

NEONATAL INTENSIVE CARE UNIT

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Abstract: Today, technology is advancing in all possible directions, especially in the field of health and care products especially where the requirements are supporting life. Additional care is taken when it comes to babies. Especially in case of premature (infants that come into the world earlier than full-term) babies/Low birth weight (less than 1 Kg) babies, who wouldn't have developed the thermo-regulatory mechanism (*i.e.* not able to adjust to the outside environmental temperature because of lack the body fat) the precaution is doubled.

The Neonatal Intensive Care Unit (NICU) is designed to provide an atmosphere that limits stress on the infant and meets basic needs of warmth, nutrition, care and protection to assure proper growth and development. In such cases babies have to be kept either naked / half-naked in an incubator (which has the capability to maintain the temperature inside it and comforts the baby).

The aim of this project is to develop a Neonatal Intensive Care Unit with the following features:

- PC Control And Monitoring of NICU
- Neonatal Intensive Care Incubator (NICI)
- Two modes: Baby Mode, Air Mode
- Temperature Monitoring
- Feeding Inlet
- Prevent Infection
- Heartbeat Reader
- Radiant warmers
- Head Up and Head down Option

Neonatal Intensive Care Incubator (NICI): The Incubator, which is used to keep the babies warm, is an insulated enclosure in which environmental conditions (temperature) can be regulated at levels optimal for growth, and metabolic reactions to give baby proper care. Incubator is made up of transparent material, and will completely surround infant to keep it warm and to maintain the normal body temperature (*i.e.* 37 degree Celsius), decreases the chance of infection, and limit water loss by maintaining the humidity level. The Insulated enclosure helps in giving protection because Infection is a big threat to premature infants as they are less capable to fight germs that can cause serious illness.

Incubator when kept in the baby mode in critical conditions, the sensors will be patched to the baby's skin and will consider the baby's body temperature to maintain the temperature of the environment and the required temperature will be set from the PC by the doctor.

Incubator when kept in the Air mode in Non-critical conditions, the sensors will be left in the air to consider the temperature inside the incubator to maintain the temperature of the environment and the required temperature will be set from the PC by the doctor.

The sensors will be clamped/patched up to the thumb, toe, heel or ear lobule and temperature, humidity and heart beat rate will be displayed on the PC.

Radiant warmer is an electrically warmed bed open to the air, which is used when the medical staff needs frequent access to the baby for care. In this the temperature is maintained by a controlled radiation of heat by using heat source and a shade, 2ft distant from the baby.

The tray/base containing baby can be lifted up /down near the side of head. Head Up option is required after feeding, to stop food enter into the trachea/respiratory system And Head Low option is required in case of Respiratory problems.

Keywords: Neonatal, Incubator, Premature, Thermo-regulatory, Radiant, Insulated.

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1. INTRODUCTION

Today, technology is advancing in all possible directions, especially in the field of health and care products especially where the requirements are supporting life. Additional care is taken when it comes to babies. Especially in case of premature (infants that come into the world earlier than full-term) babies / Low birth weight (less than 1 Kg) babies, who wouldn't have developed the thermo-regulatory mechanism (*i.e.* not able to adjust to the outside environmental temperature because of lack the body fat) the precaution is doubled.

The Neonatal Intensive Care Unit (NICU) is designed to provide an atmosphere that limits stress on the infant and meets basic needs of warmth, nutrition, care and protection to assure proper growth and development. In such cases babies have to be kept either naked/half-naked in an incubator (which has the capability to maintain the temperature inside it and comforts the baby).

A prospective contraption of PIC18F4520 based Incubator is deemed to be a noticeable tuning point as this is micro-controller controlled and is completely automatic, hence enabling the work to be done efficiently and without mistakes.

Scope of Study: Incubators have been around for quite a while now and have been aiding premature infants from ever since. This paper's focus is on presenting a completely automated version of the same, using the PIC 18F4520 and ZigBee technology which will effectively help us in reducing costs as well as complexity, thus making it more feasible for practical implementation.

2. PROPOSED WORK

The two most important features that are being implemented are:

- PIC18F4520
- ZigBee Modem

Detailed functional block diagram

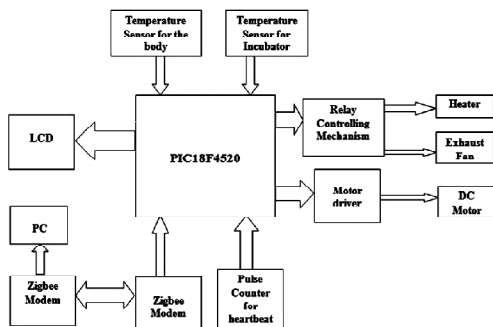


Figure 1: Detailed Functional Block Diagram

3. BRIEF DESCRIPTION OF EACH BLOCK

Temperature Sensor: Two temperature sensors are used. One, for the premature infant and the other, for the Incubator. The type of temperature sensor we are using here is **LM35**. The specifications of temperature sensor are coded such that if the sensor detects that the temperature is 34° Celsius or greater, the fan will get switched on automatically, in order to reduce the temperature to an optimum of 22-27° Celsius. Likewise, if the sensor detects that the temperature has reduced to 20° Celsius or less, the heater will automatically get switched on (which, in our case, is a bulb) to increase the temperature up to the desired value.

Pulse Counter: The idea is to use a heart beat sensor which detects the heart beat when a finger is placed in it, by determining the Blood volume at the finger tip. The sensor calculates the average value of the heart beat and displays it for every five seconds. This process is repeated twelve times, every five seconds. Thus, at the end of a minute the average value of the heart beat for twelve readings is determined and displayed on the LCD. If the heart beat exceeds the normal rate, a message will be sent to the LCD Display as well as the monitor, which displays that the heart beat is above or below normal and the required corrective measures are undertaken.

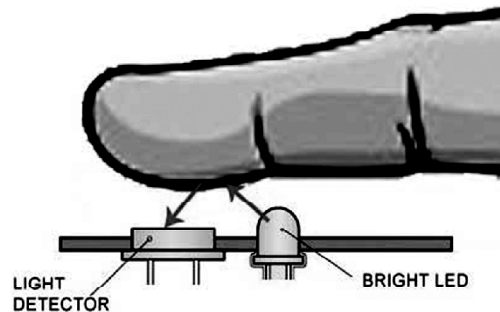


Figure 2: Heartbeat Sensor

Heater: The heater is used to increase the temperature if it has exceeded the specified value and bring it up to the normal value, hence protecting the baby. The heater used in our project is demonstrated in the form of a bulb. A relay circuit is used for the switching mechanism of the heater.

Fan: The fan is used to decrease the temperature if it has exceeded the specified value and brings it down to the normal value, hence protecting the baby. A relay circuit is used for the switching the voltage from 5V to 12V, which is the Voltage required to run the Fan.

Motor Driver: L293D is a bipolar motor driver IC. This is a high voltage, high current push-pull four channel driver compatible to TTL logic levels and drive inductive loads. It has 600 mA output current capability per channel and internal clamp diodes.

All inputs are TTL compatible. Each output is a complete totem-pole drive circuit, with a Darlington transistor sink and a pseudo-Darlington source. Drivers are enabled in pairs, with drivers 1 and 2 enabled by 1,2EN and drivers 3 and 4 enabled by 3,4EN.

When an enable input is high, the associated drivers are enabled, and their outputs are active, in phase with their inputs. When the enable input is low, those drivers are disabled, and their outputs are off and in the high-impedance state. With the proper data inputs, each pair of drivers forms a full-H (or bridge) reversible drive suitable for solenoid or motor applications.

DC Motor: A DC motor is an electric motor that runs on direct current (DC) electricity. DC motors can rotate in both directions depending upon the polarity of current through the motor. These motors have free running torque and current ideally zero. These motors have high speed which can be reduced with the help of gears and traded off for torque. Speed Control of DC motors is done through Pulse Width Modulation techniques.

Concept of Brushless DC Motor: This design is simpler than that of brushed motors because it eliminates the complication of transferring power from outside the motor to the spinning rotor. Advantages of brushless motors include long life span, little or no maintenance, and high efficiency.

Relay: A relay is an electrically operated switch. Current flowing through the coil of the relay creates a magnetic field which attracts a lever and changes the switch contacts. The coil current can be on or off so relays have two switch positions and most have double throw (changeover) switch contacts as shown in the diagram.

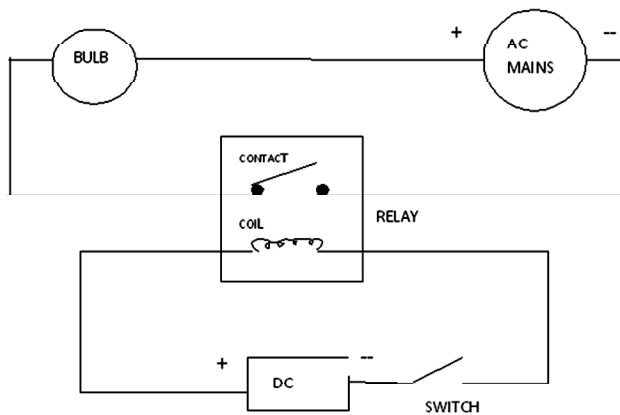


Figure 3: Relay Circuit

Relays allow one circuit to switch a second circuit which can be completely separate from the first. For example a low voltage battery circuit can use a relay to switch a 230V AC mains circuit. There is no electrical connection inside

the relay between the two circuits; the link is magnetic and mechanical.

When Switch near DC source is closed the Relay coil gets energized and it attracts the Relay contact towards it. The Relay Contact is closed and the AC Mains circuit gets a closed path and the Bulb glows.

Thus a Relay is DC operated but controls AC.

Alpha-numeric LCD display: A liquid crystal display (LCD) is a flat panel display, electronic visual display, based on Liquid Crystal Technology. A liquid crystal display consists of an array of tiny segments (called pixels) that can be manipulated to present information. Liquid crystals do not emit light directly instead they use light modulating techniques. We are using a 16x2 Display, which means that 16 characters can be displayed in a single line, and we are using two such lines.

There are two types of registers; Data register and Command register. In the command register, the functions of the LCD are specified and in the Data register the particular value is stored. The LCD is used to display Room Temperature, Body Temperature, Pulse counter, and also to indicate if the temperature is high or low.

ZigBee Modem: ZigBee is a specification for a suite of high level communication protocols using small, low-power digital radios. The technology defined by the ZigBee specification is intended to be simpler and less expensive than other WPANs, such as Bluetooth. ZigBee has a defined rate of 250 kbps best suited for periodic or intermittent data or a single signal transmission from a sensor or input device.

ZigBee Modem is preferred over BlueTooth, because it offers a much wider radius of operation for the same cost, as for an equivalent BlueTooth Network, thereby reducing the effective cost of construction. Hence it is clearly more advantageous than a BlueTooth network.

Here, the ZigBee Modem is used to communicate wirelessly between the Incubator and the PC and the operation is completely automated.

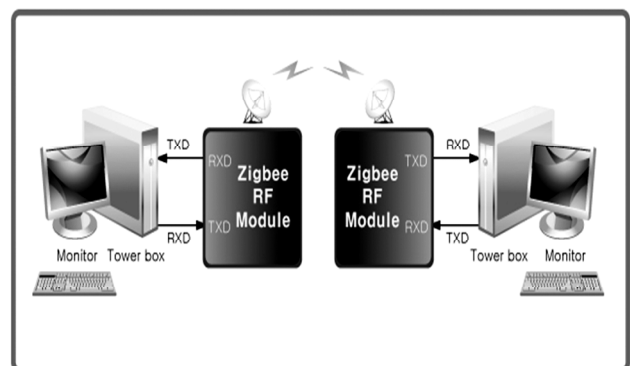


Figure 4: Block Diagram for the ZigBee Modem

PIC18F4520

The main features of this microcontroller are:

- Sleep mode
- Watchdog timer (WDT)
- Code protection
- In-circuit serial programming
- In-circuit debugger

4. APPLICATIONS AND FUTURE SCOPE

4.1 Applications

- **Oxygenation:** Adequate supply of oxygen and ventilation is supplied to the infant to make it breathe easy and proper medication is given in appropriate quantity to correct its respiratory system.
- **Administration of medicines:** The supply and control of medicines that should be given to the infant at the appropriate time and the required quantity is monitored which results in the well being of the baby.
- **Protection from cold, infection and noise:** The incubator is designed to provide the infant with a secure and comfortable environment which is free from noise, very hygienic to protect the infant from any possible infections, and facilities like the heater are provided to protect the baby from cold temperature.
- **Provision of nutrition:** The required supplements and nutrition to the baby is fed to it by means of a catheter, and for easier feeding operations, head-up and head-down operations are provided.
- **Maintaining the fluid balance:** The enormous number of fluids supplied to the infant in order to make sure that all its vital organs are functioning correctly have to be maintained according to the proportions prescribed. The incubator incorporated this facility.

4.2 Future Scope

- Besides the features shown in this paper, there is always scope for improvement in every field, especially in the field of medicine. Hence, more advanced features can be added to provide an error free, sophisticated Incubator for the protection of the infant.
- Using technology, one can hope to find a means by which the operating range can be made more than 10 meters at a more reasonable cost, than what the ZigBee has currently got to offer.

- This can be implemented in all the hospitals in the near future, which makes it less complex for the doctors and more fool proof for the infant.

In addition to all the aforementioned, several other features can also be added, as per the requirement.

1. To further automate the system, a low power alarm can be installed such that, whenever the temperature or heartbeat crosses a certain threshold value, the alarm goes off and alerts the concerned people.
2. Sound monitoring can also be done, such that whenever the infant feels discomfort and cries out, the sound triggers an alarm of sorts or a message (Text or mail) is sent to the concerned authority.
3. Video cameras can also be installed so as to further monitor the situation in a more holistic manner.
4. Also, computerized systems can be developed which provide timely medication and required nutrition to the infant automatically, as and when required.

5. CONCLUSION

The need for the advancement in technology and the invention of useful products and equipments is to primarily benefit the common man and the society as a whole.

The design approach used here has given satisfactory results and the PIC microcontroller is sufficient for measuring the required parameters. The power consumption has been kept as low as possible and the measurements made by the device are quite reliable. Accordingly, a highly interactive user friendly controller was developed. The module which is developed will make the job of the process easier. The user module has resulted in reducing the work of humans, hence making it more comfortable.

The module is therefore functioning as a very good tool. Incorporating the future enhancements as specified earlier would make the software a perfect tool in the medical field, which would greatly benefit the users.

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