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# Arduino and Iot Based Child Monitoring System Using Gsm Module

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**Abstract—** *This paper presents a design of a Baby Monitoring System based on the GSM network. A prototype is developed which gives a reliable and efficient baby monitoring system that can play a vital role in providing better infant care. This system monitor vital parameters such as temperature, pulse rate, moisture condition, movement of an infant and using GSM network this information is transferred to their parents. Measurements of this vital parameters can be done and under risk situation conveyed to the parents with alarm triggering system to initiate the proper control actions. The system architecture consist of sensors for monitoring vital parameters, LCD screen, GSM interface and a sound buzzer all controlled by a single AURDINO. The output display is corresponded to temperature and smoke level and wet level and sound level. The devices are tested for accuracy and reliability*

**Keywords-** Baby monitoring, vital parameters, microcontroller, GSM network.

## I. INRODUCTION

In India, both the parents need to work and look after their infant, so more workload and stress is there in such families, especially on female counterparts. Increasing female participation in various work fields have given rise to a need where Women have to take care of their family and at the same time handle the work pressure. Subsequently, infant care has become a challenge to many families in their daily life. Mother always worries about the well being of her baby while working. In order to tackle this, a "Baby Monitoring System" can be developed which would help the parents to track the infant‟s health and also obtain continuous updates of health.

Besides this, the system will also notify the parents about the abnormal situation so that they can take appropriate steps accordingly. The system will help the parents to take care of their child not only when they are at home but also when they are at the office or outside their home. this system will provide peace of mind to parents when they are away from their infant as they can obtain the updates of health of baby. Communication is done by GSM interface in which Short Messaging Service (SMS) is a fundamental part.

Earlier the manual participation was required for monitoring babies which was a tedious job. With the advancement in technology, various different types of baby monitoring systems were introduced such as Sound Monitors which included the use of transmitter and receiver to transmit the voice of baby to its parents. The main drawback of this system was that the device was capable of transmitting the voice only in one direction that is from baby to its parents but not vice versa.Another system that used Video Monitors displayed the video of baby‟s live activities continuously to parents. The problem with the above systems was that they were inefficient to take appropriate care of the baby as they either used video or audio which was inefficient to provide the proper information and parameters of baby's health. Usually, when a young baby cries, the cause is one of the following things i.e. they are hungry, tired, not feeling well or need their diaper changed. So we developed a prototype which can monitor the activities of the babies and/or infants along with finding one of the above causes and give this information to their parents. This proposed system focus on the information that it receives from sensors which would be helpful to maintain health of a baby by transmitting

information. The Text messages are sent to parents in order to provide the live updates of baby's health and thus overcome the drawbacks of the above-mentioned systems.

## II. LITERATURE SURVEY

Andre G. Ferreira et al. A Smart Wearable System for Sudden Infant Death Syndrome Monitoring, SIDS i.e. Sudden Infant Death Syndrome is one of the major causes of death among infants during sleep. The wearable IoT device is a wireless sensor node integrated into a chest belt, and it monitors parameters such as body temperature, heart and breathing rates and body position. If a critical event occurs, the device will trigger an alarm, visible and audible in the proximity and sends a distress message to a mobile application. [1]

Mairo Leier et al. Miniaturized Wireless Monitor for Long-term Monitoring of Newborns, Wireless infant monitoring system is a small size wearable sensor platform. In this paper; they proposed a monitoring system that detects the most important vital signals of baby and transmits results over a wireless link to the control device that could be any Smartphone. By measuring the raw signals, it is possible to use this system in different, possible life threatening situations during long-term monitoring. [2]

Angelo M. Fonseca et al. A Sudden Infant Death Prevention System for Babies, the Sudden Infant Death Syndrome (SIDS) is an expert diagnosis when an apparently healthy baby dies due to some imperceptible cause. This paper proposes a mobile solution based on biofeedback monitoring that tries to prevent the sudden death of infants. When an issue is detected by this system, it sends a warning to parents. Mobile devices are used to process the sensed data and monitoring baby and performing alerts/ warnings when an abnormal situation is detected. [3]

Savita P. Patil et al. Intelligent Baby Monitoring System, this system monitors vital parameters such as body temperature, pulse rate, moisture condition and movement of an infant. By using GSM network, this information is transferred to their parents. Measurements of these vital parameters can be done and under risk situations, this information is conveyed to the parents with alarm triggering system to initiate the proper control actions. The system architecture consists of sensors for monitoring vital parameters, LCD screen, GSM interface and a sound buzzer which are controlled by a single microcontroller core. [4]

Octavian Dospinescu et al. Implementing Monitoring Systems in Mobile Applications a Case Study, this case study is presented for a monitoring system using the Android platform and the benefits of computer Networks. The power of mobile sockets and mobile threads is integrated into a complex architecture in order to obtain a real monitoring system. As an immediate application, a baby monitoring system is proposed where children could be remotely supervised by their parents. The case study is based on Android mobile client-server architecture and also uses the capabilities offered by the phones speaker and microphone. [5]

V.Ramya et al. Embedded Patient Monitoring System, the condition of patient in ICU can be informed to the doctor through wireless. In medical professionals, it is necessary to continuously monitor the condition of patient to track their health and understand various parameters. A device is introduced which can monitor continually and do the data logging without any interruptions. Moreover, in the critical condition, an alarm could be raised and concerned doctor is notified using SMS. [6]

G. Rajesh et al. Baby Monitoring System Using Wireless Sensor Networks, sudden death of an infant during sleep which remains unexplained even after death investigation is marked by SIDS. This system provides solutions by making a smart crib using WSN i.e. Wireless Sensor Networks and Smart phones. The service of visual monitoring is also be provided through live video. The alert services can be provided by making use of fencing of the crib. Also, monitoring services can be delivered by temperature reading, vaccine reminder and weight monitoring etc. [7]

Yedu Manmadhan et al. Remote Patient Monitoring System, this paper provides an image-based techniques to acquire and analyze a constant streaming of ECG signal through the digital camera for image capturing, information extraction and analysis performed using MATLAB tools as well as data sending system based on Internet network. This method captures the vital signs and parameters from

the ICU monitoring machine using web camera and transmits the image through the Internet. This original image is then availed to the consulting doctor via an ANDROID cell phone. In case of an anomaly, a notification is sent to the doctor's phone. The paper proposes a method to capture, compare and generate an alert regarding the patient's condition using the heart rate and make the captured image be available to the physician. [8]

Suresh B et al. Advanced Baby Care System, constant Monitoring of the child is necessary especially up to an age of 18 months. In this, a mobile robotic device has been designed and developed which can help a parent to track their baby and its surroundings without having to check on the baby every now and then. Advanced Baby Care System (ABCS) has a Master Controller (Arduino Mega 2560), which integrates all the different modules of the robot by receiving the necessary signals from the sensor modules and sending signals to the trigger alarm and the DC motors. It is a microcontroller board based on the ATmega328. This board can be easily interfaced with the CMUCam5 module, used for tracking, as well as other sensors which are being used in the project. ABCS is an intelligent, baby friendly system, which integrates many functions into a single device, automatically alerting the parent when it is necessary and allowing them to carry on with their activities uninterrupted. [9]

Chanakya Mothukuri et al. Patient Monitoring System, in present days, real-time monitoring of the physical condition of the patients is one of the major challenges faced by hospital authorities. Here, a Patient monitoring system is implemented which will be one of the major improvements in the hospitals. All the hospitals today have the monitoring systems which are wired. Also, human intervention is needed frequently for critical patients. In this proposed system i.e. PMS (Patient Monitoring System) is operated wirelessly. This wireless patient monitoring system in this paper measures heartbeat, body temperature and percentage of oxygen in the blood. This paper discusses the design and development of a low-cost apparatus which uses GSM technology for monitoring the health condition of the patient. [10]

## III. SYSTEM ARCITECHTURE

The architecture of the system consist of both hardware and software. Block diagram is as shown in Fig.1,hardware components were assembled according to the block diagram. The code is written in embedded C and is burnt into the microcontroller

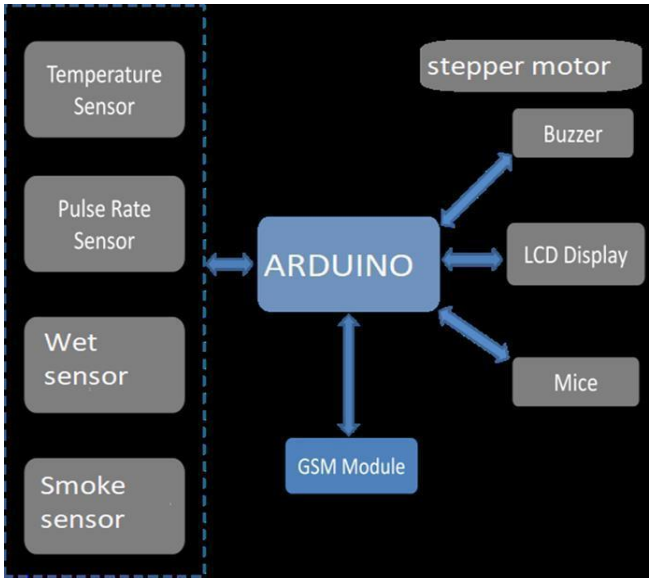



**Fig. 1. Block Diagram of Proposed System**

The following subsections provide more details of the components used in our prototype:

### Temperature Sensor

Human body needs special type of sensors for reliable readings which led to the choice of using the LM35 temperature sensors in our prototype[1,6]. It operates at 3 to 5 V and can measure temperature in the range of - 40 C to +125 C which is sufficient for the targeted body temperature range .It is having linear response and easy conditioning. The sensor's output is an analog DC voltage signal which is read by the microcontroller using an analog pin linked to an ADC. The ADC used has a resolution of l0-bits, 1024 levels, with a sample rate of 9600 Hz and input voltage range depending on the ground and Vee. The output voltage of the LM35 is analog and in the linear range of -1 V to 6 V with accuracy of ±0.5 °C can be converted from volts to degrees of Celsius and Fahrenheit .

The placement of sensors is also important for accurate measurements. In our prototype it is placed in the socks of an infant wrapped in cotton so that no irritation made.

The temp sensor and actual readings are listed in table below:

TABLE I

| Serial No | Actual Temp ( $^{U}$C) | Practical Temp($^{U}$C ) |
|---|---|---|
| 1 | 32 | 36.1 |
| 2 | 31 | 35.6 |
| 3 | 32.5 | 36.7 |
| 4 | 33 | 37.2 |

B. Pulse Rate Sensor

Fig. 1. Block Diagram of Proposed System

The following subsections provide more details of the components used in our prototype:
subject. Pulse rate signal is applied to the Non-inverting input terminal as shown in Fig. 2.Voltage gain of Non Inverting amplifier is given by Equation 1+ Rf/R1.

Gain=1+ 180/1=181.

This amplified signal is given to comparator circuit where voltage divider circuit is used. Voltage at non-inverting input is compared with reference voltage and whatever voltage is generated is applied to the base of transistor. There is a 100 Ohm resistor at the base of transistor used to limit the current flowing to the base of transistor. As soon as the voltage across this resistor increases beyond 0.7V the transistor turns ON and at the output we get 0v and the LED D2 glows.

The pulse-rate sensor and actual readings are listed in table below:

TABLE II

| Serial No | Actual pulse rate | Practical pulse rate |
|---|---|---|
| 1 | 72 | 78 |
| 2 | 66 | 72 |
| 3 | 70 | 76 |
| 4 | 54 | 60 |

C. Moisture Detection Sensor

To determine the moisture condition i.e. urine detection ,two pairs of copper electrodes are placed under the cloth on which baby is sleeping. The signal obtained is given to microcontroller.

The components used are 5mm photodiode and 5mm light emitting diode. The system consist of IR transmitter and receiver, high pass filter ,amplifier and comparator .By using this circuit component biological signal in mill volt is converted to larger magnitude about one to two volt and then send it to the microcontroller.

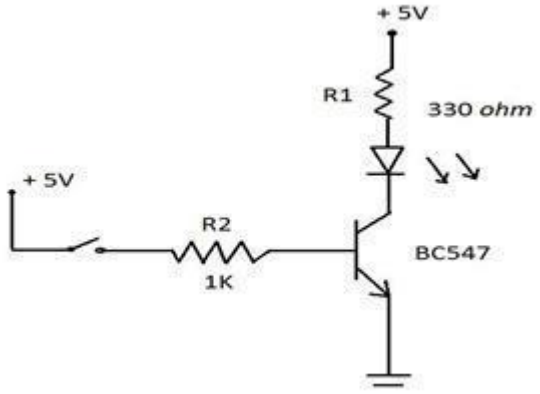



Fig. 3. Moisture Detection Circuit

For detection of urine ,transistor as a switch circuit is used as shown in Fig.3 When urine is present switch is closed transistor turns on. When urine is absent switch is open, transistor turns off.

D. Motion Sensor

An accelerometer is an electromechanical device that will measure acceleration forces. These forces may be static, like the constant force of gravity pulling at our feet, or they could be dynamic - caused by moving or vibrating the accelerometer. By measuring the amount of static acceleration due to gravity, one can find out the angle the device is tilted at with respect to the earth. By
sensing the amount of dynamic acceleration, one can analyze the way the device is moving. Accelerometers use the piezoelectric effect - they contain microscopic crystal structures that get stressed by accelerative forces, which cause a voltage to be generated. The three axis accelerometer are basically used to identify the movements across the three axis i.e. x-axis, y-axis, z-axis. The accelerometer used in this system is ADXL335, [20] which is small low profile package, can measure minimum full scale range of +/- 3g as shown in Fig.4.In this way movement of an infant is monitored by placing accelerometer properly. It is positioned in the socks of an infant so accurate motion will be detected.

E. LCD screen

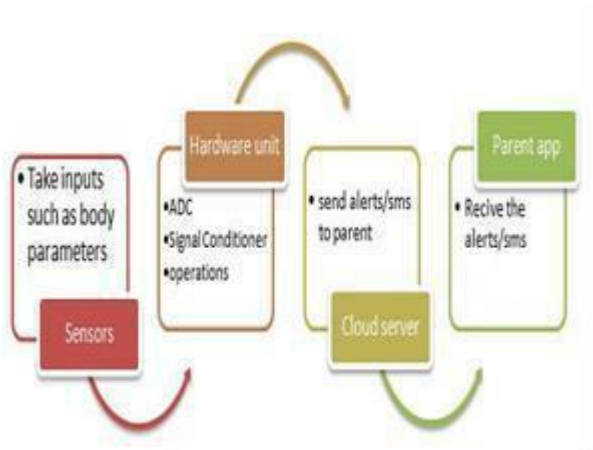
In our prototype 16 X 2 LCD module is used. It has 2 rows and 16 column therefore total 32 characters are displayed. It has two operation modes, one uses all 8 pins and the other uses only 4 of them. The 4-bit mode was used to manage the LCD screen. All sensor output is displayed continuously as it is being measured.

F. GSM Module

GSM (Global System for Mobile communication) is a digital mobile telephony system. With the help of GSM module interfaced, we can send short text messages to the required authorities as per the application.

## A. PROPOSED METHODOLOGY

In this paper, the proposed methodology, tries to overcome the limitations of the earlier system.
It mainly consists of sensors, hardware unit, cloud server and parent's application. The following diagram shows how these all element interact with each other.




The system will take two inputs from the sensors which are pulse rate and oxygen level. Signal conditioner will be used for signal conditioning that will maintain originality of signal required for next stage of processing thus by eliminating noise for proper data acquisition.

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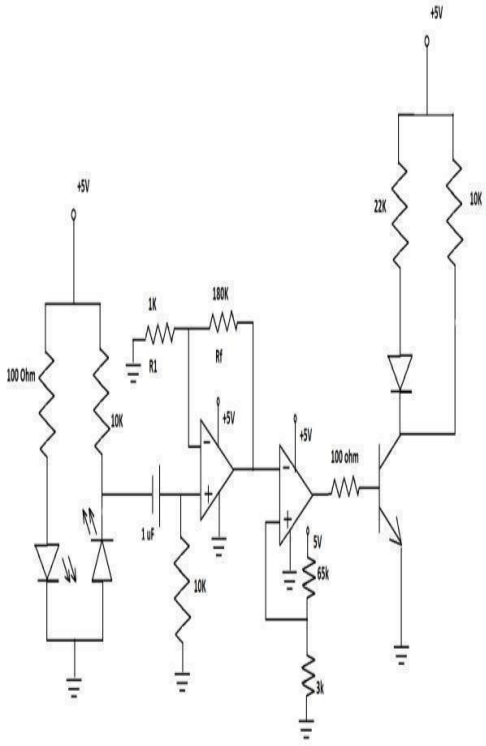
GSM module is provided by SIM uses the mobile service provider and send SMS to the respective authorities as per programmed. This technology enable the system a wireless system with no specified range limits. In this way, whenever the safe range of the vital parameter of an infant is violated, the programmed microcontroller produces an alarm and GSM Modem interfaced with the microcontroller sends an alert SMS to the parent's mobile number deploying wireless technology.

G. Controller

The PIC 18f4520 is an 8-bit microcontroller, which has an on-chip eight channel 10-bit Analog-to-Digital Converter(ADC).The amplified and conditioned sensor signals are fed to the microcontroller.

Pulse rate will be measured from the finger using optical sensors and displayed on the LCD. The transmitter-sensor pair is clipped on one of the fingers of the



## IV. SOFTWARE DETAILS

After the processing of the signals which are got from the sensors, They are converted into digital if necessary and are given to a decision algorithm which is previously written in the form of code and it is stored in the memory of a microcontroller. These signals are compared with the standard statistics of a normal standard values. Hence the continuous inspection of the patient which is in the intensive care unit is done using indicators and sensors. The output of the sensors, indirectly or in some form are connected to indicators. If the patient is in good health condition, then the indicator will display "BABY IS NORMAL", otherwise it will display "BABY IS ABNORMAL. It should be noted that: If the patient is normal, then no warning/alert messages are sent to the doctor; otherwise the doctor receives alert messages which indicate him to attend the patient immediately

Fig. 8. LCD displaying Infant's Urine detection condition

## V. RESULTS

The system was tested carefully on an infant, the results found to be same as the one's measured by standard instrument. While testing this system on an infant parent's concern was considered. During the execution of the system snapshots of the display were taken. The system being a complete hardware design and the data available on cell phone and LCD display have been captured. Test results of the system are given below, shows successful implementation of the system. Fig.5 and Fig.6 shows hardware module and the actual implemented system.Fig.7,8,9 shows a sample readings of infant onto the LCD attached to the module on an infant's side. The reading were matched to the readings taken by standard instrument and found to be same.Fig.10 and Fig.11 shows message received on parent's cell phone when some abnormal condition exists. Message shows temperature is high and moisture condition exists.



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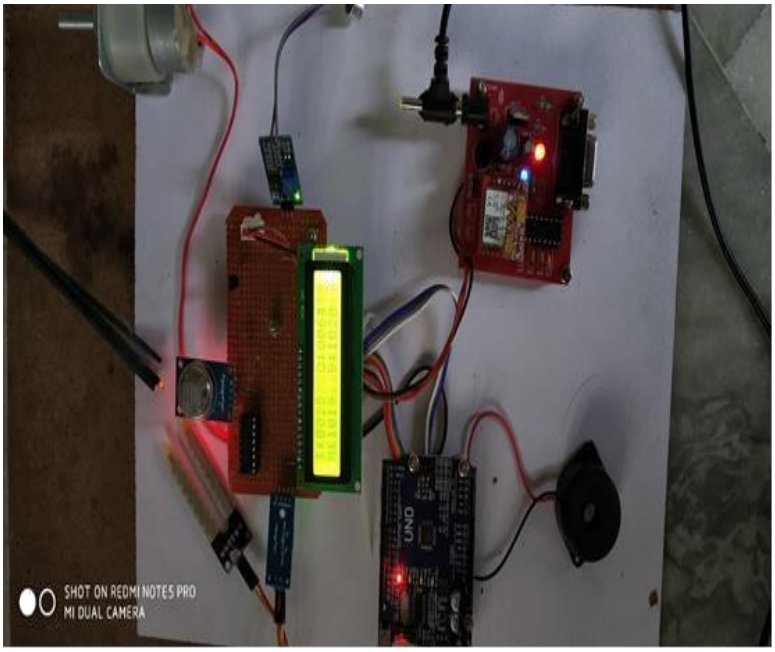
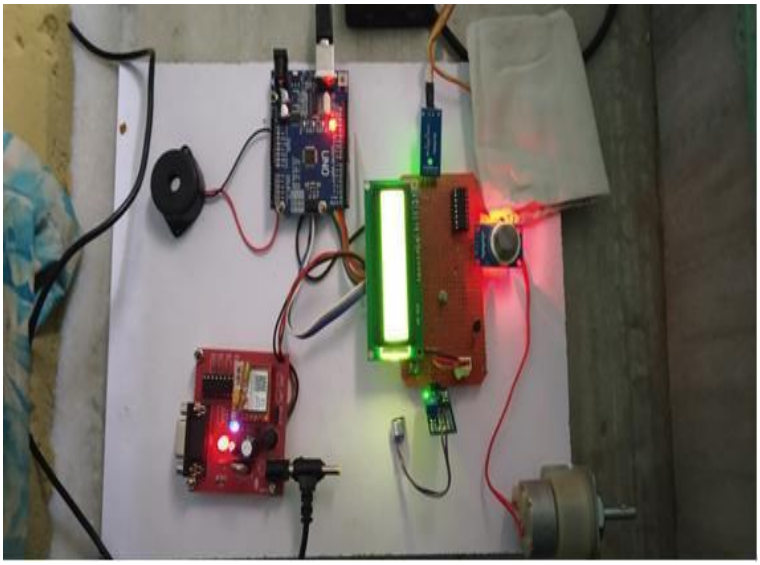



Results displayed when smoke sensor gets activated



Results displayed when wet sensor gets activated

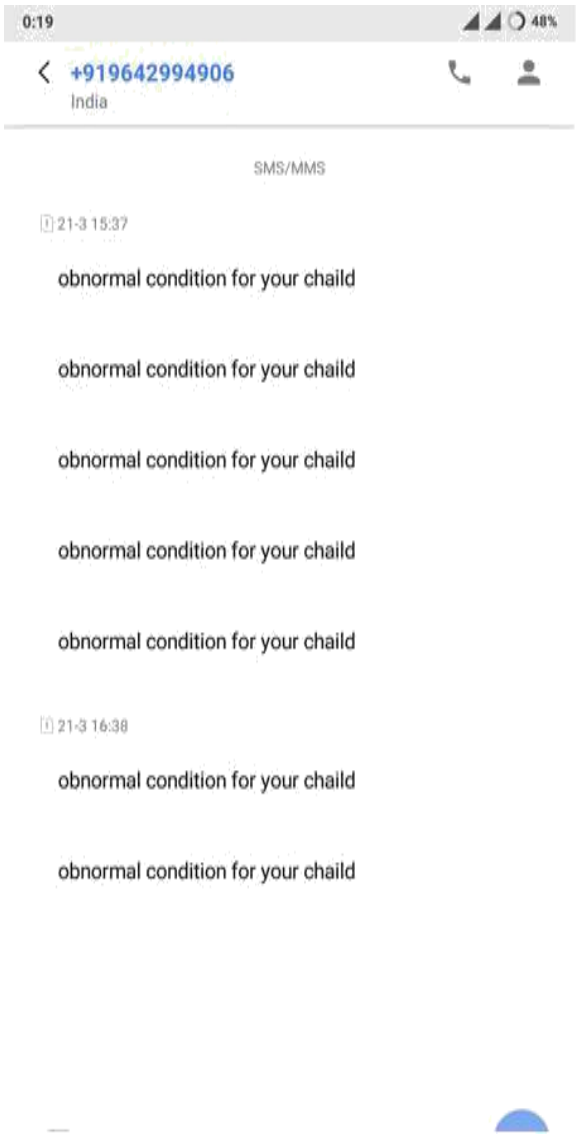



Fig. 11. Message received on parent's cell phone

## VI. CONCLUSION

Proposed Infant Monitoring System is an inexpensive and simple to use, which can improve the quality of infant-parent communication. This system expressively provides the parents with the feeling of assurance. The constant capturing of multiple biological parameters of the baby and analysis of the overall health helps mother to understand the internal status of the baby. As GSM technology is used which makes the users to communicate for longer distances. This is a convenient system to monitor the baby's health condition from any distance.

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