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SMART CRADLE SYSTEM

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Abstract: High-speed internet and mobile phones, and with increasing usage and access, have popularized this IoT-based information technology mobile phone. One of the reasons is that it will enable working parents to be able to monitor the activities of the baby when they are not around. In this paper, we develop a Smart Cradle where we provide the monitoring of the baby in real time using a camera. This cradle swings when the baby cries, this is implemented with the help of a sound sensor and the swing motion is assisted by a servo motor. There is even a wet sensor to alert the parents if the bed is wet and has to be changed.

We also have a buzzer that rings for the parents in case the baby needs a parent's interference.

Keywords: Network, Real-time, monitoring, buzzer, Network, Real-time monitoring.

I. INTRODUCTION

In today's lifestyle, working parents find it a bit hard to work with the baby. They cannot keep an eye on their child all the time during their long working hours. So manually swinging the cradle may be difficult in such cases. Because sometimes their baby needs a sitter for it, baby safety-related thoughts keep on appearing in their minds, which is also a very hectic task to deal with this. So, the latest generation requires a solution similar to a smart cradle system that bridges the gap between parents and children in relation to this product; helps one take care of the child safely and with features below

1. Self-activating cradle swing starts through the baby cry detection
2. Camera with an app used for real-time monitoring of the baby
3. Sensors that detect wetness, temperature, and sounds; alert messages are sent to their mobile phones
4. Long-lasting battery along with solar panel installation.

The smart cradle system will be equipped with an automated swing mechanism that will swing automatically when the detection of a crying baby is made and will also send a notification to the parent if the baby does not stop crying, it has a wet detector that will determine the wetness of mattress and send message to the parents smartphone. A camera is mounted on the top of the cradle so that the parent can continuously observe their baby while at work. This cradle also has an automatic toy to entertain the baby, thereby reducing the possibility of baby crying. And using long-term durable batteries along with solar panel installation to increase the backup of the battery.

II. LITERATURE SURVEY

1. Madhuri P. Joshi [1] developed a smart cradle system using aurdino uno microcontroller board,so according to paper[1] we used the methodology to implement the smart cradle system,the referred paper contains how the other sensors connected to microcontroller and how they are going work.
2. According to the paper published by Natasha Saude [2],proposed an IoT-enabled cradle that transmitted real-time data to the parents,via mobile app so we implemented this technology in our project.
3. W. A. Jabbar, H. K. Shang, S. N. Hamid,[3] A. A. Almohammedi, R. M. Ramli, and M. A. Ali, “Iotbbms: Internet of things-based baby monitoring system for smart cradle,” IEEE Access, vol. 7, pp. 93791–93805, 2019.
4. The latest advancement have been proposed by the authors Nur Zarifah Zakaria and Dur Muhammad Soomro [4],has implemented the sound sensor for building the IOT based smart cradle system,the sound sensor was used to detect baby cries using frequency pattern which through testing has successfully work,we imaplemented this objective,to carrying out our project.

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III. IMPLEMENTATION

1) Requirements in Hardware:

✞ **Arduino UNO:**

Arduino Uno is an open-source microcontroller board. It is based on ATmega328P. The board has been widely used in making digital devices and interactive objects for numerous applications, including the smart cradle system. It is user-friendly, with highly compatibility with various sensors, actuators, and communication modules, making it suitable for prototyping and integrating multiple components in an IoT-based project.

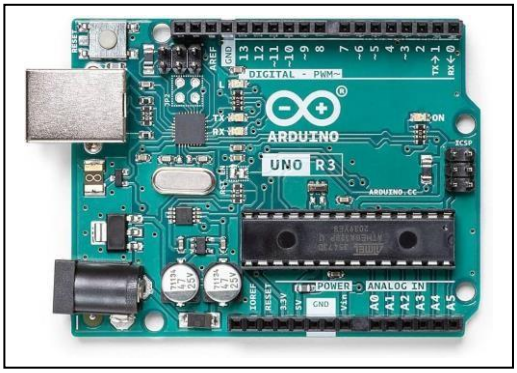

Fig.3.1 Arduino Uno Board

Specifications of Arduino Uno Board:

Specification	Details
Microcontroller	ATmega328P
Operating Voltage	5V DC
Input Voltage (recommended)	7V to 12V
Digital I/O Pins	14 (6 of which can be used as PWM outputs)
Analog Input Pins	6 (10-bit ADC resolution)
Flash Memory	32 KB (of which 0.5 KB used by bootloader)
SRAM	2 KB
EEPROM	1 KB
Clock Speed	16 MHz
Size	68.6 mm x 53.4 mm
Weight	~25 grams
USB Interface	USB-B for programming and power supply

Role of Arduino Uno in the Smart Cradle System:

In the smart cradle system, the Arduino Uno board serves as the central control unit coordinating all the components. Here's how it fits into the system:

1.**Sensor Integration:** The Arduino Uno connects to various sensors (e.g., PIR motion sensor, moisture sensor) to gather real-time data about the baby's condition (e.g., crying, wet diaper).

2.**Control Actuators:** It controls the servo motor that is set up to rock the cradle for the crying and fussy baby.

3.**Connectivity Management:** It interacts with the ESP8266 Wi-Fi module, so the infant can get online connectivity. Using this connectivity, parents will get an alert from this smart nursery.

4.**Processing Logic:** The Arduino Uno processes the sensor data, triggers alerts via the buzzer, and makes decisions based on pre-programmed logic (e.g., when to activate the servo motor or send notifications).

5.**Real-Time Operations:** It ensures that the system operates in real-time, ensuring smooth functioning of the cradle based on sensor inputs and system requirements.

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✞ **PIR Motion Detector:**

A PIR (Passive Infrared) Motion Sensor is used to detect movement by sensing infrared radiation emitted by objects, especially humans and animals. In the context of your smart cradle system, it detects the baby's movements and triggers appropriate actions, such as activating the buzzer or servo motor.
In the context of the Smart Cradle system, this PIR motion Sensor is used to gauge the movements of the baby and sends an alert either by a buzzer or by WiFi module to the parents that the "Baby is awake pls pay a visit".

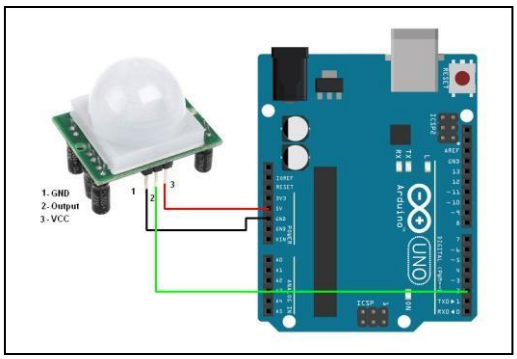

Fig.3.2 Pir motion sensor connected to Arduino uno

Specifications of Pir motion sensor

- **Operating Voltage**: 5V to 12V DC.
- **Detection Range**: 3-7 meters (adjustable).
- **Field of View**: Approximately 110°.
- **Output**: Digital (HIGH/LOW).
- **Delay Time**: Adjustable (e.g., 5 seconds to 5 minutes).

In the context of Smart Cradle system this PIR motion Sensor is used for analysing the baby movements and send an alert to the parents either through buzzer or through the WiFi module to the parents that the “Baby is awake pls pay a visit”.

✞ **Ultra sonic sound sensor HC -SR04:**

HC-SR04 is a highly used module in measuring distance using ultrasonic waves. The module sends out ultrasonic pulses and determines the time these pulses take to return, after having been reflected from an object in the nearby proximity. This helps it calculate the distance of an object without physical contact.
In a smart cradle system, the HC-SR04 can be utilized in detecting the baby's position and monitoring movements and then maintaining safety by measuring distances inside the cradle.

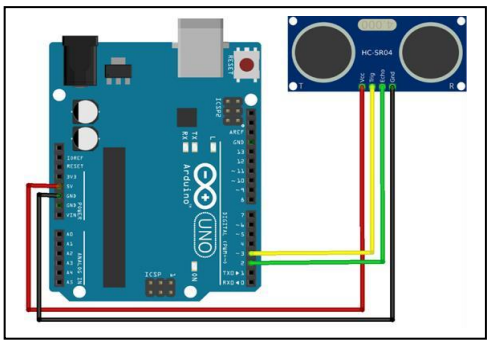

Fig.3.3 Ultra sonic sound sensor HC-SR

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Specifications of Ultrasonic sound sensor:

- **Operating Voltage**: 5V DC
- **Current Consumption**: 15 mA
- **Measurement Range**: 2 cm to 400 cm (4 meters)
- **Accuracy**: ±3 mm
- **Operating Frequency**: 40 kHz
- **Field of View**: 15° cone
- **Response Time**: About 20 ms
- **Output**: Digital (pulse width corresponding to distance)

In the context of a **smart cradle system**, the HC-SR04 can detect the baby's position, monitor movements, and ensure safety by measuring distances within the cradle.

✞ **Water Level sensor HW-038:**

The HW-038 is a widely used moisture sensor that measures the presence of moisture or water. It finds application in applications requiring the measurement of liquid levels, leak detection, or wetness checking, among others. Examples of its use include soil moisture monitoring and smart cradle systems.

The HW-038 moisture sensor is an important component in a smart cradle system since it can detect wet diapers or bedding and automatically alert parents to change the baby's diaper. This keeps the baby dry, comfortable, and healthy without causing discomfort or irritation of the skin. The sensor also ensures a hygienic environment, enhances sleep quality by keeping the baby dry, and provides comfort to caregivers by not having to constantly.

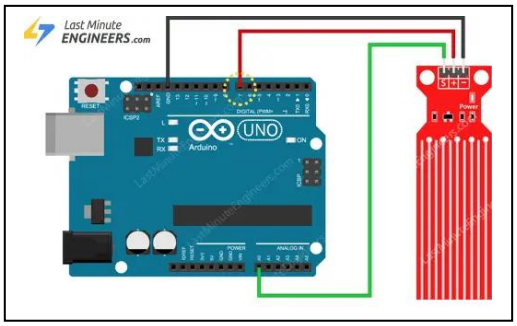

Fig.3.4 Water level sensor

HW-038 Moisture Sensor Specifications :

- **Power Supply**: 3.3V to 5V (DC)
- **Output Signal**: Analog (varying voltage) or Digital (High/Low)
- **Sensor Type**: Capacitive or resistive
- **Sensitivity**: Detects moisture from dry to wet conditions
- **Size**: Approx. 4 cm x 2.5 cm
- **Operating Temperature**: 0°C to 60°C
- **Response Time**: Fast, within a few seconds
- **Material**: Copper or stainless steel probes
- **Applications**: Soil moisture, water leakage, baby care (diaper wetness detection)
- **Compatibility**: Arduino, ESP8266

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✞ **ESP 8266 WiFi module:**

The ESP8266 is a low-cost Wi-Fi module that is commonly used for connecting microcontrollers to the Internet in IoT projects. It is a powerful, highly integrated chip that provides wireless connectivity, making it ideal for remote monitoring and control systems like the smart cradle system.
In the case of Smart Cradle system, it will be utilized for real-time monitoring of the baby through their network and baby alerts sent to them in BLYNK.

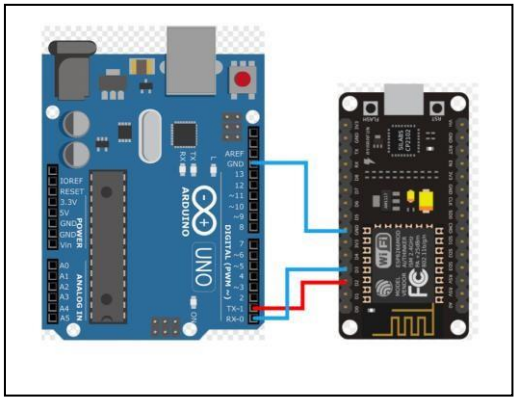

Fig.3.5 ESP 8266 WiFi Model

Specifications of WiFi module:

Operating Current: 70-200mA (depends on module and load)

Wi-Fi Standard: IEEE 802.11 b/g/n

Wi-Fi Range: Up to 100 meters in open space (depending on environment)

Data Rate: 72.2 Mbps (max)

Interface: UART (TX/RX), SPI, I2C, and GPIO pins

Flash Memory: 512KB to 16MB (depending on module variant)

Processor Speed: 80 MHz to 160 MHz

Size: 24.8 mm x 16 mm

Power Consumption: Low power consumption (depending on use case)

✞ **Servo Motor SG-90:**

The SG-90 is small, lightweight, and a servo motor widely used in applications from robotics, RC hobbies to automation systems.
It offers accurate control over the rotation of its shaft. It makes it suitable for projects where specific positioning is required.

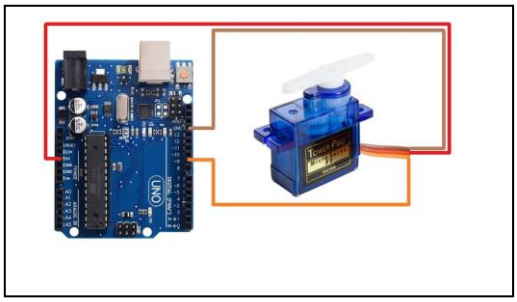

Fig.3.6 Servo motor connection to Arduino

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Wi-Fi Range of ESP8266:

- The ESP8266 typically has a Wi-Fi range of up to 100 meters in open space, although the actual range may vary depending on environmental factors such as obstacles, interference, and Wi-Fi router strength.
- In typical home environments, the range could be around 30-50 meters inside buildings.

✞ **Buzzer:**

An electronic buzzer is a sound-generating device that indicates a warning or alert. Its use ranges from various alarm systems that alert people when something specific has occurred, to those that signal when an action should be taken, indicating a condition. In the smart cradle system, this would mean that it will alert the parents in case the baby is crying, the diaper is wet, or it detects any movement.

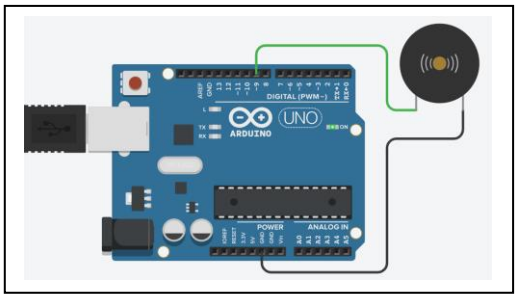

Fig.3.7 Buzzer to Arduino

Specifications of Buzzer:

Specification	Details
Operating Voltage	3V to 5V DC
Current Consumption	10-20 mA (depends on type of buzzer)
Frequency	2,000 to 3,000 Hz (for piezo buzzer)
Sound Level	70 to 100 dB (depending on type)
Size	Small (typically 20mm to 30mm in diameter)
Type	Active Buzzer (produces sound when powered) or Passive Buzzer (requires external signal)
Connection	2 or 3-pin connectors (Power, Ground, Signal)
Response Time	Instant sound emission upon signal input

2) Software Requirements

Arduino IDE is a software application used to write, compile, and upload code into Arduino microcontroller boards such as Arduino Uno, Arduino Nano. It simplifies the development process by providing a user-friendly interface for writing code, debugging, and interaction with various hardware components. It supports programming in C and C++ languages, and it offers built-in libraries for interacting with sensors, actuators, and communication modules.

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Why the Arduino IDE is the Best Fit for the Smart Cradle System:
The Arduino IDE provides a simple, flexible environment to write and upload code to the Arduino board, which is at the heart of the smart cradle system.
It is easily integrable with sensors, actuators, and communication modules which makes it ideal for this project since real-time decision-making and control is a must.
The Serial Monitor and built-in debugging tools help ensure the system is functioning correctly during development.

3) Pseudo code

Initialize Components:
Create a servo motor object.
Set pins for:
PIR motion sensor (pirPin)
Wet sensor (wetSensorPin)
Ultrasonic sensor (trigPin, echoPin)
Buzzer (buzzerPin)
Servo motor (servoPin)

Serial Setup for ESP8266.
Set servo motor to an initial position of 0°.
Print "Smart cradle system initialized" on the serial monitor.

Main Loop:

Continuous loop:
Sensor Readings:
Motion Detected using PIR sensor. (movementDetected).
Moisture Value read using wet sensor. (wetValue).
Distance Measured using ultrasonic sensor. (distance).

Look for wet sensor notification:
In case moisture reads above threshold, then call out the notification function with "Moisture detected! Check the baby." Monitor movement and cry
In case the motionDetected is high and also at a distance < cryDistanceThreshold, then alert function has to be called out by saying, "Baby crying and moving. Check baby" Rock cradle 5 times:
Smoothly move the servo motor from 0° to 45° and back to 0°.
Wait for a little time to prevent it from fast triggering.

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Functions:

Measure Distance Function:

Transmit ultrasonic pulse.
Calculate the distance in centimeters by measuring time taken by echo to travel back and return.
Smooth Rocking Function:

Step the servo motor from startAngle to endAngle.
Introduce delay between steps to allow smooth motion.
Alert Function:

Blink the buzzer for a short period to raise an alert.
Call the sendToIFTTT function to send a notification via the ESP8266 Wi-Fi module.
SendToIFTTT Function:
Create the HTTP GET request for activating the IFTTT Webhook.
Send the request over TCP to the IFTTT server using the ESP8266.
Close the connection after the request is sent.

Flowchart Representation:
Start
Initialize Components
Set up sensors, servo, and communication.
Main Loop
Read Sensors:
movementDetected = Read PIR sensor
wetValue = Read wet sensor
distance = Measure ultrasonic distance
Check Wet Sensor:
If wetValue > wetThreshold:
Call alert("Moisture detected!")
Check Motion & Crying:

IF movementDetected AND distance < cryDistanceThreshold:
Alert("Baby is crying and moving!")
Rock cradle 5 times using smoothRocking(0, 45)
Repeat Loop
End

4) FINAL ASSEMBLY

Assemble the cradle with all components securely in place. Ensure all connections are tight and secure. Test the entire system to ensure it functions as expected.

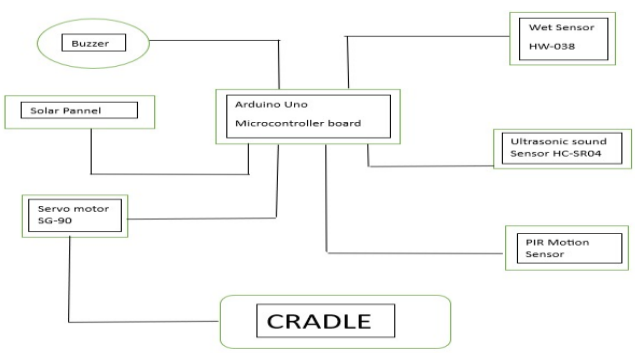

Fig.4.1 Block Diagram of Smart Cradle System

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- You can also integrate a solar pannel for a power back up,where energy can be replenished.

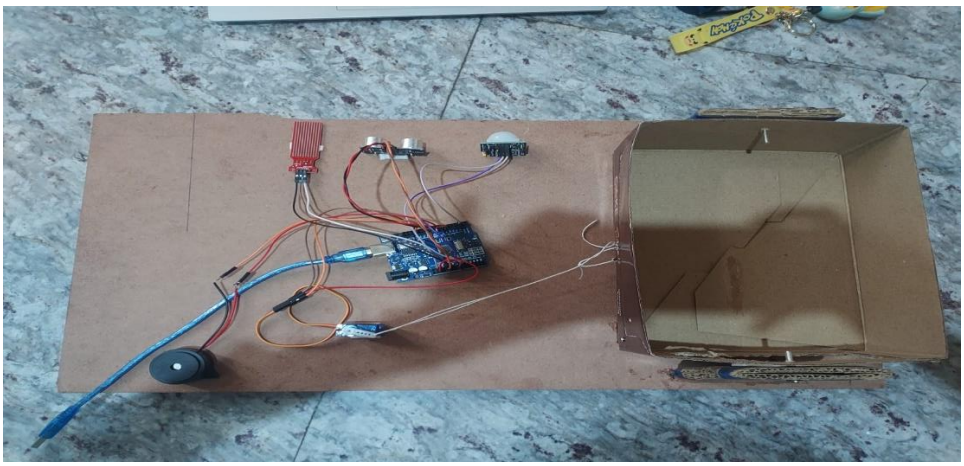

Fig 4.2 Complete assembled model

IV. CONCLUSION

Baby care is one of the toughest problems in this world. It is an extremely important responsibility as they are our future. Though the mother's lap is the best place for the baby, considering the requirements of the present world and aware of the importance of baby care, this system is designed.
This system is cost-effective and simple to work with, which will help working parents in their work. Video monitoring can be accessed with most of the commonly used Android smartphones. In the future, more features such as IR (Infrared cameras for night vision may be extensions of this system. Also other client applications, i.e. applications for iOS etc can be designed for this system.

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