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Design of a Smart Baby Cradle Using Blynk and Local Customer Priorities

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Abstract

Nowadays, automation in the baby cradle system proved reliable and supports in effective baby monitoring. This system monitors the baby's mattresses condition, cry detection, body temperature etc., and thus provides better care for the babies. Also it makes the parents very easy to take care of the baby and experience those worry-free feelings. Especially for the professional women who are busy in their work schedules, always find scarcity of time to take care of the baby. As a concern of money, they are unable to afford a maid or nursery to look after their baby. In this paper, a local market is studied to decide the degree of automation and best suit mobile application required for the smart baby cradle. Three sensors are used such as a sound sensor for detecting the crying sound of a baby, a wet sensor for detecting the condition of mattresses, and a temperature sensor for detecting the body temperature. To make this automated cradle internet of things (IoT) based, a Blynk platform is used and this entire feature is monitored and controlled via mobile phone. An automatic swing motion of the cradle is provided using a link mechanism. Automation in the cradle allows the remote parent to take care of their baby, monitor its actions, and maintain the balance in their professional and personal lives.

Keywords: Blynk Mobile App, Link mechanism, Microcontroller, Sensors, Smart Baby Cradle.

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Introduction

In the present days, where both parents are busy in their professional life, it has become veritably tough for them to get enough time to look after their babies. It has been seen that most of the time babies stop crying or sleeping when they are in the cradle due to giving them a gentle swing movement. In the here and now, it's problematic for parents and nurses to sit close to their children and soothe them whenever they cry. In such a situation, parents fail to balance their duties at work and parenthood. So IoT-based automation of the baby cradle is carried out, which would support the parents and homemakers during their domestic work to look after their babies with paying the least attention. Also, it is a reality that professional women find it very tough to concentrate on her children due to busy house life schedule. The situation becomes more critical when her job or domestic business does not allow to compromise for attending her child's needs. That's why the automated cradle is the correct answer for it.

The automatic baby cradle system is not yet significantly common in developing countries where local manufacturers dominate the cradle demand. The targeted customer comes from families where members spend plenty of time with the baby.

The automatic baby cradle available in the market currently uses the DC motor to swing the baby buggy. The motor consumes more power and produces noise, which disturbs the baby and reduces the comfort degree of the baby. Whereas occasionally starting off, the baby cradle has to jerk full swing.

The introductory factors used in the current baby cradle are controller, motor, power supply, timer, and different sensors like voice detector, wet detector, temperature detector, etc. The timer is set to the controller which provides the movement to the cradle for a previous set time. The presented automation in the cradle is intended to furnish the following features as to reduce the labor of parents as well as take care of the baby, to control the system via the mobile app, to determine temperature, mattresses humidity, and crying voice of the baby, to operate the cradle as per the program specified, etc. This proposed cradle (Figure 1) is to serve not only for domestic application but at mass-utility

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Figure 1: Design Model of Baby Cradle with attached sensor

places like daycare centers, hospitals, etc. most conveniently and affordably.

In this paper, an Indian-style baby cradle available in the local market has been taken for IoT-based automation. The features to be incorporated are decided such as detection of temperature, baby pee, cry sound, etc. in the proposed cradle. A mechatronic system for the above-mentioned features is developed with due section and procurement of the mechanical and electronic components. For the operation and control of the cradle functions using mobile application, an internet of things (IoT) is applied.

Literature Survey

Due to the growing number of working couples in India, a smart baby cradle has fetched their attention to ensure a comfortable and reliable solution to monitor and remotely control their baby's conditions. Several kinds of research have been conducted[1-4] that have proposed the IoT-based smart cradle system for an individual parent purpose to monitor and control their baby's real-time condition. Their system has common components like sensors, a microcontroller, and an IoT platform. RabuaCheggou *et al.*[5] used a "Raspberry Pi 3 B +" card, a Pi camera, a sound, and temperature sensor along with a convolutional neural network to develop an intelligent baby monitoring system. Thus parents can identify and interpret the baby's status in his cradle. Yusuf Abdullahi Badamasi[6] has given an overall view of Arduino Uno by stating the hardware elements necessary in the given Arduino board and the corresponding software to program it (Arduino board) with the guidelines to develop own programs and few assignments based on Arduino project. Djedjiga Belfadel *et al.*[7] claimed that Arduino had gained a wide following among tinkerers and scholars for its ease of use and the ability to make interactive systems. H I Shahadi *et al.*[8] proposed a smart baby crib by furnishing multitudinous services in conventional and automatic modes. Tanveer Husain *et al.*[9] applied vision sensor IoT technologies to monitor infants in smart health care centers. K. Adalarasu *et al.*[10] has proposed an advanced neonatal incubator that includes the non-contact type temperature sensor DHT11 model, humidity sensor, photo-plethysmography sensor, respiration sensor, HC12 wireless communication module, rechargeable battery, and microcontroller (Arduino Uno), which are used for monitoring the health conditions of newborn babies. Rina Abdullah *et al.*[11] designed an effective food cover that can maintain the food warm and protect it from pests like flies and rats using a temperature sensor LM35 and a microcontroller ATmega328p. N N Mahzan *et al.*[12] designed a home fire alarm using the Arduino Uno board connected with the ATmega328 chip and LM35 temperature sensor so that after high-temperature detection, alert signals appear on LED display a SMS also goes to the user. B. O. Oyebola *et al.*[13] suggested a Digital thermometer that combines the similar microcontrollers to be interfaced with LM35 sensors, functioning with an embedded C programming language. Johan Sidén *et al.*[14] described the Smart Diaper Moisture Detection System. It is based on a paper-based disposable moisture-actuated RFID system that embodied into the conventional cellulose-based diaper. Foram Naik *et al.*[15] in their suggested model applied IR wireless technology for lower intricacy and ready access and the slider- crank mechanism employed for the swing, making the transition smooth.

Above discussed literature has paid the least attention to making the smart cradle local customer-oriented to limit the degree of automation so that it can be more affordable for the common man.

Table 1: Various components of Cradle Mechatronics System

S.No.	*Hardware Components*	*Software Packages*
1	Node Mcu Esp8266 Wi-fi Module	Arduino IDE
2	Arduino Uno AT Mega 823P	Catia V5
3	Sound Sensor KY038 module	Blynk
4	Temperature sensor (LM35 Sensor)	
5	Wet / Moisture sensor	
6	12 V DC geared motor	
7	12v power supply	
8	Emergency Switch	

Architecture of the Smart Baby Cradle System

The data of various systems needed for the IoT-based Smart Baby Cradle is decided to propose a well-integrated, flawless, and functionally proven smart baby cradle. A rigorous market survey is carried out to procure the best-suited components required for these systems. A careful assembly work of the system components is done to erect the desired systems.

A. Mechatronics System

The required components for this system are categorized as hardware and software (Table 1). The general selection criteria used for them are; it must be safe for the baby, Low cost, Compactness, Operating range, Response speed, Sensing range, User's friendliness, etc.

a) *Temperature Detection:* LM35 series is integrated-circuit temperature sensors in which an output voltage is directly proportional to the temperature in Celsius. In comparison with the over-linear temperature sensors calibrated in °Kelvin, the LM35 (Figure 2) has the advantage that the user is not required to subtract a large constant voltage from its output to obtain convenient Centigrade scaling. Here LM 35 and ADC have direct connections. The output of LM 35 has a linear change at +10mv/°C this change can be easily detected by the ADC hence there is no need for an amplifier circuit.

b) *Wet/Moisture Detection:* It has an application as to detect the Wet/Moisture and indicate the same with alarm. The Moisture sensor module/board is shown in Figure 3. This board inherently comprises Nickel coated lines that function on the principle of resistance. The sensor module uses analog output pins to gauge the moisture, but when the moisture threshold surpasses it, it gives digital output.

   This module is analogous to the LM393 IC because it comprises both electronic module and PCB. Then water drops are collected on the PCB. A parallel resistance path is generated when the rain falls on the board to calculate it through the operational amplifier. This detector has a resistive dipole based on the humidity that only shows the resistance value. For illustration, when it's dry, it exhibits higher resistance and shows lower resistance under wet conditions.

c) *Sound Detection:* This sound sensor is a highly sensitive sound detection module with Analog and digital output (Figure 4). This is an Atmega328 compatible module. Using this module one can even measure the intensity of ambient sound. Most of the digital sound sensor module just provides digital output i.e., if the sound is present or not. But this Sound sensor module also provides an analog output voltage proportional to the ambient sound intensity.

d) *Microcontroller:* Arduino Uno comprises an 8-bit ATmega328P microcontroller (Figure 5). To support the microcontroller, the crystal oscillator, serial communication, voltage regulator, etc. are provided. Here Arduino Uno is having 14 digital input/output pins (among which 6 are used as PWM outputs), and 6 analog input pins. The Arduino microcontroller has gained immense popularity in the field of hobby and professional market due to its easy-to-use. The market price of the Arduino hardware is reasonable and its software is available for free. Secondly, Arduino programming seems to be much similar if C programming is known. This is because the programming language of Arduino can be considered as a simplified version of C/C++. Now suppose the programming language, C, is not known, still there is not much difficulty because to perform useful functions requires only a few commands. A lucrative thing of the Arduino is that a control program can get created on the PC, and when fed to the Arduino it runs automatically. Even after disconnecting from the PC, still, the program will continue to run properly. Moreover, suppose the battery is removed and the Arduino board is kept not in use for six months thereafter, it reconnects the battery, it will continue to run the last program stored. In brief, if the board is connected to the host PC to develop the required program, to run it there is no longer a need for the PC,

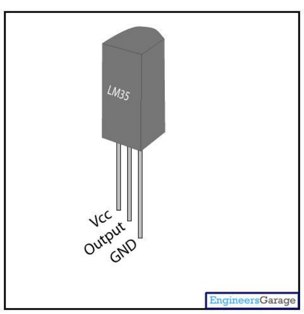

Figure 2: Temperature Sensor

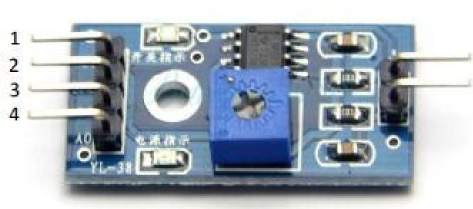

Figure 3: Rain-sensor Module

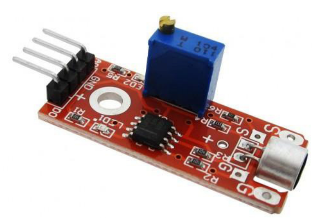

Figure 4: Sound Sensor

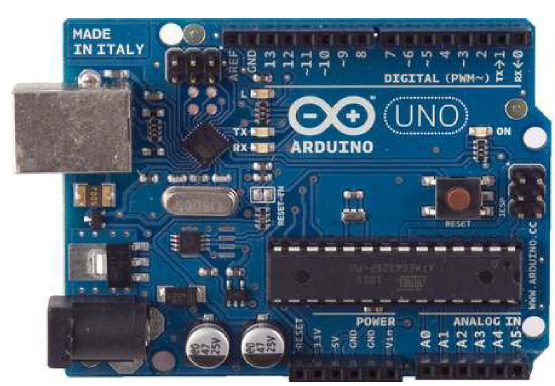

Figure 5: Arduino UNO AT Mega 328P

Figure 6: ESP8266NodeMCU Wi-Fi Devkit

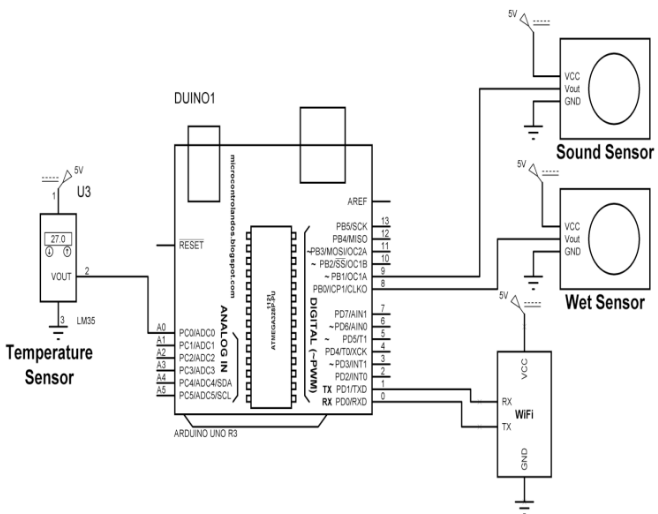

Figure 7: Circuit diagram

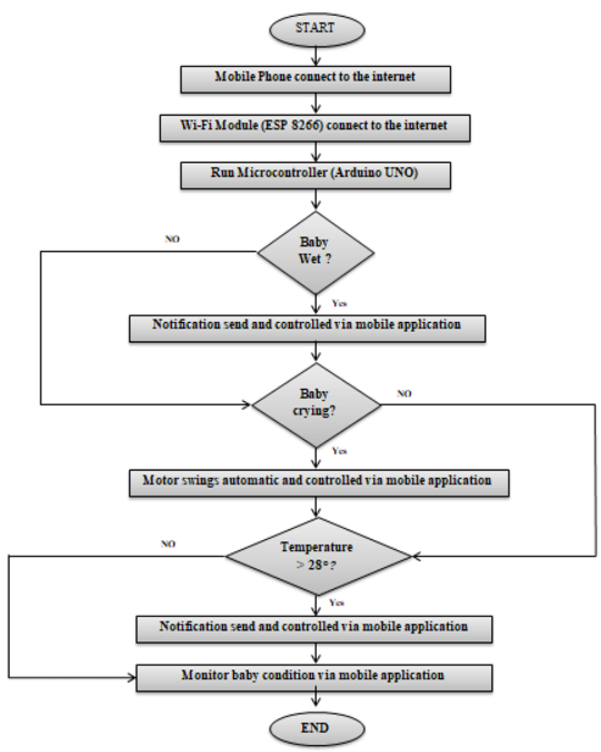

Figure 8: Flow chart of general workflow

It is required to refer the directions on the website of Arduino, http://arduino.cc/en/Guide/HomePage. Then follow all steps to where the pin 13 LED blinking is observed. This confirms that it is successfully installed and start executing the prepared programs.

Espressif Systems owns a microcontroller design of the ESP8266 NodeMCU Wi-Fi Devkit. (Figure 6). ESP8266 itself is an in-built Wi-Fi networking solution and enables the run of self-contained functions. It is associated with a embodied USB connector and a rich assortment of pin-outs. The NodeMCUdevkit is joined to the laptop using a micro USB cable and flashed without any difficulty, same as Arduino. It immediately integrates with breadboard.

In this system, three different sensors are used and all the sensors are connected to Arduino Uno At mega 328P Microcontroller as shown in the circuit diagram (Figure 7).

- Temperature sensor (LM 35 Sensor) – Lm 35 sensor connected to A0 pin of Arduino microcontroller it will detect a temperature and send the signal to the Arduino board and Arduino board.
- Sound Sensor (KY 038 Sensor) – Sound sensor connected to pin 9 detect the sound of baby and send a signal to Arduino board
- Wet Sensor – wet sensor connected to pin 8 will send a signal to the Arduino board.

After sending a signal to the Arduino board Arduino sends all the output to the Wi-Fi module, which is ESP 8266. And Wi-Fi module sends a signal to the mobile application.

B. BLYNK IoT Platform

It's a fully incorporated suite of IoT software. The entirety that desires to build and manipulate connected hardware is executed with Blynk App e.g. device provisioning, sensor information visualization, remote manipulate with mobile and internet programs, Over-The-Air firmware updates, secure cloud, data analytics, user, and accessibility, indicators, automation, and so forth. An engineer acquainted with Arduino can effortlessly join any hardware to Blynk Cloud with just 10 lines of code. Then build cellphone and internet apps to have interaction with this device with none extra skills.

Figure 8 indicates the flowchart of the overall workflow of the infant monitoring system. The Arduino Uno AtMega 328P needed to be connected to the pre-set wi-fi network when the power of the microcontroller is turned on. Through cellphone/laptop, net access is received to have a look at and control the smart cradle. Then, the user needs to run programs for Blynk App. The system begins to work with the aid of checking the detection of moist via the wet sensor. Then the infant's cry is detected, the measured value exceeds the limit value, and therefore the cradle is swung through turning by means of the DC geared motor automatically.

The user is notified via the Blynk cellphone App's notification as soon as the sound is detected. Then the temperature and humidity of the room are measured. If the room's temperature surpassed 28◦C, then even it can manually control the device thru the internet.

C. Power Supply

An electricsupply required to run all of the stated systems are organized using the following devices.

a) JOHNSON Geared Motor: Here, a Gear DC Motor (12V supply) makes it as Johnson. Those kinds of Johnson's devices are usually utilized in automation and robotics purposes. The Johnsons DC gear motor offers custom engineering solutions based on an extensive range of low voltage DC and excessive voltage DC motor structures. The power density and compact packaging options are supplied through the low voltage DC platform. A 200 RPM with Gearbox and Gears has the following specifications and features:-

- 12V DC Motors
- 18000 RPM base motor, Shaft having 6mm diameter, Shaft having a length of 15mm and without shaft 63mm.
- Motor Diameter: 28.5 mm; Gearbox Diameter: 37mm
- Load current of maximum 9.5A capacity
- No-load current of maximum 800mA capacity
- Torque: 5 kg-cm
- Weight: 300 Gms

b) AC / DC Adapter: An appropriate KRISHNA makes adapter is used to supply the power to the ARDUINO kit, with the following features.

- Universal input voltage 100-300v, AC- 50/60 Hz
- Suitable output, low ripple, and low interferences
- Short circuit and overload protection
- High efficiency and low energy consumption
- Power LED monitor

D. Mechanical System

A conventional Baby cradle procured from the local market consists of two basic parts like a bassinet and stand. Figure 9 shows the CAD model of both the cradle parts created using the CATIA V5 software package. The dimensions (LxWxH) of these parts are; Bassinet- 600x400x300 mm, Stand- 870x500x525 mm. The gross weight of the cradle observed is 3.9 Kg whereas the bassin*et al*one weighs 1.6 Kg.

A 4-bar link mechanism is being used to transmit the power and motion of the motor to the bassinet. The bassinet is coupled with the motor shaft through this link mechanism. Thus actuation of the motor creates the desired swing motion of the bassinet.

E. Local Market Study

Common customer demand for the smart cradle is evaluated based on the survey conducted via a telephone conversation with various manufacturers and retail shop keepers. It is revealed that ordinary parents primarily need acknowledgement of their baby's cries when the clothes become wet or the body temperature rises. So these two parameters are taken as the most essential in design.

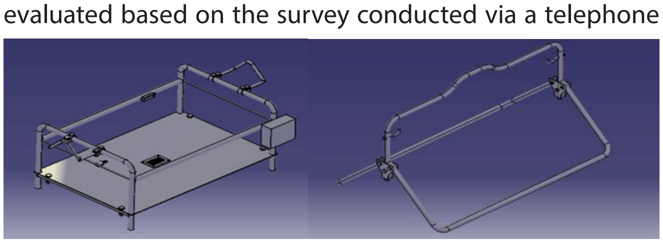

Figure 9: Major parts of the baby cradle Bassinet (top) Cradle Stand (bottom)

Results and Discussion

Figure 10 indicates the final, equipped-to-use version of the smart baby cradle. Numerous assembling steps had been executed previous to the implementation of the control gadget for it.

The measured records by way of the various sensors integrated, such as sound sensors, temperature sensors, and the moist sensor, are updated to the net and can be accessed through the Blynk server and its mobile App. While using a cellphone with an Android operating system, the mobile Blink application is the most compatible. It can be easily obtained from the play store via the label "Blynk", after which it can, without problems, sync with the Blynk server. This software was selected to generate our dashboard due to its simplicity, no subscription, and consumer-friendliness in terms of the view of usage. Throughout the synchronized system, the central Blynk server address is required, accompanied by the

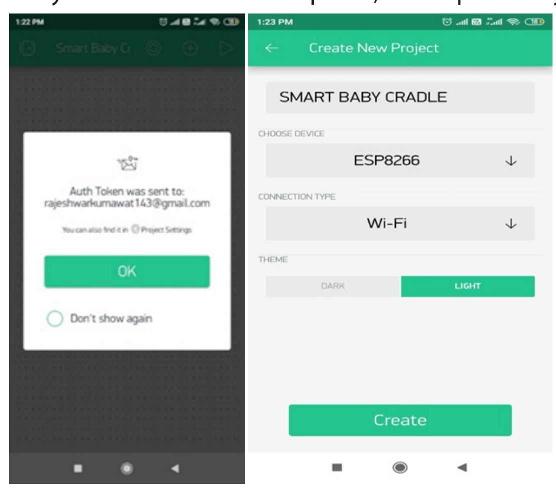

Figure 10: Process of synchronizing app with Blynk server

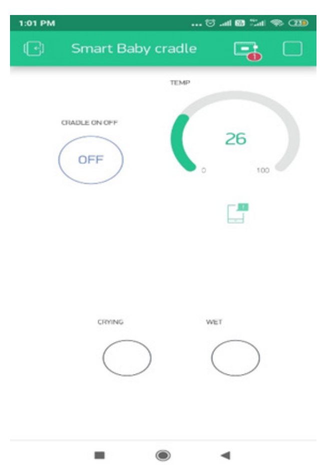

Figure 11: Blynk dashboard mobile application interface

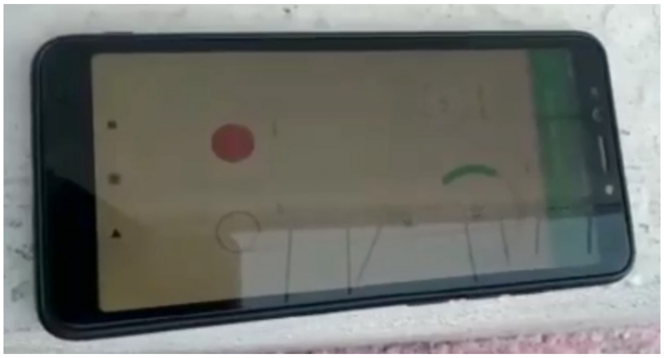

Figure 12: Baby's cry Sound Detection

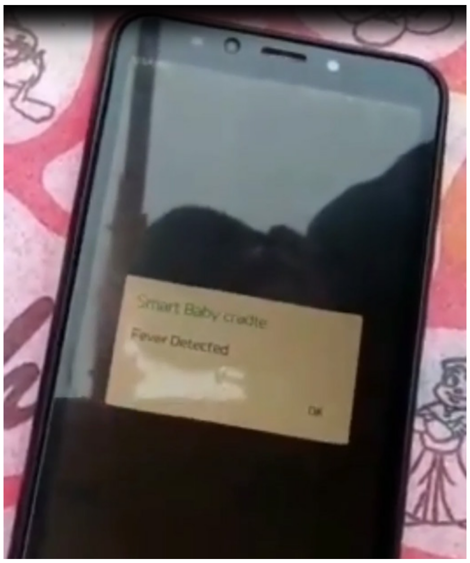

Figure 13: Baby's body temperature detection

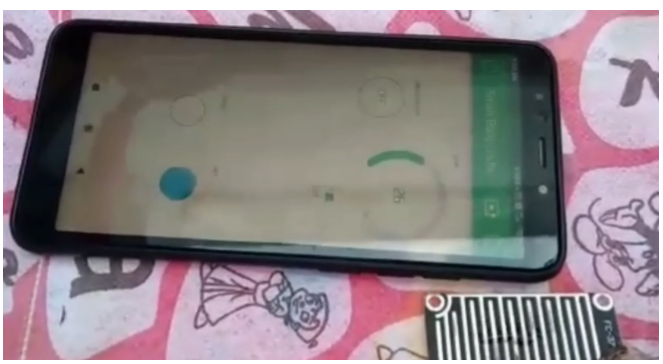

Figure 14: Wet Detection

host port, username, and the required authentication token provided by the server. Figure 10 indicates the requirement for a synchronization method for the cellphone apps to proportionally all records acquired from the sensor. The password represents the authentication token generated by using the Blynk server.

As shown in Figure 11 the Blynk server and Blynk app are synchronized and display the same reading uploaded by the Arduino Uno to the mega 328P microcontroller of the infant monitoring cradle system.

As quickly as the sound is detected utilizing the sound sensor, this smart cradle starts swinging. A notification, shown in Figure 12, is sent to the person through Blynk cell software to inform the user that crying is detected utilizing the child tracking system. The person can also remotely manage the baby cradle to swing manually via toggling the switch inside the Blynk server or cellular apps.

A notification of the temperature being counted is given to the person immediately on every occasion the infant's body temperature, measured by way of the temp sensor, is higher than 28 degrees Celsius (Figure 13).

When the baby's nappy gets overfilled and starts making the clothes wet, a notification is sent to the user immediately (Figure 14).

Thus, above Figures 12, 13, and 14 illustrate how data is retrieved from exploited sensors and actuators of the smart baby cradle while monitoring and controlling the processes.

For the validation purpose, the physical model is first tested for the appropriate functioning of all the sensors. Another test is also carried out taking the help of a cellular phone application in which the sound of an infant cry is created by a baby doll crying. This doll is kept in the actual position of the baby in the cradle bassinet. The programming codes mention a time delay of 5 seconds for sound detection. As soon as the baby's cry is detected, the cradle starts to swing. Soon after the swing motion starts, a notification goes to the user indicating the panic situation of the baby at that moment.

An evaluation of several experiments' consequences has discovered that the occurrence of time delays relies on the strength of the connected network. It is observed that no time put off turns into found while the wi-fi connection is sufficient enough. In the case of traumatic incidents like a failure of the mobile, an emergency switch provided on the cradle must be operated manually by the nearest available person to bring it to a standstill condition.

Conclusions

A BlynkIoT platform is used for the smart cradle to display the infant's conditions, including crying circumstances, moist situations, and body temperature. IoT concepts such as Arduino Uno, ESP8266 NodeMCU Wi-Fi Devkit, and Blynk mobile app are used to implement IoT concepts in the automated cradle system. A locally manufactured, conventional cradle is taken for automation first. Sensors are used to detect crying sounds, wet conditions, and body temperature. The bassinet's swing motion is made automatic with the help of an electric motor and a link mechanism. The proposed model is tested with a crying baby doll and a mobile phone. The crying sound is detected, and a notification is delivered to the cellular cellphone to intimate about the crying and activation of the bassinet swing. Moreover, signals for wet conditions and the baby's temperature are also transferred to the cellular cellphone so that the user can acknowledge the reason for the cry. This

IoT-based Smart Baby Cradle offers huge scope for further modifications from an operational and monitoring point of view, which will make it a more attractive and customer-preferred product.

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