmed onto the board's dsPIC33F device and then debugged, all using MPLAB IDE. Audio input signals from an external microphone or audio equipment are routed to the ADC module in the on-board dsPIC33F device for software processing. Alternatively, applications can use the audio codec for converting the audio signal. Output signals can be generated by the dsPIC33F device's Output Compare module as a Pulse-Width Modulated (PWM) digital waveform. This PWM signal is converted to an analog signal by a low-pass filter on the starter kit board. Alternatively, applications can output audio data using the audio codec. The output audio signal is then amplified using a headphone amplifier circuit for playback on a headphone.

B. Magnetic door sensor

To provide door security proposed system used magnetic reed RF-02 Door sensor. If any personal tries to open the door illegally or if 2 sensors are separated then the device gives indication on LED and green LED starts blinking.

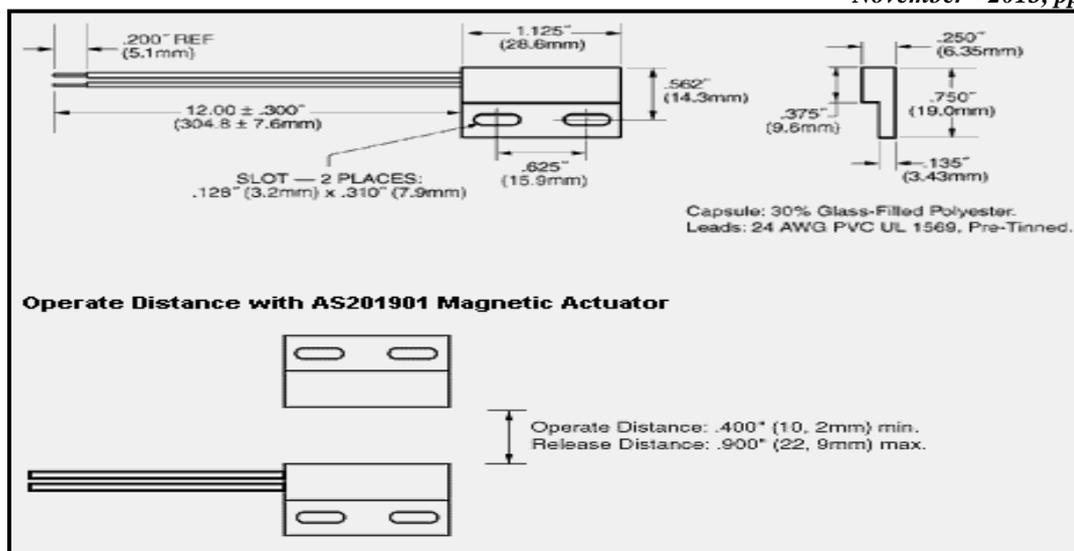


Fig 3: Working of RF-02 Door Sensor

C. Light Intensity

Light intensity can be monitored by using LDR (Light Dependent Register). An LDR is a component that has a resistance that changes with the light intensity that falls upon it. They have a resistance that falls with an increase in the light intensity falling upon the device.

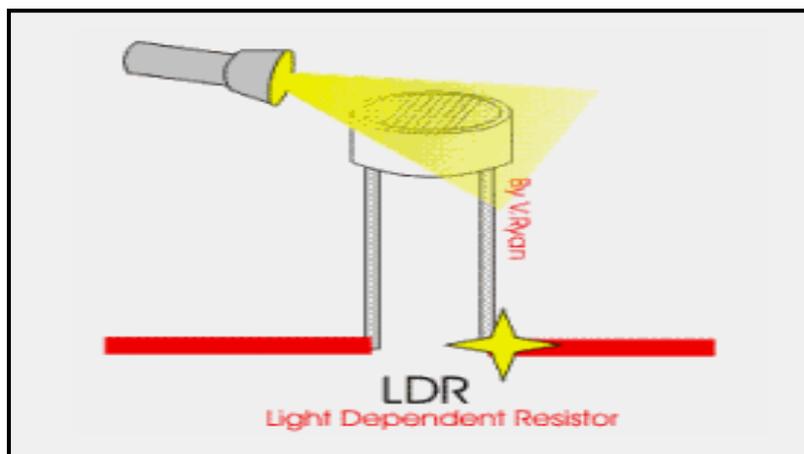


Fig 4: Fall of resistance on LDR

When the light level is low the resistance of the LDR is high. This prevents current from flowing to the base of the transistors. Consequently the LED does not light. However, when light shines onto the LDR its resistance falls and current flows into the base of the first transistor and then the second transistor. The LED lights. The preset resistor can be turned up or down to increase or decrease resistance, in this way it can make the circuit more or less sensitive.

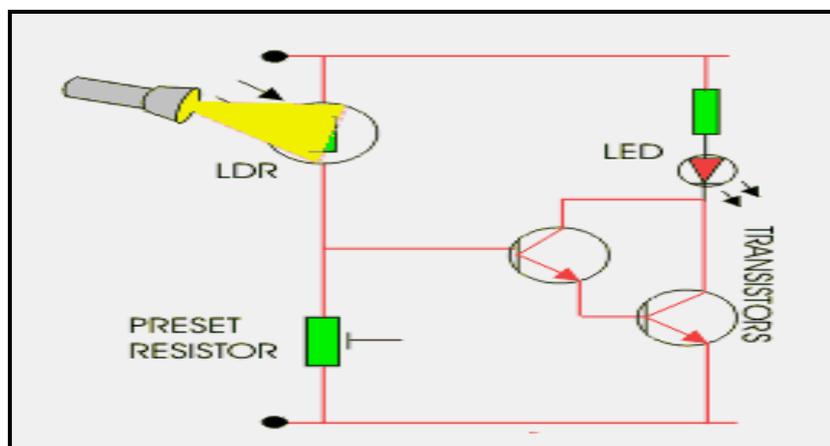


Fig 5: working of preset register

D. Audio Monitoring

One of the parameter of a proposed system is to detect voice of infants to check whether she/he is ok or crying for this monitoring following is the setup where in audio outputs are transferred to the control room.

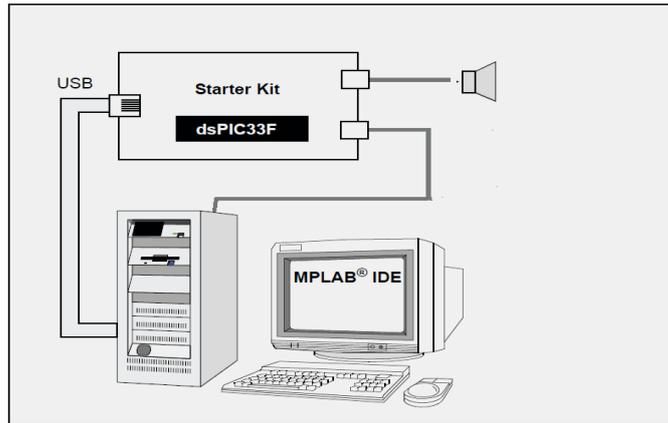


Fig 6: Setup for audio monitoring

HEADPHONE OUTPUT JACK (J8) is a 3.5 mm stereo connector. A 32-ohm headphone can be connected to this socket. We have connected here speaker for demo purpose. LINE/MICROPHONE INPUT PHONE JACK (J9).The Line/Microphone Input is a 3.5 mm mono input phone jack (SJ3504).This connection accepts either a condenser microphone or a line level signal. Here audio input is given from this. The WM8510 Codec Driver configures the WM8510 audio codec and provides an interface for reading and writing audio data to the codec. The driver uses the DCI module on the dsPIC33F device module to process data and the I2C Module as a codec control bus The G.711 Encoder and Decoder implement the ITU-T G.711 Speech Compression algorithm. This algorithm is an example of a waveform coder and provides a compression ratio of 2:1. The algorithm is implemented in G711.s and its interface is defined by G711.h. The Serial Flash Memory driver uses the SPI peripheral on the dsPIC33F device to interface with the external serial Flash memory device. The driver requires a buffer for its operation and this buffer must be allocated by the application. The driver allows the application to perform operations such as read, chip erase, sector erase and status check.

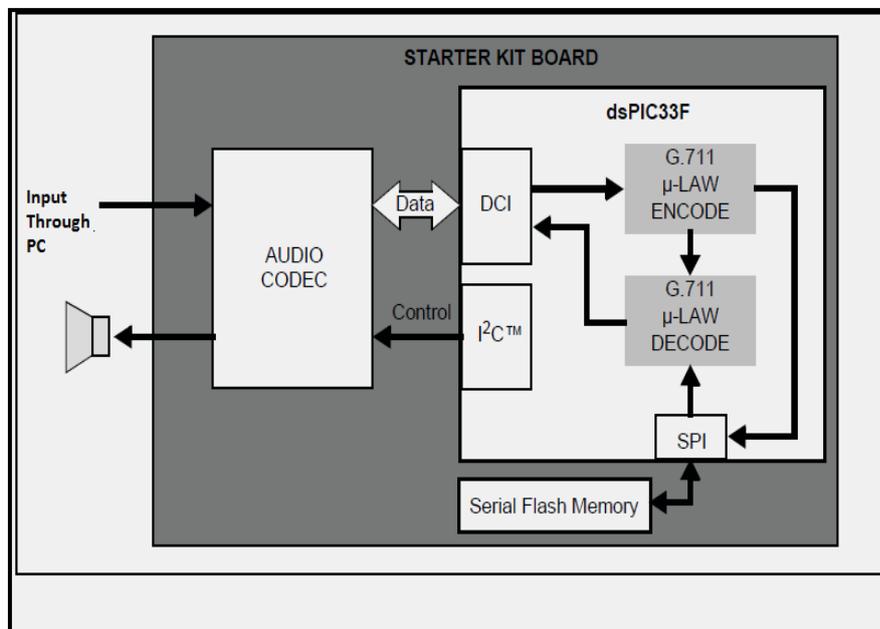


Fig 7: Audio input overview

III. CONCLUSIONS

This paper discussed a design of embedded device for incubator for the monitoring of infants. The device would involve DSPIC Processor DM330011 and sensors which can be interfaced with processor. The system will monitor the 3 parameters Door, Light, Audio/ voice of the baby that he/she is ok or crying. The Door parameter provides an Intruder bell it will gives alarm/Led indication if any person will come at the place /Room of baby by breaking the sensor. Light Intensity can be monitored by using LDR (Light dependent register). All these parameters are continuously monitored by system & will display the status on LEDs or gives alarm.

IV. FUTURE SCOPE

The future of project as it will monitor temperature of baby incubator by using Temperature sensor TC1047. It is inbuilt available with DSPIC DM330011. It will also monitor the humidity of the incubator. We can monitor more parameters like oxygen level and at the same time control them .We can send this data to a remote location using mobile or internet. We can draw graphs of variations in these parameters using computer

V. APPLICATIONS

This embedded device gives more robust protection as it is providing door security and monitoring of light intensity, audio or voice detection. So this approach is more suitable for the continuous monitoring of infants under clinical and home conditions.

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