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THE FUTURE OF NURTURE: SMART BABY CRADLE

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Abstract - *In the modern landscape of infant caregiving, the demand for innovative solutions to enhance comfort, safety, and convenience for both infants and caregivers is paramount. This research paper presents the development and implementation of an automatic baby cradle with sensor integration, aimed at addressing the challenges faced by caregivers in soothing infants and monitoring their needs.*

This paper presents the development of an automatic baby cradle with sensor integration, aimed at enhancing infant caregiving. The project integrates noise detection and wetness indication sensors with an Arduino Uno microcontroller to automate cradle movement and enable real-time communication with caregivers via SMS alerts.

Key Words: Automatic cradle, sensor integration, infant care, Arduino Uno, GSM module.

1. INTRODUCTION

The development of an automatic baby cradle has revolutionized infant caregiving by providing a hands-free solution for soothing infants and monitoring their well-being. The cradle uses an Arduino Uno microcontroller to automate its movement, allowing it to respond to detected noise levels and wetness. Sensors for noise detection and wetness indication enable the cradle to respond swiftly, enhancing comfort and promoting uninterrupted rest. The project also includes a GSM module for communication with caregivers, sending SMS alerts when the cradle detects a baby's crying or wetness. This technologically advanced solution prioritizes safety, comfort, and peace of mind for both infants and caregivers.

1.1 LITERATURE REVIEW

The paper discusses the design, fabrication, and analysis of automated cradles, an automatic E-Baby Cradle Swing based on baby cry, and an Arduino-based resonant electric cradle design with infant cries recognition. The automated cradle uses a DC motor to rotate in clockwise and anticlockwise directions, pushing the bassinet to the front and vice versa.

The system has an inbuilt alarm that alerts caregivers when the baby stops crying, ensuring hygienic conditions and indicating the need for attention. The paper also discusses an Arduino-based resonant electric cradle design with sensors designed to detect oscillation state and infant cries recognition. The force is driven at the critical time to achieve maximum output response while saving energy. A GSM module is also included to enable communication with caregivers. When the cradle detects the baby crying or becoming wet, it sends SMS alerts to notify them, ensuring prompt attention and care. The aim of these studies is to revolutionize infant caregiving by offering a technologically advanced solution that prioritizes safety, comfort, and peace of mind for both infants and caregivers.

1.2 SCOPE OF WORK

The project aims to improve the functionality of baby cradles by integrating sensors and automation technology to detect and respond to infant needs in real-time. The system will automate the cradle's motion, trigger noise detection for infant cries, and wetness indication for diaper changes. The Arduino Uno microcontroller will process sensor inputs, and a GSM module will enable real-time communication.

A user-friendly interface will be developed for caregivers to adjust settings and monitor sensor readings. Testing will validate the mechanism's reliability, accuracy, and safety, with documentation detailing operation, maintenance, and troubleshooting procedures.

2. METHODOLOGY

Requirements Gathering and Analysis: Defined project objectives and functionalities based on caregiver needs and infant care requirements, identified necessary components.

Component Selection: Researched and selected appropriate components based on project requirements and compatibility with Arduino Uno. Ensured compatibility and reliability of selected components for integration into the automatic baby cradle.

Circuit Design: Ensured proper wiring and connections between the sensors, GSM module, and Arduino Uno, following manufacturer specifications and guidelines.

Sensor Integration & Programming: Integrated noise detection and wetness indication sensors with Arduino Uno, ensuring accuracy and responsiveness. Developed software logic to control cradle movement and trigger SMS alerts through GSM module based on sensor inputs.

Testing and Evaluation: Conducted testing to validate functionality and reliability of automatic baby cradle system. Gathered feedback from caregivers to identify areas for improvement and future enhancements. Deployed cradle in real-world environment and evaluated performance and usability.

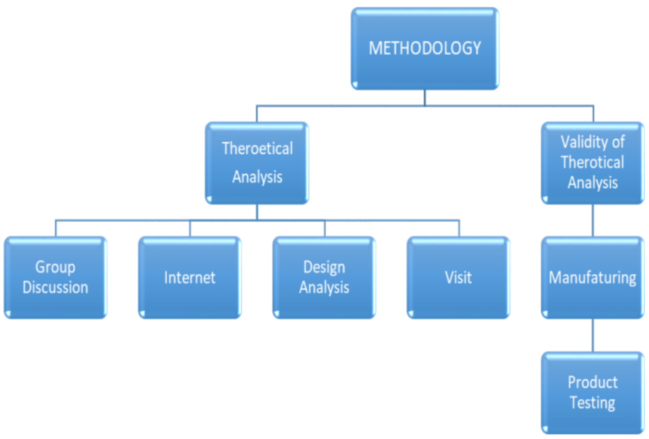

Chart -1: Flow Chart

3. MATERIAL SELECTION

The primary goal is to choose the right material for each component of a machine. During the construction of a machine. Understanding how the manufacturing process and heat treatment affect a material's properties is essential for a design engineer. The following variables influence the material selection for engineering purposes:

1) The materials' availability.
2) Material suitability for the operational environment inuse.
3) The price of the supplies.
4) The material's chemical and physical characteristics.
5) The material's mechanical characteristics.

The mechanical properties of metals are those related to the material's capacity to withstand loads and mechanical forces. Now, let's talk about these qualities as follows:

A. Power	B. Flexibility
C. Tension	D. Elasticity
E. Tension	F. Sturdiness
G. Stiffness	H. Adaptability
I. Hardness	J. Adaptability

A component that is continuously stressed at a high temperature over an extended length of time will slowly and permanently deform; this process is known as creep. When designing boilers, turbines, and internal combustion engines, this property is taken into account.

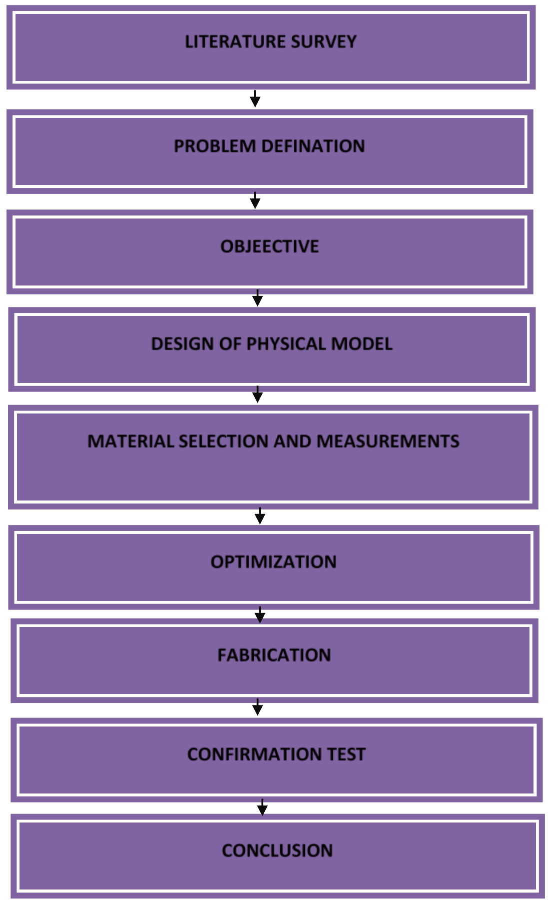

Chart -2: Process Flow Chart

4. DESIGN CALCULATIONS

4.1 For shaft -

1. Material used – Mild Steel (C30)
2. Shaft Size – Ø10 X 100 mm
3. Density :- 7850 kg/m^3
4. Volume :- 84823 mm^3

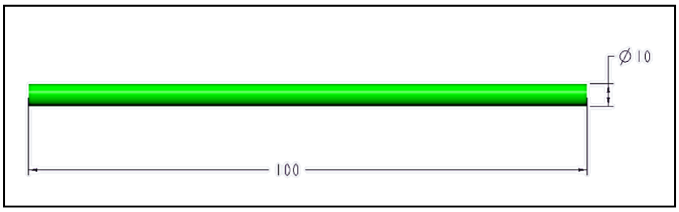

Fig -1: Shaft

4.2 For Bearing -

Selection of Bearing

Spindle bearing has been subjected to purely medium radial loads; hence we used ball bearings for our application.

Selecting; a single Row deep groove ball bearing are as follows;
Series 62

Table -1: Bearing Selection

I S I No.	Bearing of Basic Design No.	D	d1	D	d2	B	Basic Capacity	
20 BC02	6000 z	10	10	25	24	9	10000	6500

P = XF + YFa
For our application F a = o = XFr
Where F r = 204.24 N As- F r < e = X = 1
Max radial load = F r = 204.24 N
P = 204.24 N

Calculation of dynamic load capacity of bearing L = (C) p where p =3.2 for ball bearings
When P for ball Bearing
For m/c used for eight hr of service per day; L h = 12100-21000 hr

But; L = 62 n L h L = 620 mrev
Now; 600 = (C) 3
= (204.24) 3
C =1724. N

As the required dynamic capacity of bearing is less than the rated dynamic capacity of bearing, Bearing is safe.

4.3 Lower Bearing Hexagonal locker part

Part weight – 0.2 kg
Part material – M.S
Part quantity – 2
Part size – 12 X 8 mm.

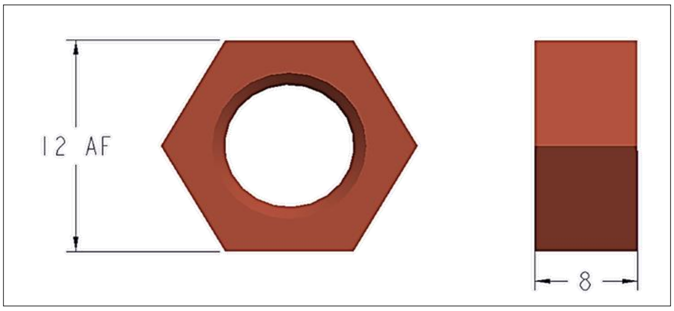

Fig -2: Bearing holder

4.4 Square hollow pipe for motor

Part weight – 0.2kg
Part material – M.S
Part quantity – 1
Part size – 24 X 24 X 2 & 70 mm length.

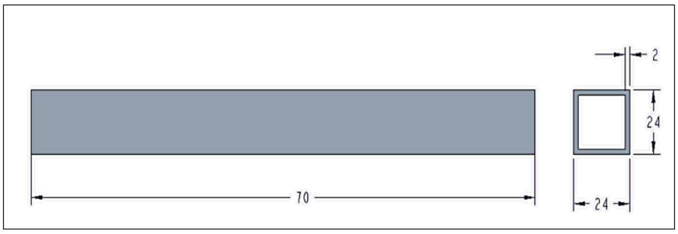

Fig -3: Square hollow pipe

4.5 Linkage plate to Cradle

Part weight – 0.2kg
Part material – M.S
Part quantity – 1
Part size – 10 X 375 X 3 mm.

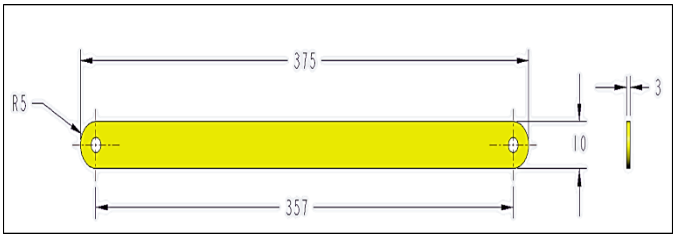

Fig -4: Linkage plate to cradle

4.6 Linkage plate to shaft

Part weight – 0.2kg
Part material – M.S
Part quantity – 1
Part size – 30 X 65 X 3 mm.

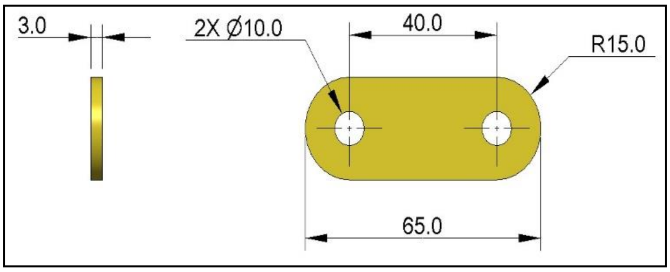

Fig -5: Linkage plate to shaft

4.7 L-type angle bar

Part weight – 0.2 kg
Part material – M.S
Part quantity – 1
Part size – 25 X 25 X 3 & 352 mm length.

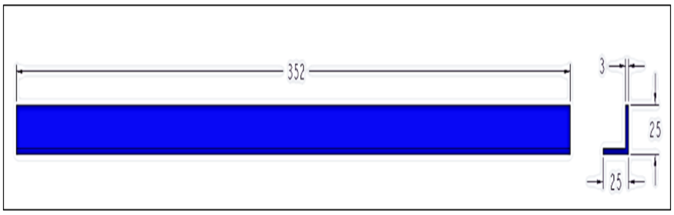

Fig -6: L-Type angle bar

5. CAD MODEL:

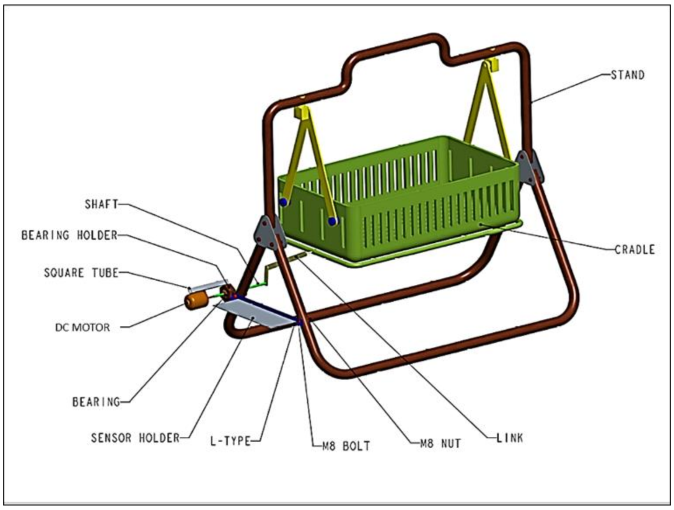

Fig -7: CAD Model

6. FABRICATION STEPS:

Step 1 – Measurement
Step 2 – Material Procurement
Step 3 – Component Assembly
Step 4 - Motor and Electronics Mounting
Step 5 – Cradle Mechanism Integration
Step 6 – Power Supply Integration
Step 7 - Final Assembly and Testing

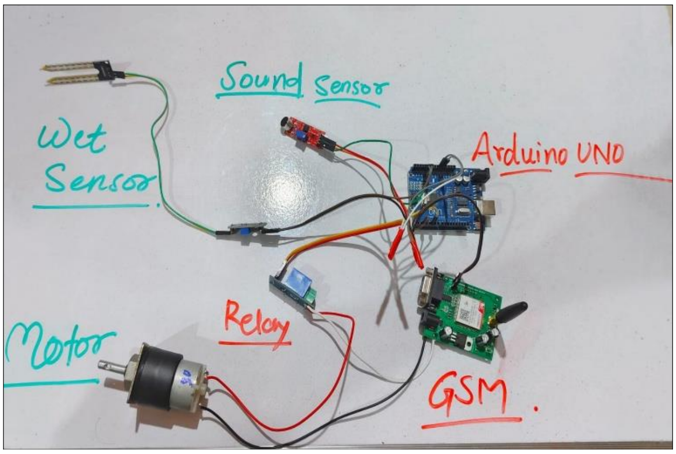

Fig -8: Electronic Components Attachment

7. WORKING:

Step 1 (Power ON) - The caregiver powers on the automated baby cradle system.

Step 2 (Sensor Detection) - Noise detection sensors continuously monitor the environment for infant cries. Wetness indication sensors detect diaper wetness.

Step 3 (Infant Cries Detected) - If the noise detection sensors detect infant cries above a predefined threshold, the system activates.

Step 4 (Cradle Movement) - The Arduino Uno microcontroller processes the sensor input and triggers the motorized mechanism to initiate gentle cradle movements. The cradle begins to sway back and forth in a soothing motion to calm the infant.

Step 5 (Caregiver Alert) - The GSM module sends an SMS alert to the caregiver's mobile device, informing them of the diaper wetness.

Step 6 (Caregiver Intervention) - The caregiver receives the alert, attends to the infant's needs by changing the wet diaper, and can optionally adjust cradle settings through the user interface.

Step 7 (Standby Mode) - Once the infant is settled and the diaper changed, the system returns to standby mode until further sensor inputs are detected.

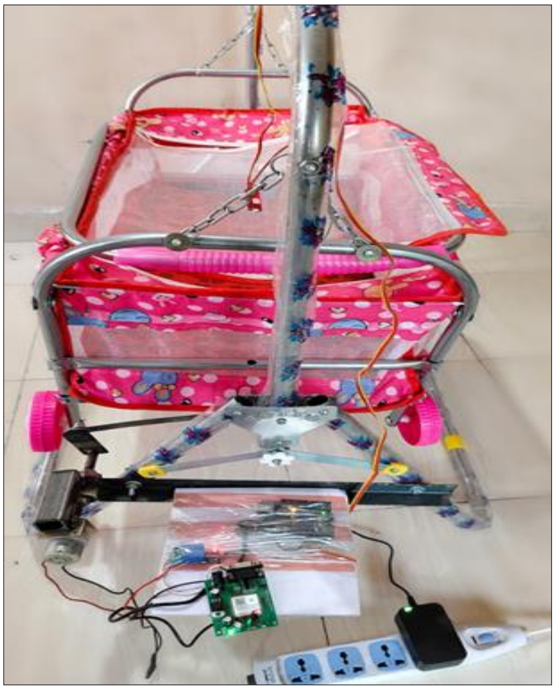

Fig -9: Actual Model

8. RESULT & ANALYSIS:

Cradle Movement Test:

Objective: Evaluated the smoothness and effectiveness of cradle movements.

Method: Visual observation and subjective assessment of cradle motion.

Results: Cradle movements were smooth and gentle, providing soothing motions for the infant.

Noise Detection Test:

Objective: Assessed the accuracy of noise detection sensors in detecting infant cries.

Method: Simulated infant cries of varying intensity levels and measure sensor response.

Results: Noise detection sensors reliably detected infant cries, triggering cradle movements promptly.

Wetness Detection Test:

Objective: Verified the effectiveness of wetness indication sensors in detecting diaper wetness.

Method: Simulated diaper wetness and measure sensor response time.

Results: Wetness indication sensors accurately detected diaper wetness, prompting timely caregiver alerts.

User Interface Test:

Objective: Evaluated the usability of the user interface for adjusting cradle settings.

Method: Task-based usability testing with caregivers.

Results: Caregivers found the user interface intuitive and easy to use, allowing for convenient adjustment of cradle settings.

Analysis:

The results of the tests indicate that the automated baby cradle system performs effectively in providing real-time assistance to caregivers and ensuring infant comfort.

The system demonstrates reliability in detecting infant cues (noise and wetness) and responding promptly with appropriate actions (cradle movements and caregiver alerts).

User feedback suggests high satisfaction with the usability and functionality of the system, indicating its potential to enhance caregiver experiences and infant care practices.

9. CONCLUSIONS:

1. Developed an automated mechanism to enhance the functionality of existing baby cradles, enabling seamless motion.
2. Integrated noise detection sensors to initiate automated cradle movements upon detecting infant cries, improving responsiveness to infant needs.
3. Incorporated wetness indication sensors to promptly alert caregivers for timely diaper changes, enhancing infant comfort and hygiene.
4. Implemented a GSM module for real-time communication, facilitating caregivers to receive SMS alerts when infant needs are detected, and ensuring timely and efficient care.

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