Journal of Neonatal Surgery
ISSN(Online): 2226-0439
Vol. 14, Issue 5s (2025)
https://www.jneonatalsurg.com

OPEN ACCESS

Design and Fabrication of Baby Health Monitoring Using a Cradle Swinging Module

Senthur N. S[1], Rekha D[2], D V V S B Reddy Saragada[3], Gavya G M[4], P Subhashini[5]

[1]Department of Engineering, PSN Engineering College, Tirunelveli, India.

Email ID; senthur.ns@gmail.com

[2]Research scholar, Bharath Institute of higher education and research, India.

[3]Department of Mechanical Engineering, Aditya University, Surampalem, India.

[4]School of Computer Science and Engineering, Vellore Institute of Technology, Chennai, India.

Email ID: gavya.g.m@gmail.com

[5]Department of Computer Science and Information Technology, MLR Institute of Technology, Hyderabad, Telangana, India

Cite this paper as: Senthur N. S, Rekha D, D V V S B Reddy Saragada, Gavya G M, P Subhashini, (2025) Design and Fabrication of Baby Health Monitoring Using a Cradle Swinging Module. *Journal of Neonatal Surgery*, 14 (5s), 53-61.

ABSTRACT

The design and fabrication of an automatic infantcradle rocking machine that can be coupled to any existing market-available mechanical cradle and transformed to an automatic smart cradle rocker was accomplished. This autonomous baby cradle rocker employs a high torque gear motor to facilitate the cradle bed in rocking and allowing the infant to sleep peacefully. In addition to swinging the cradle, thissystem contains an auxiliary temperature sensor that detects and manages the warmth using a fan to cool the cradle and an embedded humidity sensor that alerts the caregivers when the baby makes the bed wet.

Keywords: *Baby cradle, Gear motor, Arduino, Automation, Bluetooth control, Baby Monitoring.*

1. INTRODUCTION

Since ancient times humans have faced many issues withthe process of babysitting, a process which is tiring work thathas a major part in making and monitoring the baby sleep andhas a comfortable sleep, for which we have been using baby cradles which is a bed like structure which can swing when aperson pushes it, With the help of today's advancement in technology this rocking part was done automatically by usingavailable technology [5] which enhances the baby sleep process and makes the work easier for the parents or the person looking after the baby. Since many people use their oldcradle in their family or could only afford a mechanical cradlefrom the data we collected one in five households prefer usingan existing manual cradle rather than a new automatic cradlewhich is, in turn, very expensive and also exerts more variablefrequencies which affect the baby sleep[2] as they have pre- programmed speed setting which is not convenient to changeand modify according to user preferences, the currently available automatic cradles are expensive and have to be fullyreplaced when get damaged. Our research developed a cradlerocking system that can be mounted in any existing manual cradle easily and a ready-to-use cradle rocker product that aims to convert any manual cradle to automatic also this newproduct is being designed such that users can use their existing cradle and can convert their existing mechanical cradle to a fully automatic cradle that replaces the automatic part eliminating the need of fully replacing the whole cradle and also reduces waste by eliminating much of plastics used in themarket available automatic cradle. As stated above our project aims to design a separate module that can be attached to any existing mechanical cradleto convert it into an automatic cradle rocking system and hassome inbuilt features that make the baby's sleep comfortable, which addresses some issues which were baby sleep- disturbing factors that were identified by the research conducted by our team such as temperature which was a bit high inside the cradle bed as compared to the surrounding temperature and the baby frequently wetting the bed which caused a major of the sleep problem, and also the factor of work which consumes the most time of parents is rocking thecradle even after the baby is asleep for undisturbed sleep, withhelp of the above system baby monitoring is made easy

Thus there is a need for a new product that is readily accessible by the user and can be easily controlled by a speedcontrol potentiometer which varies the frequency of the current input through pulse width modulation and by doing sovaries the speed of the motor which results in the modulationof swinging speed of the cradle, as this system uses a slider crank mechanism for linkage of the cradle cot with the motorit executes a smooth transmission of force from the motor tothe cradle for the swinging of cradle. This speed system can also be conveniently controlled via a smartphone app that connects with the motor

through a Bluetooth module which executes connection and commands via a microcontroller, this microcontroller is used as the heart of the total automation system which enables pulse width modulation to the motor which is connected to the microcontroller through a motor driver to actuate the motor, this microcontroller is also used tomeasure the temperature using a temperature sensor andcontrols the fan attached to the cradle to regulate the temperature, and also the wet sensor is connected to this microcontroller which signals the parents when the baby makes the bed wet, this feature is a great addition to reduce landfill waste of baby diaper and also helps in maintaining thebaby health condition[8].

2. METHODOLOGY

This design uses a gear motor for driving the swing and acrankshaft mechanism for the linkage of the cradle to the cot.Then there is a microcontroller that processes all the sensor'sinput and gives relevant output according to the code.

3. CRADLE SWINGING COMPONENTS

Gear Motor:

High torque gear motor with 30,000 rpm as a base motorand gear reduction box which has several gears to reduce therpm [10] and give the maximum torque which is 20 Kg stall torque and 60 rpm rotation rate specifications of the gear motor are given in table 1. The motor is selected from the analysis from various motors [1], The Gear motor is mountedto the cradle and uses a mechanical slider crank to make the cradle rock, this motor uses 12V power which is connected tothe Arduino board which gives the actuation for the motor according to the potentiometer value.

Fig. 1. Gear Motor

TABLE I.: GEAR MOTOR PARAMETERS

Parameter	Value
Brand	Johnson Gear motor
Operating voltage	12V
Stall torque	20kg
Max Rotation Per Minute	60 RPM

POTENTIOMETER:

A 12V 3A potentiometer is an electronic component usedfor motor control applications that require variable speed or direction control. It is typically used to adjust the voltage or current supplied to a DC motor via a PWM [17], which in turn affects its speed and torque. The potentiometer consists of a resistive track that is adjustable by a rotary knob or slider, allowing the user to regulate the amount of current flowing through the motor.

Fig. 2. potentiometer

TABLE II. PARAMETERS OF POTENTIOMETER

Parameter	Value
Brand	Generic
Operating voltage	12V
Outout voltage	5V TO 12V
Inputs	1

SLIDER CRANK MECHANISM:

This is the main linkage mechanism used to drive the cradle by motor, this system has a circle component attachedto the motor embedded with a ball bearing from which an extending rod [9] further connects to the cradle, the connecting rod is designed in such a way that it can be adjustedaccording to the length needed for the cradle to swing, the connecting rod is further connected to the cradle cot by usinga specially designed clamp which is designed in such a way that it can be attached to any mechanical cradle irrespective ofthe frame size. This crankshaft works on the basic principle ofmechanical push and pulls motion [14],[15] which in turn makes the cradle swing and comforts the baby's sleep process,As stated the clamp mounted for the cradle cot attachment tothe cradle frame is a specially designed stricture which can beclamped to any circle flat or even square rod of the cradle cot(which would be hanging from the cradle frame), for easy installation on any existing cradle for the baby.

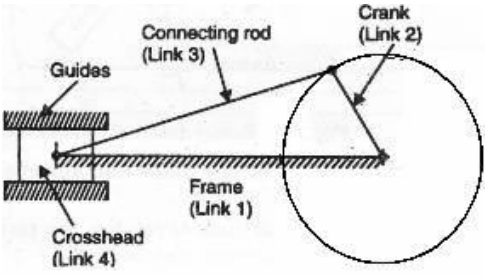

Fig. 3. Slider Crank mechanism

This mechanism of our system has a dual connection rodthat can be adjusted and extended according to the swing distance needed for the baby and according to the existing mechanical cradle manufacturing specification.

SENSORS USED FOR MONITORING

TEMPERATUREURE SENSOR

The temperature sensor is to be placed inside thecradle to measure the cradle temperature [11] and sends the current temperature reading to the microcontroller which in turn sends a signal to the fan to the ON/OFF state.

TABLE III. TEMPERATURE SENSOR PARAMETERS

Parameters	Value
sensor accuracy	+/- 1 C
Operating temperature range (c)	-20 C to 30 C
Min supply voltage	4V
Max Supply voltage	30 V
Supply current	114 Ma
Interface type	Analog output
Sensor Gain	10 Mv/Deg C

The temperature sensor sends an analog signal to the microcontroller and there it gets converted to a digital signal

[4] and made to be compared with the required temperature which was already programmed to the microcontroller usingthe code structure which controls the entire unit of the mechanism.

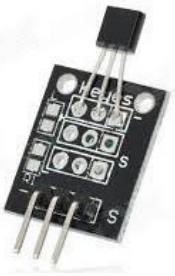

Fig. 4. Temperature sensor

MOISTURE SENSOR:

A moisture sensor is used to detect and send a signal aboutmoisture once the probe (as shown in Fig.5) comes into contact with moisture as soon as the baby makes the bed wetthe moisture sensor sends the reading to the processor whichtakes the value and compared it to the value that is given to give alert. Moisture sensor works on the principle of conductivity which when comes into contact with salt water which is a great conductor of electricity passes the value [18]and converts it to a digital signal by the inbuilt controller which the moisture sensor has and after which it sends that value to the Arduino Uno microcontroller.

Fig. 5. Moisture sensor.

DHT11 SENSOR

The DHT11 sensor is a low-cost digital temperature and humidity sensor. It consists of a capacitive humidity sensor and a thermistor to measure the surrounding air's relative humidity and temperature. The sensor is relatively easy to use,with a single-wire digital interface that can be connected to most microcontrollers.

The DHT11 sensor has a range of 0-50 degrees Celsius fortemperature measurement and 20-90% relative humidity for humidity measurement, with an accuracy of ±2°C for temperature and ±5% for humidity. The sensor is suitable fora variety of applications, including environmental monitoring, HVAC systems, and weather stations.

The DHT11 sensor is a popular choice among hobbyists and DIY enthusiasts due to its low cost and ease of use. It is often used in conjunction with microcontrollers such as Arduino, Raspberry Pi, and other development boards.

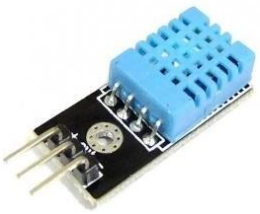

Fig. 6. DHT 11 SENSOR

LCD DISPLAY WITH I2C MODULE

An LCD display with I2C module is a type of liquid crystal display (LCD) that is paired with an I2C (Inter-Integrated Circuit) module to enable easy communication with a microcontroller or other digital device. The I2C module acts

as an interface between the LCD and the microcontroller, allowing for a simplified and streamlined connection.

The I2C protocol is a widely used communication standard that allows for the transfer of data between digital devices. The I2C module used with an LCD display typicallyhas a small on-board chip that acts as a translator between themicrocontroller and the display, making it easier to control thedisplay without the need for complex wiring.

The LCD display with I2C module typically has a standard16x2 or 20x4 character display that can show alphanumeric characters, symbols, and custom graphics. It also has a backlight that can be controlled through the I2C module.

ARDUINO UNO:

This design relays on a microcontroller for processing thedata and giving the system a relevant output, for this purposewe have equipped this system with Arduino Uno which is a readily available and programmable microcontroller, this hasmany inbuilt inputs and output pins of analog pins and digitalpins to read the input from the sensors and give relevant output. As we use sensors like Temperature & moisture that are connected to the Arduino analog pins which convert thatto a digital signal and give output as fan ON/OFF & moisturealert in order. As Arduino Uno doesn't have an inbuilt Bluetooth facility an external module is added to this controller for Bluetooth connectivity.

Fig. 7. Arduino UNO

MOTOR DRIVER

The motor driver used in this project is L298n [12] which is adual motor driver that translates the signal from the Arduino UNO which is basically a low-current control signal and thenturns it into a higher-current signal that can drive a motor [7], this is also used to alter the pulse width modulation which alters the speed of the motor, here we use fan motor which modifies the speed according to the temperature level.

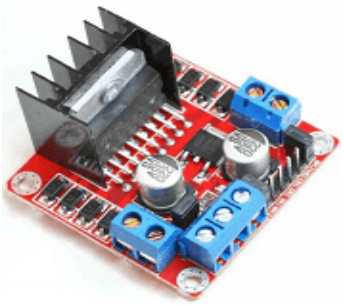

Fig. 8. Motor driver L298n

BLOCK DIAGRAM

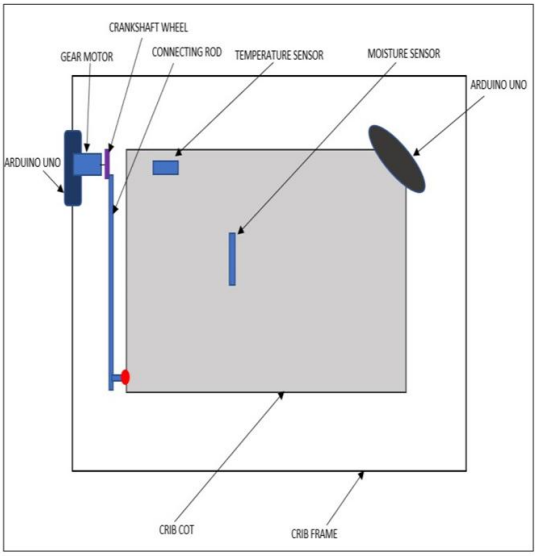

Fig. 9. Block Diagram

The above diagram Fig.8 shows the system function through which the designed cradle racking system is functioning and the whole baby monitoring system works, Firstly the cradle rocking motor is attached to the cradle frame

4. RESULT AND DISCUSSION

Design of slider crank for cradle swinging

CRANK WHEEL

The crank wheel is designed in an aspect to attach to the motor and have the adjustments for the swinging length of thecradle by changing the hole in which the hand is attached.

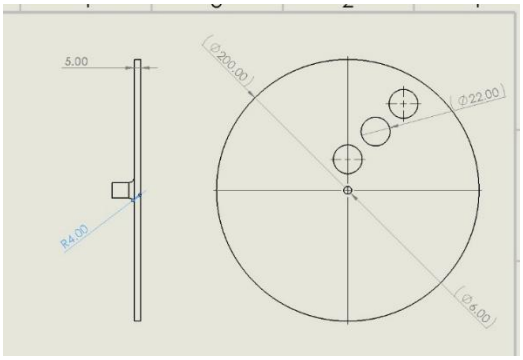

Fig. 10. Crank Wheel

The above figure is the design of the crank hand which isdesigned to attach to the cradle bed so that it swings the bed with the help of the crank wheel, the dimensions of the designed hand are given in detail in fig 10. This part has been

3D printed by using a 3D printer which can prototype parts, this 3D print is done by using a PLA filament which isdone by studying a different type of material [6] and then fixed PLA as the material to print with a solid infill layer of 80% which makes the crank wheel sturdy and strong.

CRANK HAND

The crank system driven by the wheel uses a hand that pushes and pulls the cradle cot that making the cradle swing.This design has four holes for the attachment adjustment so where the Arduino and potentiometer are also included in thesame system which has connection ports to the sensors such as temperature and moisture which is further paced inside thecradle and the connection is made. The fan is mounted in theframe and connected to Arduino Uno to get the output after reading the value from the temperature sensor and give the feedback to the Arduino microprocessor which intern gives the fan which is connected via motor driver to Arduino whichis made to on and off by the relevant output given by the Arduino.

The moisture sensor is also connected in the same way asgiven in the block diagram to the Arduino Uno with sensors the moisture from the babies wetting the bed gets identified and the voltage signal is been sent to the how do you know where it gets processed and output is been given as a moisturealert so that the parents can identify whether the babies bed cloth change for the baby comfortable sleep.

Apart from the center operations, the motor which was which is attached to the script frame is attached to the cradlebed by using a crankshaft mechanism that has connecting rodwith a specially designed clamp to hold the cradle cot this mechanism makes the cradle automatically swing and iscontrolled via potentiometer which is also connected to Arduino Uno.

that it can be adjusted to the wheel so that it can be connectedto any cradle and the swinging distance can be controlled. The measurement for the shaft is given in fig.11.

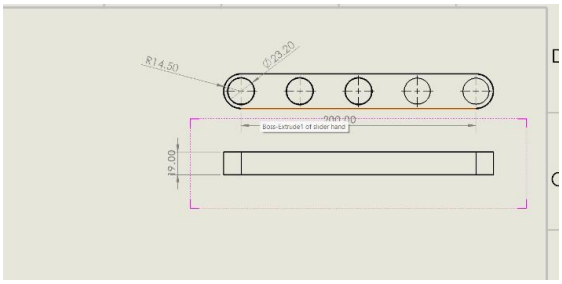

Fig. 11. Crank hand

ARDUINO CODE

The whole system is made to function using the code shown in fig.11 which is executed in the way mentioned below the figure. The Arduino Uno is a universal prototype platform made of an Atmel 3351 processor and can be programmed using C++ code.

The above figure Fig.12 shows the software used for coding the Arduino Uno which is an opensource software called Arduino IDE (Arduino Integral Development Environment) which has an inbuilt function to upload code tothe Arduino Uno board which processes the code and gives relevant output with the input given according to the code feed in the Arduino. This code works in such a way that it executesthe operati0on given in the loop function, to start the code wehave given the declaration for the Temperature sensor analogpin, Moisture sensor, Potentiometer, and the motor driver which is used to control the fan motor and cradle swing motor,this motor driver has 3 input pins for one motor out of whichtwo is for directional control which changes polarity and changes direction and the other one pin is used for PWM modulation speed control [17] , There are six pins for two motor in motor driver these pins are declared in correspondence in the code.

The code identifies and starts the code after declaring thesensor pins as input and output pins, which take data from theinput and give data to the output.

All the sensors are declared as separate functions which are then declared in the loop to run all the functions continuously

Each function is declared individually and so both input and output are declared inside each function so that all the function are separately declared and is made to repeat in the loop for the whole cradle to function and execute all the sensor operations as stated above it would be easy for the microprocessor to execute all the stated functions in the loopwhich is based on separately declared functions for every senor operation.

CIRCUIT

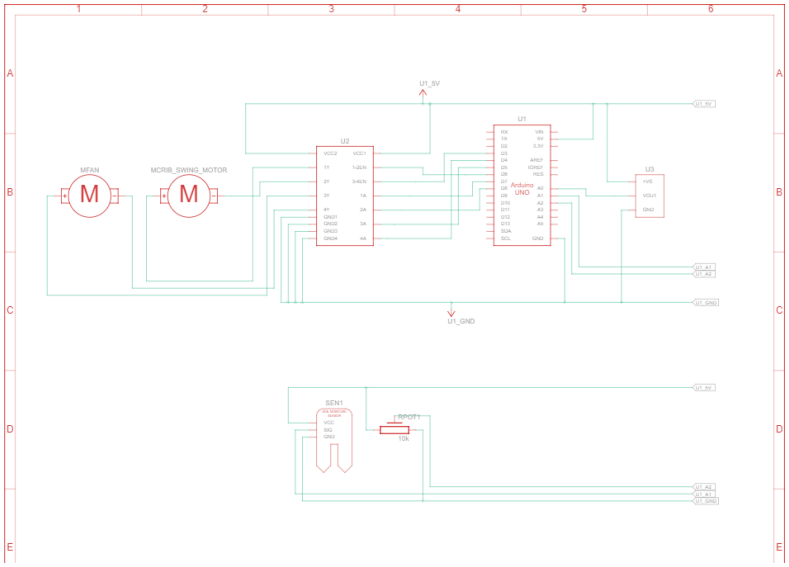

Fig. 12. Circuit connection

The above circuit connection was designed and successfully tested for the correct output, The power source for the entire circuit is given by a 12V 2amps power adapter which is directly connected to 240V AC and after which this power adapter converts AC to DC and supplies 12V power to the circuit, all the components including the sensors, motor, and the microprocessor takes power from this for the circuit to function. The motor used for cradle swinging takes up to 2 amps of power at its peak torque (which won't be necessary as compared to baby weight and motor torque) we have provided a 2Amps power adapter.Both the cradle swinging high torque gear motorand the fan are connected to the L293D motor driver which isused to control the motors via Arduino by sending signals tothe motor driver through the driver, the motor driver is also used to vary the speed of the fan according to the temperatureby varying the voltage supply to the fan motor.

The fan motor is connected to output 1&2 of themotor driver and which has the 3 corresponding input pins from the Arduino 2 pins to alternate the polarity and 1 PWMpin to change the speed of the motor, the 2 pins in1 and in2 are connected to the Arduino board according to the declaration of pins in the coding and the en A pin as stated isthe speed control pin of the motor driver that is connected tothe Arduino as declared in the coding, the cradle motor is alsocircuited in the same way as the fan motor to make the cradlebed swing, This cradle motor is controlled via a potentiometerwhich is also connected to the Arduino the pin varies the supply voltage and gives the input to Arduino which convertsthat signal and sends that to the motor driver which in turn increases or decreases the speed according to the input givenby Arduino.

The part marked U3 is the temperature sensor which is connected to the analog pin A1 of Arduino this sensorcalculates the temperature of the cradle and sends it to the Arduino where it compares the temperature reading to that ofour coding and controls according to it.

The soil moisture sensor named sen1 in the circuitis connected to the Arduino analog pin which gives an alert output by blinking the LED light in the cradle and alerting theparent's mobile which is connected to the system via Bluetooth to look at the baby's current condition of bed and change the bedspread.

Thus the testing of the circuit for the baby monitoring system is done successfully and the requiredoutput was obtained for the smooth and concurrent functioning of all the components which is employed in the system for the baby sophistication, this circuit is efficient to function and gives proper output thus increasing the baby health condition, This whole circuit function using the Arduino coding which is C++ language this coding employsall the pin declaration and for the whole function of logic to work.

5. CONCLUSION

This system was studied to be the best solution for babyhealth improvement by making the baby sleep comfortableand the parent's job easy, This system can further beextended by making use of a baby monitoring system witha camera and face recognition alert to parent, also making ita full baby health monitoring system which tracks the babybody temperature and other health parameters to sort and show the result on baby's healthy growth. This project canfurther be extended to an IoT project which stores the datain the cloud and gives reports to the parent

REFERENCES

[1] T. Verstraten, G. Mathijssen, R. Furnémont, B. Vanderborght, and Lefeber, "Modeling and design of geared DC motors for energy efficiency: Comparison between theory and experiments," Mechatronics, July 2015.

[2] Ko Ying hao, Lu-Ean Ooi, Yoon Ket Lee , et al., "Vibration Analysis of Electronic Baby Hammock," in Transactions on Science and Technology, pp. 3623–3630, March 2016.

[3] Ali A. Hassan, Nabil K. Al-Shamaa, and Kasim K. Abdall, " Comparative Study for DC Motor Speed Control Using PID Controller," IJET, pp. 3623–3630, January 2018.

[4] Gerard C.M. Meijer, Guijie Wang, and Ali Heidary, "Smart temperature sensors and temperature sensor systems," in Smart Sensors and MEMs, vol. 2, pp. 58–85, February 2018.

[5] Tushar P. Patekar1, Pooja S. Dawale2, and Pooja A. Jaiswal 3, "Design and Fabrication of Automatic Baby Cradle System," in IRJET, Volume: 05 Issue: 02, pp. 973–976, February 2018.

[6] Giovanni Putame, Mara Terzini, Dario Carbonaro, Giuseppe Pisani, Gianpaolo Serino, et al., "Application of 3D Printing Technology for Design and Manufacturing of Customized Components for a Mechanical Stretching Bioreactor," in Hindawi Journal of Healthcare Engineering Volume 2019, Article ID 3957931, 9 pages, 21 April 2019.

[7] Babangida Ibrahim, V Siva Brahmaiah, and Pradeep Sharma, "Design of smart autonomous remote monitored solar powered lawnmower robot," Materials Today: Proceedings, 23 April 2020.

[8] S. Maloji, S. Malakonda Sai Lokesh, K. Nikhil Sai, M. Vasavi Prasanna, M. K. Ashwaq, and S. Arunmetha, "An innovative approach for infant monitoring system using movel s.Odi based iot system," Int. J. Adv. Sci. Technol., vol. 29, no. 6, pp. 3623–3630, 2020.

[9] Daoming Wang, Yan Xiong, Bin Zi, Sen Qian, Zhengyu Wang, and Weidong Zhu, "Design, analysis, and experiment of a passively adaptive underactuated robotic hand with linkage-slider and rack- pinion mechanisms", in Mechanism and Machine Theory, August 2020.

[10] A. Arjun, P. Umar Ahamed, K. Shahul Hameed, M.P.M. Mohamed Ibraheem, et al., "Experimental analysis of solar wiper and its power estimates." In Materials Today: Proceedings, 25 September 2020.

[11] Ramesh Saha, Supra Biswas, Satyajit Sarmah, Sushanta Karmakar, and Pranesh Das, "A Working Prototype Using DS18B20 Temperature Sensor and Arduino for Health Monitoring," in SN Computer Science, Vol 2:33, January 2021.

[12] N. Srilatha, T. Malyadri, V.V.D. Sahithi, and Priyadarsini Morampud, "Design of unmanned guided vehicle for rescue missions," Materials Today: Proceedings, Proceedings 45 (2021) 3177–3185, pp. 3177–3185, February 2021.

[13] Hongliang Hua, Zhenqiang Liao, Xiaofeng Wu, and Yongjiang Chen, "A Bezier based state calibrating method for low-cost potentiometer with inherent nonlinearity," Measurement 178 (2021) 109325, 2021.

[14] Grzegorz Kudra, Jose M. Balthazar, Angelo M. Tusset, Grzegorz Wasilewski, Bartosz Stanczyk, and Jan Awrejcewicz, "Dynamics analysis and control of a pendulum driven by a DC motor via a slider-crank mechanism," Mechanical Systems and Signal Processing, Mechanical Systems and Signal Processing 166 (2022) 108415, August 2021.

[15] Yong Cheng, "Modified PWM Direct Instantaneous Torque Control System for SRM," Mathematical Problems in Engineering Volume 2021, Article ID 1158360, 13 pages, August 2021.

[16] N Lakshman Pratap, K Anuroop, P Nirmala Devi, A Sandeep, Sunanda Nalajala, "IoT based Smart Cradle for Baby Monitoring System," ICICT 2021, pp. 1298–1303, 2021.

[17] Tan Jiawan, Yan Langtao , Liu Yusheng, and Huang Sanshan, "Realization of the Ultrasonic Motor Speed Control System Based on H-Bridge," Mathematical Problems in Engineering Volume 2021, Article ID 8106164, 12 pages, 2021.

[18] Jaysukh C.Songara, and Jayantilal N.Patel, "Measurement Calibration and comparison of various sensors for soil moisture measurement" in Measurement, Volume 197, 30 June 2022.