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Smart Baby Cradle System using IoT

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ABSTRACT:

The current number of working mothers has greatly increased. Subsequently, baby care has become a daily challenge for many families. Thus, most parents send their babies to their grandparent's house or to baby care houses. However, the parents cannot continuously monitor their baby's conditions either in normal or abnormal situations. Therefore, the Smart Baby Cradle System is proposed as an efficient and low-cost IoT-based system for monitoring in real time. The proposed system exploits sensors to monitor the baby's vital parameters, such as wetness detection, ambient temperature, and crying. A prototype of the proposed baby cradle has been designed using Arduino UNO micro controller and other sensors such as water sensor, mic sensor, DHT11 sensor. The model also consists of a servo motor, speaker and a fan. The system architecture consists of a baby cradle that will automatically swing using a motor when the baby cries, detects wetness and reads the decibels of baby cry. Temperature around the cradle can be monitored. The Blynk application is used to know the readings of temperature, wetness and cry of the baby. It also provides access to play music and operate fan for the baby. The proposed system prototype is fabricated and tested to prove its effectiveness in terms of cost and simplicity and to ensure safe operation to enable the baby-parenting anywhere and anytime.

Keywords: *Baby monitoring, smart baby cradle, sensor, Arduino UNO*

1. Introduction

Taking care of a child is a crucial responsibility for a parent. In the current growing world, it's very difficult for a parent to look after their work and take care of their baby. After long working hours, it is hard for parents to constantly watch out for their kid. Keeping an eye on a child or employing a caretaker is an expensive undertaking which not every parent can bear the cost of. Hence, with the help of Internet of Things a smart cradle system is designed. This project's goal is to create an innovative, cost-effective baby cradle that will provide them with the essential care and assistance they need.

1.1 Problem Definition

We are fully aware of the difficulties parents encounter while caring for their young kids. Especially, when both the parents are working. It is impossible for a parent to give 100% attention to the infant. Thus, to overcome problems like this we need to develop a system which could help parents to have a watch on the Baby and can get message alerts about the same. Thus, we have proposed a system to design called Smart Cradle System which would help a parent to look after the infant by monitoring continuously from any place. It is a simple but effective prototype for child care.

1.2 Existing System

The existing and traditional cradles doesn't have any automatic features. For monitoring the baby, the parent should be around them for the whole time which is very hard for the parents to give their 100% attention. Many problems may arise if the parent leaves their kid in cradle without any supervision. Some may employee a care taker but it may be expensive which everyone cannot afford. For these reasons a smart cradle system should be developed for monitoring the baby efficiently.

1.3 Proposed System

The following features are present in the proposed system:

- Automatic swinging of the cradle if the baby cries
- Checking the wetness condition of the baby
- Monitoring temperature around the cradle

- Observing the readings of baby's cry
- Play lullabies to help baby sleep
- Use a mini fan for baby comfort

1.4 Requirement Specification

The smart cradle system requires the given hardware modules- Arduino Uno micro controller, 7805 voltage regulator, DHT11 – Digital Temperature and Humidity sensor, KY-037 Sound sensor, Water sensor, NodeMCU ESP8266 WiFi Module, Servo motor, Speaker and Mini Fan. Arduino IDE is required for coding purpose and Blynk application for observing readings and control fan and music.

2. Literature Survey

[1] Senoj Joseph, Ajay Gautham.J, Akshaya Kumar, Harish Babu M.K "IOT BASED BABY MONITORING SYSTEM SMART CRADLE", in IEEE, 2021. The

system is developed to recognize each and every moment of baby by connecting various sensors to the cradle such as Gas & Temperature Sensing Module for discovery of wetness of the cradle. A Camera is fitted in the top Cradle for live video film & sound sensor to break down Cry Patterns. All the information which is being taken from the sensors will be put away in information base & recognized at normal stretches. Parents may be certain of their babies' safety and wellbeing at any time, in any location, using all of those data and photographs.

[2] Waheb A. Jabbar, Hiew Kuet Shang, Saidatul, Akram A. Almohammedi, Roshahliza M. Ramli, Mohammed A. H. Ali "IOT-BBMS: INTERNET OF THINGS-BASED BABY MONITORING SYSTEM FOR SMART CRADLE", in

IEEE, 2019. The proposed system exploits sensors to monitor the baby's vital parameters, such as ambient temperature, moisture, and crying. A prototype of the proposed baby cradle has been designed using Nx Siemens software, and a red meranti wood is used as the material for the cradle. The system architecture consists of a baby

cradle that will automatically swing using a motor when the baby cries. Parents can also monitor their babies' condition through an external web camera and switch on the lullaby toy located on the baby cradle remotely via the MQTT server to entertain the baby. The proposed system prototype is fabricated and tested to prove its effectiveness in terms of cost and simplicity and to ensure safe operation to enable the baby-parenting anywhere and anytime through the network.

[3] Natasha Saude, Dr.P.A.Harsha Vardhini "IOT BASED SMART BABY CRADLE SYSTEM USING RASPBERRY PI B+", in IEEE, 2019. This smart baby

monitoring system have n number of parameters such as live video and sound, set down audio and leisure moment of infant, measuring the room temperature and the humidity indicates if the baby is sleepless and the most important characteristic is the ability to listen to the baby noise with cry detection feature.

[4] Kavitha S, Neela R R, Sowndarya M, Madhucha-ndra, Harsh-itha K "ANALYSIS ON IOT BASED SMART CRADLE SYSTEM WITH AN ANDROID APPLICATION FOR BABY MONITORING", in IEEE, 2019. A system of

interrelated computing devices, mechanical, and digital machines that are provided with the ability to transfer data over a network without requiring human interaction constitutes Internet of Things. This brings out automation of things. It is achieved through sensor and actuator devices. This brings out a survey on various sensors and actuator which is used in the implementation of Smart Cradle.

[5] Aniruddha Rajendra Patil, Nitesh Janardhan Patil, Anjali Deepak Mishra, Prof. Yogita Deepak Mane "SMART BABY CRADLE", in IEEE, 2019. The proposed Smart Cradle System which can be monitored by parents on mobile apps. The System has very distinct features. It has Four Sensors which are used to check the condition of the baby. There are 2 apps to monitor the baby, one for Swinging the cradle and checking all the accurate responses. Another is for Live monitoring of the baby. This System is made using Two Main Modules Arduino and Raspberry Pi3.

Table 1: Literature Survey of Smart Baby Cradle System using IoT

S. No	Title of the Referred paper, Journal name, Year of publication	Names of the Authors	Methodology/ components used	Merits	Demerits
1	IOT Based Baby Monitoring System Smart Cradle, IEEE, 2021	Senoj Joseph, Ajay Gautham.J, Akshaya Kumar, Harish Babu M.K	Raspberry Pi, Gas sensor, sound sensor and, Cry Detecting Mechanism, camera surveillanc e	Sound sensor used to quantify infant cry. It also sends the data over the web to give far off access.	It only provides sound sensor to sense the baby's cry but doesn't provide any solution to control it.
2	IoT- BBMS: Internet of Things- Based Baby Monitoring System for Smart Cradle, IEEE, 2019	Waheb A. Jabbar, Hiew Kuet Shang, Saidatul, Akram A. Almohammed i, Roshahliza M. Ramli, Mohammed A. H. Ali	NodeMCU is used to connect to the Wi-Fi and transfers data to AdaFruit and MQTT server	The designed system is fabricated to monitor a baby's vital parameters. Real time vision monitoring was achieved with the help of the wireless camera.	GUI needs to be improved and in the developed system wireless camera is used, which can only be connected to a local network.
3	Iot based Smart Baby Cradle System using Raspberry Pi B+, IEEE,2019	Natasha Saude, Dr.P.A.Harsha Vardhini	Raspberry Pi B+ module, condenser Mic, PIR motion sensor, pi camera	Features for baby monitoring such as cry, motion, sleep-ing condition, wet condition, live video and live audio	In this system, it sends notification to the parents in some abnormal condition but doesn't support heartbeat measuring feature
4	Analysis on IoT Based Smart Cradle System with an Android Application for Baby Monitoring, IEEE, 2019	Kavitha S, Neela R R, Sowndarya M, Madhucha- ndra, Harsh- itha K	Moisture sensor, Sound sensor, Methane sensor, Mobile application, Servo motor.	Swing the cradle and methane sensor is used to detect the smell of the diaper to avoid allergies and rashes	Costly to implement
5	Smart Baby Cradle, IEEE, 2019	Aniruddha Rajendra Patil, Nitesh Janardhan Patil, Anjali Deepak Mishra, Prof. Yogita Deepak Mane	PIR sensor, PCB sensor, Arduino camera, Geared motor, Arduino microcontrolle r	Send timely alerts in form of SMS and alarms, easy to use, has easy interface. An external switch is attached to battery to on or off the Arduino.	Components are fragile and it needs to be handled carefully. Hygiene condition of the cradle should be taken care by the parents.

3. Design Methodology

3.1 Block Diagram

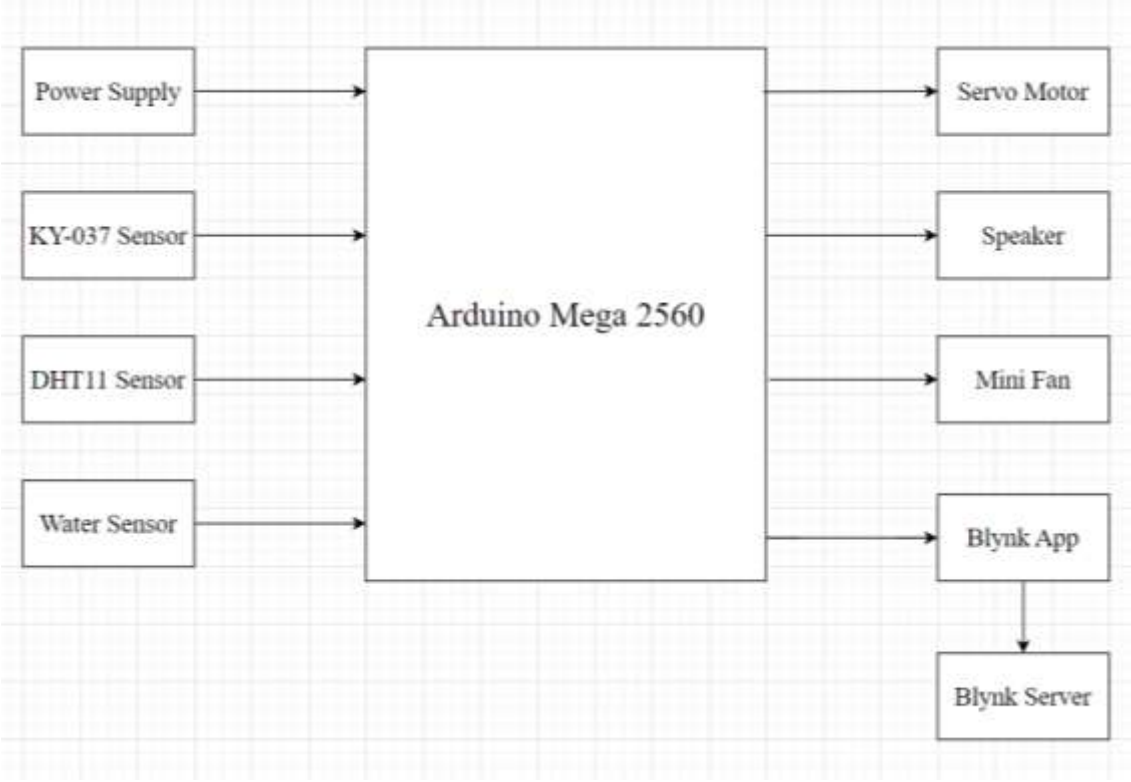

Figure 1: Block Diagram of Smart Baby Cradle System using IoT

The key components of the smart cradle system are shown in Figure 1, which all combine to provide an effective result. The key component is the Arduino uno, which comes with everything required to support the micro controller and may be powered by an AC-to-DC adapter or battery to get started. Other components include a power supply, a DHT 11 sensor, a water sensor, a servo motor, KY-037 sensor, speaker, mini fan and blynk app operated through blynk server.

3.2 Hardware Modules

The hardware modules used in smart cradle system are:

Arduino UNO: A popular open-source microcontroller board created by Arduino.cc is the Arduino UNO. The analog and digital pins on the Arduino Uno are present. The ATmega328P microprocessor serves as the basis for the Arduino UNO, which was created by Arduino.cc. The Arduino UNO has 14 digital pins, a USB port, a power jack, and an ICSP (In-Circuit Serial Programming) header in addition to 6 analogue pin inputs. The main mechanism for operating the cradle is the Arduino. It gathers information from numerous sensors, notifies the user, and then outputs the information via a message or a display system. The GSM module is used by Arduino to transmit the message to the receiver after collecting data from all other modules.

DHT11 sensor: DHT11 is a low-cost digital sensor for sensing temperature and humidity. The sensor includes a dedicated NTC for temperature measurement and an 8- bit microprocessor for serial data output of temperature and humidity information. The sensor has an accuracy of 1°C and 1% and can measure temperature from 0°C to 50°C and humidity from 20% to 90%.

Mic sensor: The sound sensor module provides an easy way to detect sound and is generally used for detecting sound intensity. It makes use of a microphone as the input source for an amplifier, peak detector, and buffer. The sensor processes an output signal voltage that is transmitted to a microcontroller and then completes the necessary processing when it detects sound. In our system the arduino controller reads the input from mic sensor and if sound is detected the cradle swings.

Water sensor: This water sensor module is used to detect the moisture level. The water sensor consists of two probes that are used to detect the moisture level. The immersion gold coating on the water sensor probes prevents oxidation of the nickel. These two probes are used to pass the current and then the sensor reads the resistance to get the moisture values. In our system when wetness is detected the buzzer is set to low causing it to buzz and message is sent to the receiver.

Servo motor: Servo motors are DC motors that allow for precise control of the angular position. A standard DC motor, a gear reduction unit, a position-sensing component, and a control circuit make up a servo motor. When the baby is crying it is detected using mic sensor and with the help of servo motor the cradle swings.

NodeMCU ESP 8266 Wifi Module: The NodeMCU ESP8266 WiFi module is a highly versatile and popular piece of hardware crafted by the NodeMCU team, leveraging the powerful capabilities of the ESP8266 chip.

Speaker: The speaker is a compact, high-fidelity audio component seamlessly integrated into the smart baby cradle system. Its primary function is to deliver soothing sounds and melodies to create a calming atmosphere for the baby.

Mini Fan: The mini fan is a small, low-power fan integrated into the smart baby cradle system. Its purpose is to provide gentle airflow within the baby cradle, contributing to a comfortable environment for the baby.

3.3 Flow Diagram

The Figure 2 is the flow diagram for the working of the smart cradle system. The sensors used collect the information at different situations, analyze it and send the appropriate output obtained from analyzed data to the baby's parents.

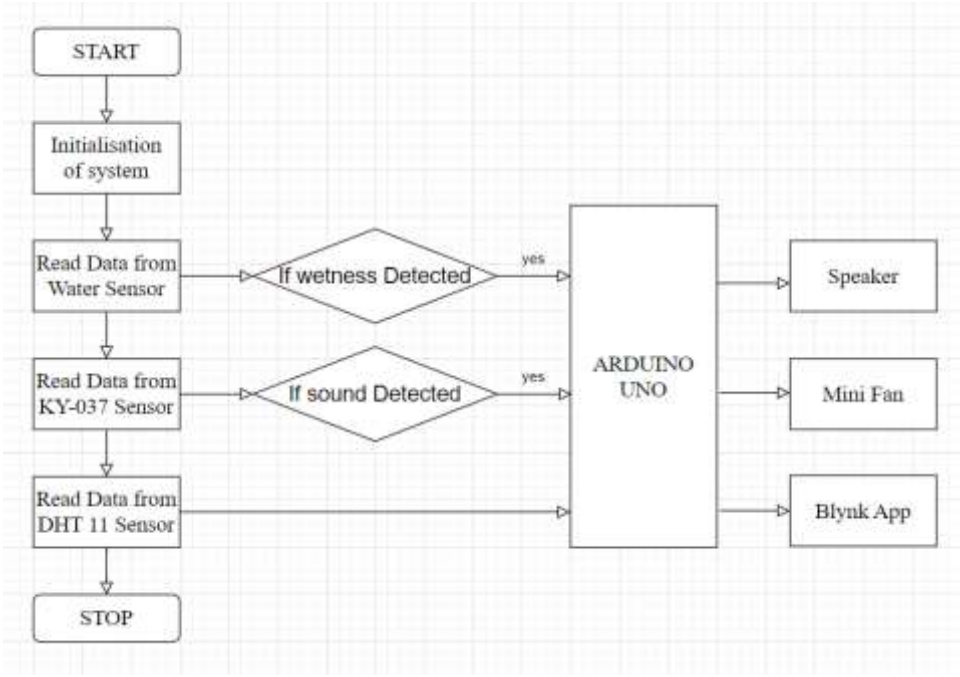

Figure 2: Flow Diagram of Smart Baby Cradle System using IoT

4. Implementation and Results

4.1 Hardware Implementation

Connect the Vcc (yellow pin) of the water sensor to the positive rail of the breadboard, and then connect the positive rail to the 5V pin of the Arduino. Connect the Gnd (green pin) of the water sensor to the negative rail of the breadboard, and then connect the negative rail to the GND pin of the Arduino. The D0 (white pin) of the water sensor should be connected to D3 of the NodeMCU.

For the temperature sensor, connect the yellow wire to the brown wire, and then connect it to D5 of the NodeMCU. The orange wire should be connected to the positive rail of the breadboard, which is then connected to the 5V pin of the Arduino. Connect the green wire to the negative rail of the breadboard, and then connect the negative rail to the GND pin of the Arduino.

The sound sensor's +ve (red wire) should be connected to the positive rail of the breadboard, and the positive rail should be connected to the 5V pin of the Arduino. The Gnd (orange wire) should be connected to the negative rail of the breadboard, and the negative rail should be connected to the GND pin of the Arduino. Connect the D0 (yellow wire) of the sound sensor to A0 of the NodeMCU.

For the speaker, connect the blue wire to the negative rail of the breadboard. The green wire should be connected to the yellow wire, which is then connected to D4 of the NodeMCU.

The relay's In (white to green wire) should be connected to D6 of the NodeMCU. Connect the Gnd (brown wire) to the negative rail of the breadboard, and then connect the negative rail to the GND pin of the Arduino. Connect the Vcc (red wire) to the positive rail of the breadboard, and then connect the positive rail to the 5V pin of the Arduino.

For the servo, connect the orange wire to D7 of the NodeMCU. The red wire should be connected to the positive rail of the breadboard, and the positive rail should be connected to the 5V pin of the Arduino. Connect the brown wire to the negative rail of the breadboard, and then connect the negative rail to the GND pin of the Arduino.

Finally, connect the red positive rail of the breadboard to the 5V pin of the Arduino, and connect the brown negative rail of the breadboard to the GND pin of the Arduino.

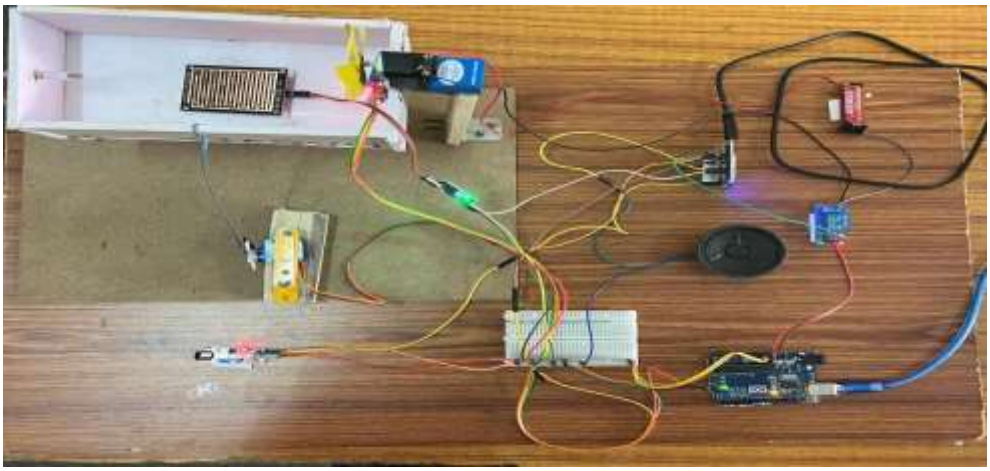

Figure 3: Hardware Model of Smart Baby Cradle System using IoT

The Figure 3 shows the working hardware model of Smart Cradle System. It describes about how various hardware modules are connected to the Arduino using digital and analog pins. The hardware modules are connected by using jumper wires.

4.2 Software Implementation

The software implementation of Smart Cradle System involves the execution of the code in Arduino IDE.

The steps for implementing the code are:

1. Download the Arduino IDE software
2. Connect the Arduino USB cable to the Arduino
3. Choose the port:”COM3(Arduino uno)”, write your and the save it.
4. Compile the Sketch(code) without any errors
5. Upload the code using the Upload button

The steps for using Blynk app are:

1. Download the Blynk.Console or Blynk.App.
2. Open the Blynk console or app and sign up.
3. Enable Developer Mode to access advanced features for customization.I
4. In Developer Mode, create a new project within the Blynk.Console.
5. Name the project, select the appropriate hardware.
6. Add widgets to the project to display sensor readings and control the fan and music
7. Add buttons for fan and music control.
8. Use the Button widget and customize it for turning on/off the fan and music.
9. Test the setup by monitoring sensor readings and checking if the fan and music control buttons work as expected.

4.3 Results

Figure 4: Blynk app displaying Baby's Cry Readings

Figure 4 shows the wetness detection. The water sensor detects the wetness and it is displayed on the Blynk App.

Figure 5: Blynk app displaying Baby's Temperature Detection

Figure 5 shows the temperature near the cradle is monitored using DHT11 sensor and it is displayed on the Blynk App.

Figure 6: Blynk app displaying Baby's cry readings

Figure 6 shows the cryness of baby is monitored using sound sensor and it is displayed on the Blynk App.

Figure 7: Blynk app displaying button of music

Figure 7 shows the music is played when baby cry is detected. Speaker is used to play any song as per baby comfort.

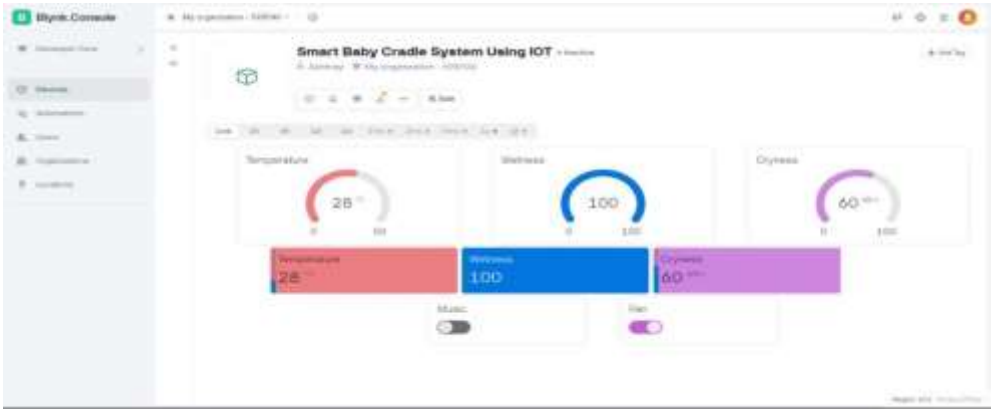

Figure 8: Blynk app displaying displaying button of fan

Figure 8 shows the fan is turned on by using Blynk console for the comfort of baby.

5. Conclusion

The system is developed using Arduino with the various features for monitoring a baby even if the parents are far away from the child. If the baby cries, then immediately the system will swing the cradle. If there is any wetness detected then the readings of it can be seen in Blynk application. The temperature of the surroundings is checked regularly and if any sudden increase or decrease is observed then parent can on/off the fan by using Blynk application. It will show the DB readings to the parent when the baby cries, the feature of playing the lullabies whenever the cry of baby is identified.The fan can be operated by parent through Blynk app for baby's comfort. The Blynk application has a very good user interface, which is convenient for parents to monitor and take necessary actions. To conclude a very flexible system is developed which can be used easily by the parent.

6. Future Scope.

Incorporating sensors to monitor vital signs such as heart rate, breathing rate, and even oxygen levels can provide parents with additional peace of mind and alert them to any potential health concerns.

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