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Comfort sense baby bed

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” Hardware Graduation Project”

August 2023

Acknowledgements

We want to thank our parents, family, and friends for always supporting us. A big shout-out goes to our supervisor, Haya Samaana. She helped us a lot and we're thankful to her. We also want to thank the Computer Engineering Department teachers; they taught us so much.

And of course, thanks to our friends who were there with us all the time, keeping us positive and motivated.

Disclaimer

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Abstract

For our graduation project we've come up with an idea that focuses on bringing advantages to both babies and their mothers. Our proposal centers around creating a baby monitoring system named "ComfortSense Baby Bed." This groundbreaking system aims to empower mothers by enabling them to observe their babies and take measures to ensure their utmost comfort during their sleep. As part of this project, we plan to develop a user application that will facilitate tracking of the baby's information, for the mother. So, this application will notify the mother whenever:

- There is a need to change the baby's diapers.
- The baby moves, then there will be a camera that will pass the view to the mother so she can watch her baby.
- Also when he/she cries, in this case she will be given three options the first one is to make the bed swing, the second one is to turn on a musical crib mobile toy and the final option gives the mother the choice not to request the bed to do anything, but let's assume that she was busy and didn't notice the notification, in this case the bed will choose the second option by default.
- The temperature of the room is higher than a specific degree, so a fan attached to the bed will be turned on to cooler the temperature.
- The baby's temperature is higher than the normal range.

The application will provide the mother with the temperature of her baby, the temperature of his/her room, either by using the application or by reading the information from the LCD screen that will be provided beside the bed.

And the bed is smart enough to open a cover to protect the baby from the sunlight whenever is senses the sun.

1.Introduction

1.1 Problem

Frequently, mothers find themselves distanced from their child's crib, particularly when the child is asleep. Yet, what transpires if the child awakens or starts crying? What if the child's body temperature becomes elevated? What if the ambient room temperature surges to a degree that poses potential harm to the child? Moreover, consider instances when the child necessitates a diaper change. In such scenarios, the mother's thoughts remain preoccupied with her child's well-being, leading to a situation where her focus is singularly dedicated to the child, allowing minimal room for other endeavors.

1.2 Objectives

The main goal of the Comfort Sense baby bed is to make the baby and the mom feel really comfy. It does this by doing things that suit the baby's needs and the environment around. Plus, it uses a special app to keep the mom updated about how the baby is doing, which helps her feel connected and at ease.

1.3 Scope of work

1.Temperature Monitoring System: This keeps track of how warm the baby and the room are, checking every minute. The information is shown on an LCD next to the bed.

2.Fan System: If the room gets too hot, a fan turns on by itself to cool things down.

3.Sun Umbrella: If the baby's bed is near a window and the sun shines right in, an umbrella closes on its own to block the sunlight.

4.Mobile App: Moms can use this special phone application to watch the baby from different sides:

- Diaper and Room Temperature Alerts: The app says when it's time for a diaper change, or when the room temperature becomes high.
- Movement and Crying and Temperature Notices: Moms get messages if the baby starts moving or crying or if the baby's temperature becomes high.
- Bed Swing Control and Toy Play: Moms can make the baby's bed swing and start a toy using the app.

5.Live Streaming Camera: There's a camera that shows the baby on the phone in real-time, so moms can watch what the baby is doing.

1.4 Significance

The project holds great importance as it focuses on the well-being of infants and aims to provide a sense of relaxation for mothers. The intelligent design and practical features of this project bring comfort to both babies and their mothers. Let me explain why this project is significant:

- 1- Improved Monitoring and Safety for Babies
- 2- Empowering Mothers through Access to Information
- 3- Convenience and Remote Monitoring for Easy Management
- 4- Tailored Comfort Solutions for Personalized Experience
- 5- Shielding from Harmful Sunlight
- 6- Ensuring Peace of Mind for Mothers
- 7- User-Friendly and Effortless to Use
- 8- Pioneering Innovations in Baby Care
- 9- Fostering Strong Parent-Child Connections

In summary, the "ComfortSense Baby Bed" project plays a pivotal role in transforming the way we monitor and care for babies by adopting a comprehensive approach. By addressing various aspects such as comfort, safety, and convenience, this project contributes to the overall well-being of infants and provides support to mothers throughout their parenting journey. The incorporation of technology and thoughtful design showcases a commitment to enhancing the lives of families.

2. Constraints and Earlier coursework

2.1 Constraints and limitation

- Time constraints: it was quite challenging to get all this work done while having such a short period of time, beside the requirements of the other subjects.
- Lack of experience: although we had some hardware subjects throughout our studying, this was our first time in practical application, so we made some mistakes that cost us extra effort, money and time.
- Budget: our project required a significant number of sensors, motors and other components that weren't cheap, also because of the lack of experience, we had to buy some parts multiple times.
- Handling the components: some components like the esp8266 and the esp32_CAM were difficult to work with, especially the camera, we had a rough time trying to get it to stream.
- Unforeseen Challenges: sometimes hardware projects force you to face an unexpected challenge, despite being well prepared, so this was also one of the challenges that we faced.
- Safety and security: monitoring systems like ours should be safe and secure to use by the mother and for her baby, so we had to pay attention to this point.
- Power constraints: as mentioned above it was our first time building such a project, so we faced problems dealing with the electrical part. Each component requires a different amount of voltage levels, they work on 3.3v, 5v or 12v.

2.2 Earlier Coursework.

- 1- Microcontroller course that helped us to deal with some components because of the hardware project we built.
- 2- Critical thinking and scientific research course was very useful. It teaches us how to prepare a good presentation.
- 3- The Electronics course provided us with instructions for electronic systems.
- 4- Microprocessor Lab gave us better understanding to the motors.

3. Literature Review

Here are some examples of a baby monitoring system that we found while searching for some features to add in our project.

- Babysense Video & Movement Baby Monitor:

This baby monitor's secure design incorporates split-screen functionality, high-def cameras, and motion sensors for enhanced monitoring. Much like CuboAi, it harnesses an under-the-mattress sensor to gauge the baby's movements within the safety of home. The ultra-sensitive, touchless monitor provided by Babysense detects even the slightest movements within the mattress, while the two sensor pads discreetly cover the crib area without disrupting the baby.

- Nanit Complete Monitoring System:

Comprehensive sleep solution, providing real-time monitoring through high-def Wi-Fi camera, specifically tracking movement, growth, and breathing. Both wall-mountable and freestyling configurations are available for this 1080P camera, courtesy of its cutting-edge smart safe-cord technology. Providing a multifaceted communication experience, this device features a speak, microphone, and adjustable light, all via the app. Notably, this device boasts a motion sensor, thermometer, humidity indicator, and can monitor the baby. Of note, Nanit is the lone Wi-Fi-enabled motion-detecting monitor offering a split-screen feature for simultaneous viewing and control in its corresponding app.

- The Infant Optics DXR-8 Pro baby monitor:

The Infant Optics DXR-8 Pro baby monitor is an advanced version of the DXR-8 model, known for its popularity. The Pro model boasts a larger five-inch HD screen for clearer viewing, improved night vision, and a coverage range of up to 1,000 feet. It features active noise reduction and a unique LED soundbar indicator that visually monitors noise levels. The monitor can be paired with up to four additional cameras, offers versatile pan and tilt functions, and includes a zoom lens. Notably sturdy, it's designed to withstand drops and rough handling. Unlike Wi-Fi-based monitors, it uses a local radio-frequency system with a camera and separate parent unit. The DXR-8 Pro provides a reliable, high-quality solution for baby monitoring needs.

- Lollipop Baby Monitor:

For affordable Wi-Fi enabled monitors with smart functions, both LaBracio and Nevares prefer the Lollipop. Portability and cute design attract praises Its adaptability leads to a wider practicality range. Like the Nanit, this device can spot crying, record crib climbing, log sleep schedules, and monitor respiratory activity. Complimentary for seven days, plans ranging from \$8 monthly are available. Alternative choices involve teaming up with a sensor for monitoring humidity, temperature, and air quality. With enhancements like night vision, two-way

conversation, a pre-installed white noise maker, and soothing lullabies, this product excels. Affordable smart monitoring is among The Lollipop's features.

4.Methodology

4.1 System Architecture:

4.1.1 The Body:

Wooden body in a shape of a baby crib with size of 50cm*25cm*15cm for the base box, a wooden crib, and later on we added a wooden pole to stabilize the moving toy on it.



Fig 1. the project body design.

4.2 Processing Units and Used Components:

4.2.1 Arduino Mega

The Arduino Mega 2560 is a board that operates on the ATmega2560. It comes equipped with pins for connecting components such as buttons, sensors, and motors. We used it for the large number of inputs/outputs it has that we needed to get this project done.

We basically connected most of the components on it like the esp8266, all the sensors, the DC and the servo motor, the fan, the LCD screen, and the toy.

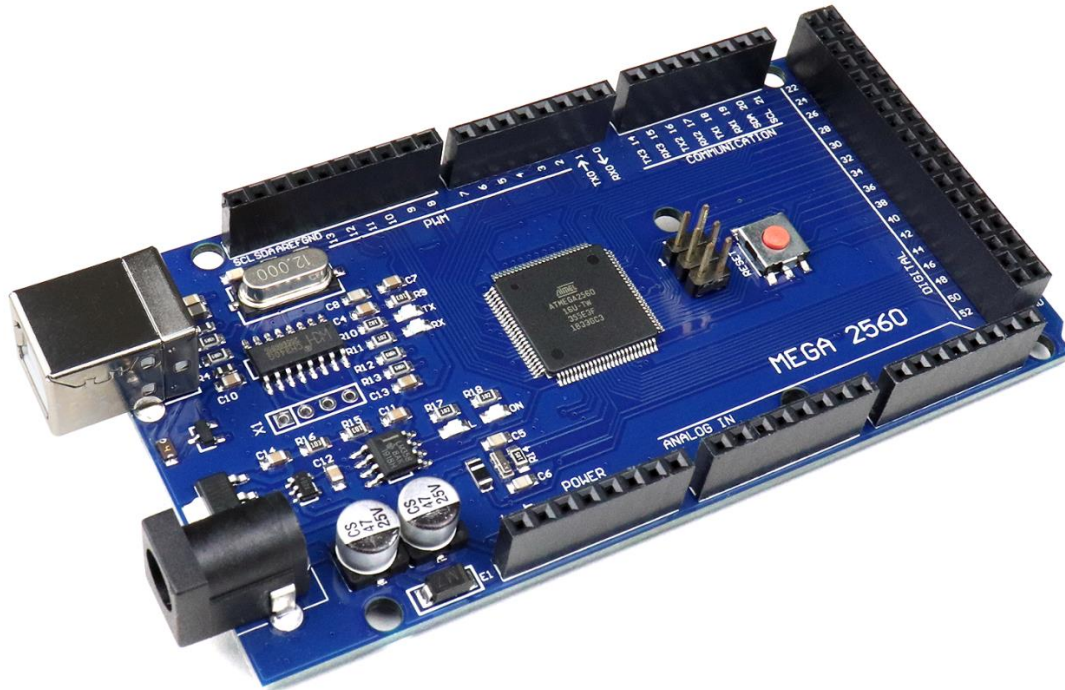


Fig2. arduino mega.

4.2.2 ESP8266 NodeMCU

The ESP8266 NodeMCU is a small and versatile microcontroller board that combines Wi Fi capabilities, with programmability. It is commonly used in the development of Internet of Things (IoT) projects allowing devices to connect to the internet and communicate wirelessly. The NodeMCU is built around the chip. Provides GPIO pins for connecting sensors, actuators and other components. It can be programmed using the Arduino IDE. Supports programming languages. Due to its size, affordability and integrated Wi Fi functionality it has become a choice, for DIY electronics enthusiasts and IoT applications.

And in our project we used it to connect the project to the Blynk application that we have created.

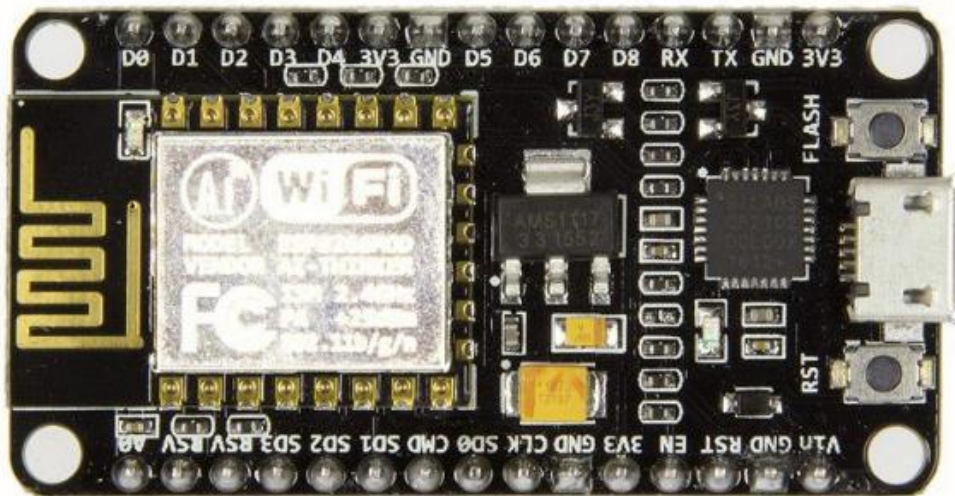


Fig3. EDP8266 NodeMCU.

4.2.3 LDR Sensor.

An LDR, or photoresistor, is a passive electronic component that modifications its electrical resistance due to varying light intensity. In the presence of light, LDR's resistance lessens; when hidden from light, its resistance intensifies. By harnessing their light-sensitive properties, LDRs are versatile enough to be used in many fields, including light-based technologies, automated lighting control systems, and light detection systems. Ambient light sensor involvement can provoke reactions or system settings adjustments.

We used this sensor so it can sense the sunlight whenever it hits the baby's crib, then the servo motor turns on, we will talk about what would happen with the motor later.

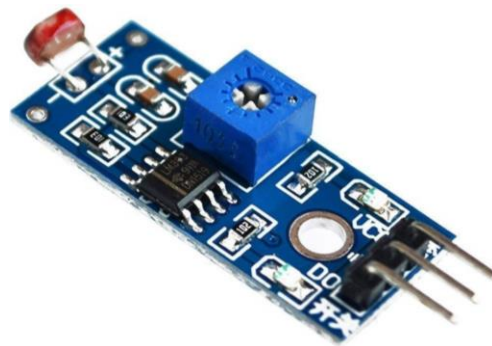


Fig4. LDR Sensor.

4.2.4 Moisture Sensor.

Measuring moisture, the sensor provides accurate readings. By measuring the opposition to electricity offered by metal probes inserted into the earth, it functions. As soil moisture varies, its resistance shifts accordingly – dry soils offering more resistance than wet ones.

So, we took advantage of the soil moisture and used it in the baby's diapers, because of its working process.

Putting this sensor in the baby's diapers will make it possible to detect whenever the diapers should be changed, because it senses the moisture level in the diapers and if it is higher than a specific value then it notifies the mother by turning a LED on in the application interface.

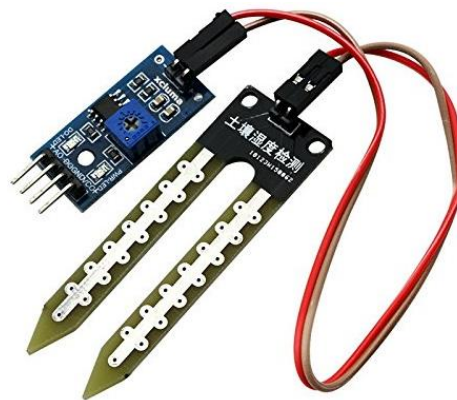


Fig5. Moisture Sensor.

4.2.5 PIR Motion Sensor.

An electronic device that identifies changes in infrared radiation within its field of view, a Passive Infrared (PIR) motion sensor is designed to detect motion. With a foundation in the radiation heat principle, it functions.

Typically, a pyroelectric sensor is combined with a Fresnel lens to form a PIR sensor. Heat variations within its range trigger the sensor's electrical output. With the Fresnel lens, the sensor can more accurately capture motion within a particular angle and distance.

Motion detection results in an electrical signal from the PIR sensor, which can then launch subsequent actions like activating lighting, sounding alarms, or initiating surveillance. PIR sensors, widely used in security systems, additionally find applications in various fields such as energy efficiency, automated lighting, and climate control.

And here we've used it to detect the baby's movement and notify the mother about it. One of the reasons why we used it is because maybe the baby was asleep, and he wakes up without making a sound.



Fig6. PIR Sensor.

4.2.6 103 Temperature Sensor.

It is a thermistor that measures temperature by changing its electrical resistance. It's mostly used for temperature control and monitoring in different applications. Also, it requires connecting a 10Kohm to it.

This sensor is important to detect the baby's temperature, by attaching it to his arm or just putting it on the bed under him/her, we chose this one for its size, so it won't annoy the baby if it was touching his/her body, also because it is so sensitive, so it gives a better reading.

Also, the application will warn the mother if the baby's temperature is higher than the normal range.



Fig7. 103 Temperature Sensor.

4.2.7 DHTL11 Temperature Sensor.

Offering a comprehensive look into the local climate, the DHT11 Temperature Sensor accurately measures temperature and humidity levels. It delivers precise readings and is frequently employed in weather stations, home automation systems, and IoT projects for climate monitoring.

We used it here to measure the temperature and the humidity of the environment that surrounds the baby.

And there is an LED on the application that will be on when the room temperature becomes high.

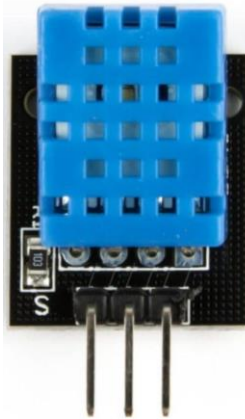


Fig8. DHTL11 Temperature Sensor.

4.2.8 Sound Sensor (Microphone).

Measuring sound intensity with exactitude, the Sound Sensor and microphone are essential components in various fields. In audio recording, voice recognition systems, noise monitoring, and other applications mandating audio input or analysis, these sensors have widespread applications.

And in our project it detects whenever the baby is crying and then notify the mother.



Fig9. Sound Sensor.

4.2.9 16x2 LCD Screen.

Being a popular alphanumeric display type, a 16x2 LCD screen can showcase up to 16 characters arranged into 2 columns. Widely used in electronic projects and devices, computing can display data/message via alphanumeric characters in devices such as thermometers, clocks, and interfaces.

It displays the readings of both the DHTL11 and the 103 Sensors, it shows the baby's temperature for 5 seconds then the temperature and humidity of the surrounding environment for another 5 seconds too.

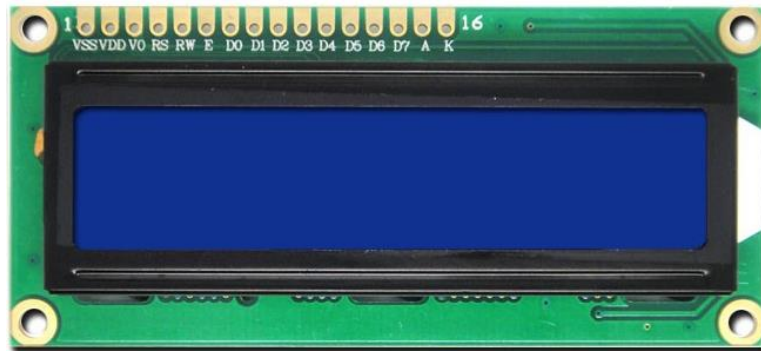


Fig10. 16x2 LCD Screen.

4.2.10 I2C LCD Driver.

By means of an I2C LCD driver, you can easily connect a Liquid Crystal Display (LCD) to a microcontroller or other digital devices through the I2C communication channel. By using the I2C protocol, this driver bridges the gap between the microcontroller and LCD screen, facilitating seamless control and display of information. Serial communication allows for seamless LCD display interaction and control in embedded systems and electronics projects, thanks to its widespread usage.

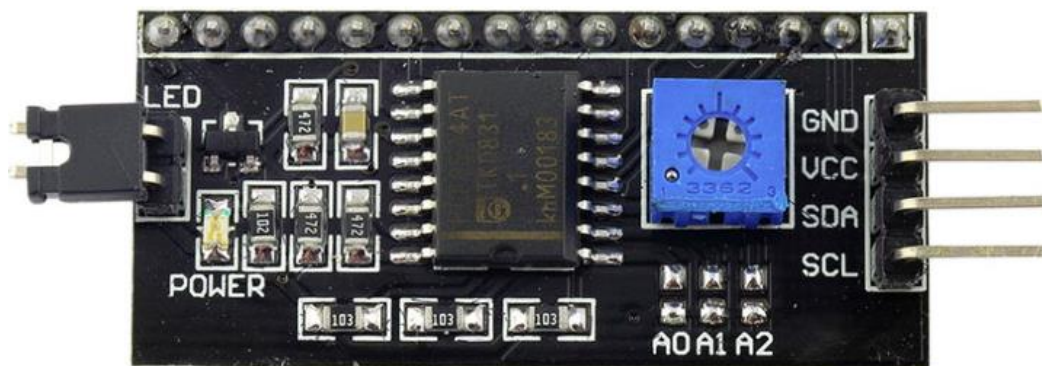


Fig11. I2C Module.

4.2.10 AD082MS-A70GL Fan.

It is a fan designed for electronic cooling, often used in computers and industrial equipment. It operates at 12 volts.

The Fan here depends on the readings of the DHTL11 sensor, so when the temperature is higher than a specific value, the fan will turn on automatically to make the surrounding weather cooler.



Fig12. Fan.

4.2.11 MG996R Servo Motor.

Renowned for its application in robotics and beyond, the MG996R servomotor is widely used. Combining precise control with high torque, this component is tailor-made for projects like robotic arms and RC vehicles.

The benefit of this motor in this project is that there is a metal rod with an umbrella attached to it, so when the LDR sensor senses the sunlight, the motor turns on and cover the bed by moving in a specific degree, also it goes back to its original place to close the umbrella when the sunlight is gone.



Fig13. Servo Motor.

4.2.12 A 12v 4rpm DC Motor.

An electric motor that runs on 12 volts and operates at 4 revolutions per minute (RPM) is known as a 12V 4RPM DC motor. These motors are widely used in situations where slow speeds and high torque are vital, such as in slow-moving machinery, conveyor systems, or rotating displays.

This motor is the one responsible of the crib swings.

Also, it is connected to the application so the mother can turn it on/off any time.



Fig14. DC Motor.

4.2.13 Toy.

We bought a toy module which already got a motor inside it, all we did was connect it to a relay to control it.

It can be controlled by the application so the mother would turn it on or off any time, also it will automatically turn on whenever the baby cries.



Fig15. Toy.

4.2.14 2 Relays.

Relays are responsible for turning the electrical circuits on or off in response to an electrical signal. They are important for remote control.

And here we have two relays to control the fan and the toy.

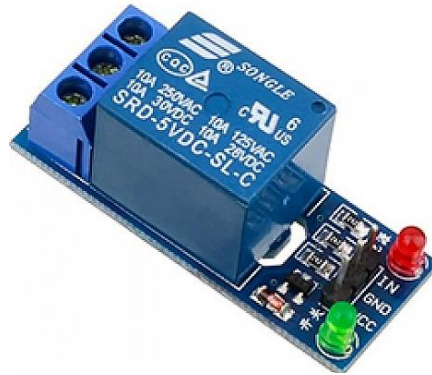


Fig16. Relay.

4.2.15 L298N Motor Drive Controller Board Module Dual H-Bridge for DC Motor.

It is used to control the speed and the direction of the motors.

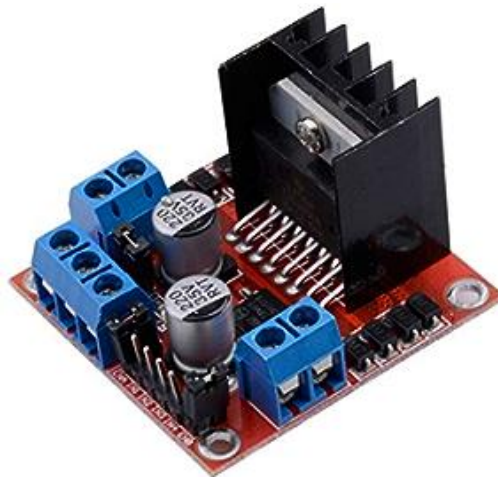


Fig17. L298N H-Bridge.

4.2.16 ESP32-CAM W-BT Board with USB cable.

Of course, we had to use a camera that wirelessly live streams the baby to his mother, so she can feel connected to her baby the whole time, and whenever the application shows that the baby is crying or moving, she can check the camera to see him/her and take the appropriate action, whether to swing the bed or to turn the toy on.

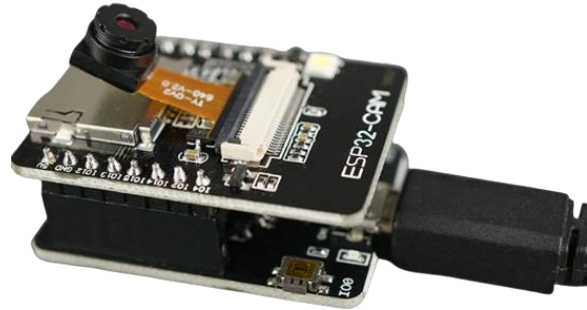


Fig18. ESP32-CAM.

4.2.17 Voltage Converters.

That gives two voltage levels which are 5V, and 12V that we need for different components, for example we need the 12V for the DC motor, and the fan, but the 5V is for the sensors. Etc.



Fig19.Example for a Voltage Converter.

4.2.18 Intercom Wires.

We used them for wiring and connecting different components together.

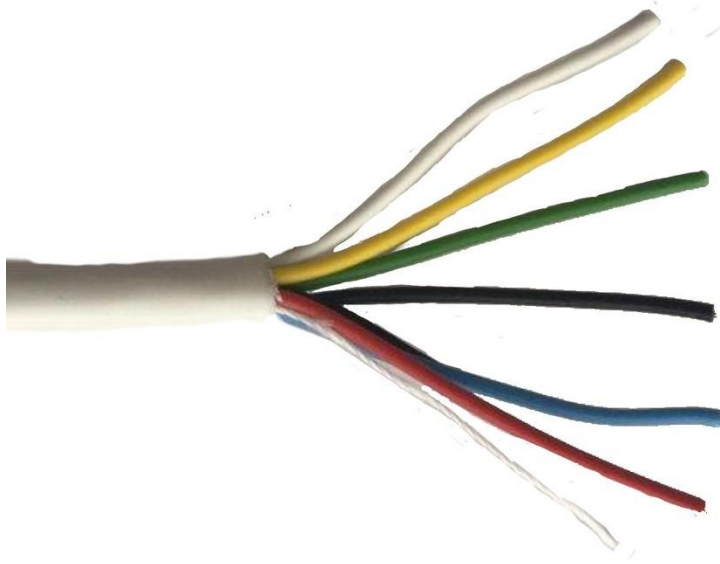


Fig20. Intercom Wires.

4.2.19 Arduino Wires.

To be able to connect the components to the Arduino.

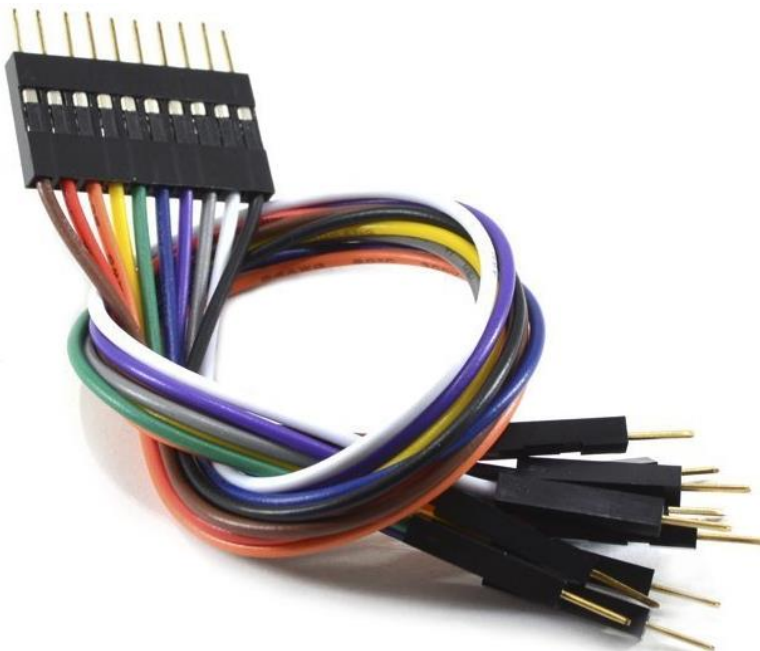


Fig21. Arduino Wires.

4.2.20 Copper Plate for Welding.

We've welded the ESP8266 on it to make it easy to work with, and to connect the wires to it.

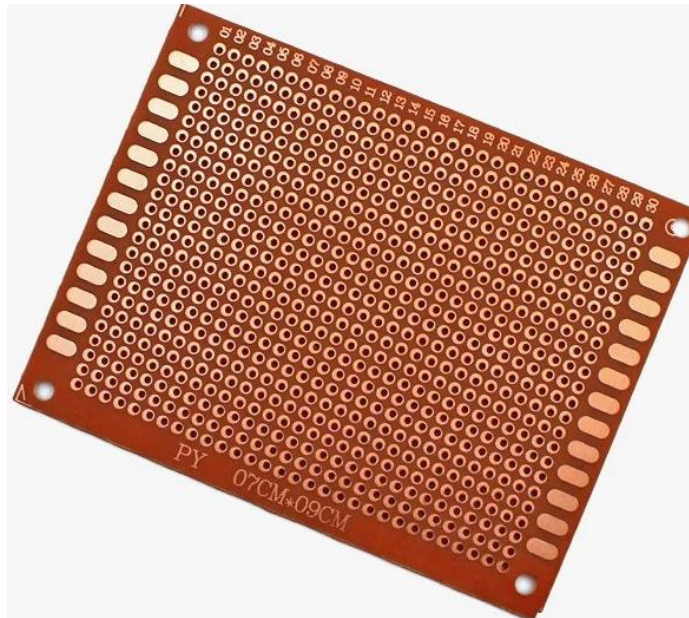


Fig22. Copper Plate.

4.2.21 10Kohm resistor.

It is connected to the 103-temperature sensor.

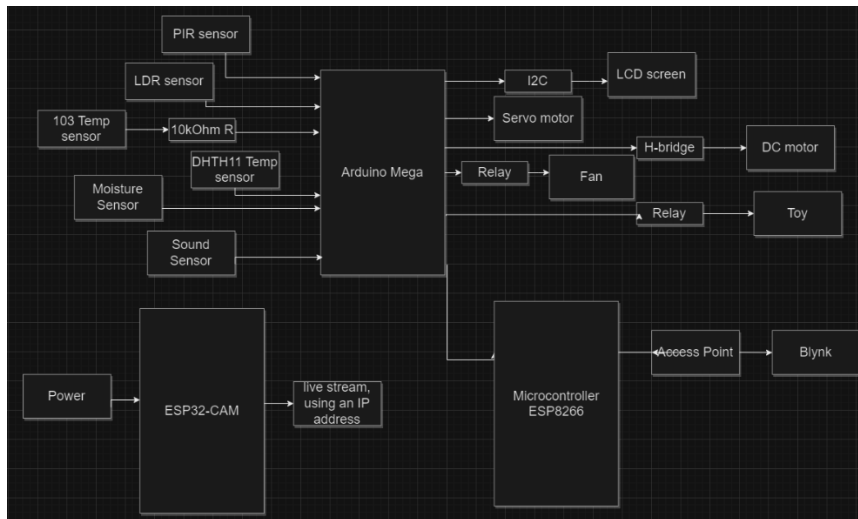


10K ohm

Fig32. 10Kohm Resistor.

4.3 how the system works.

4.3.1 Block Diagram.



In this block diagram its obvious that we connected the sensors to the Arduino(Slave) as inputs, and the motors, LCD, Toy, and a Fan as outputs because they depend on the values that the sensors read, also the ESP8266-NodeMCU as a microcontroller (master), to be able to connect the project with the Blynk application.

And ESP32-CAM to stream live video in IOT.

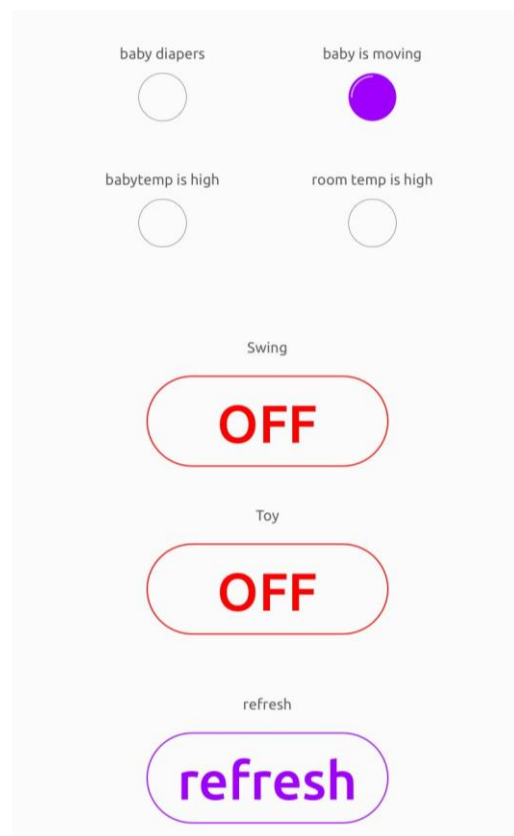
4.3.2 Mobile Application.

We've created a simple, user-friendly interface using Blynk, that has four LEDs on it to notify the mother whenever the baby's diapers need to be changed, if he/she moves, if the room temperature is higher than a specific value, or if the baby's temperature is higher than a specific value.

Here you can see an example of a lighting LED that notifies the mother that her baby is moving.

For the switches we have one to control turning on/off the toy and the bed swings.

And the refresh button is to give the mother the flexibility to turn off the whole LEDs, in case she is already with her baby so no need for these outputs now and she may want to keep them off to check the earliest readings.



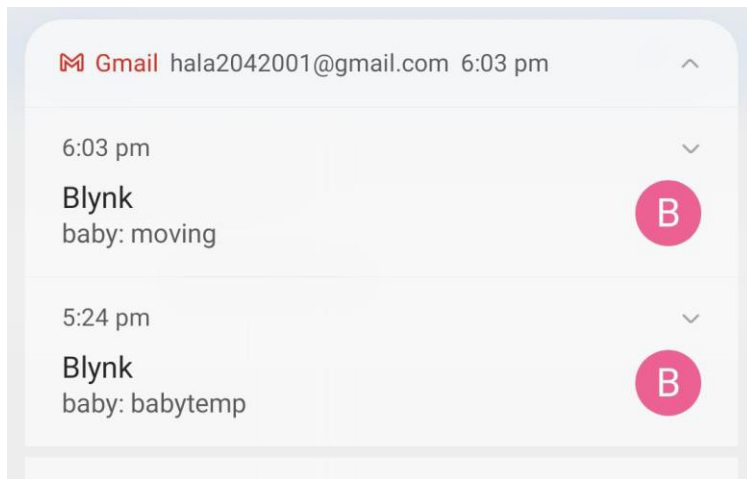
We've talked before about notifying the mother using LEDs on the application,

Now, we will present another method for alerting the mother through notifications coming from the application; those notifications show up whenever the baby is crying, moving, or if his/her temperature is high.

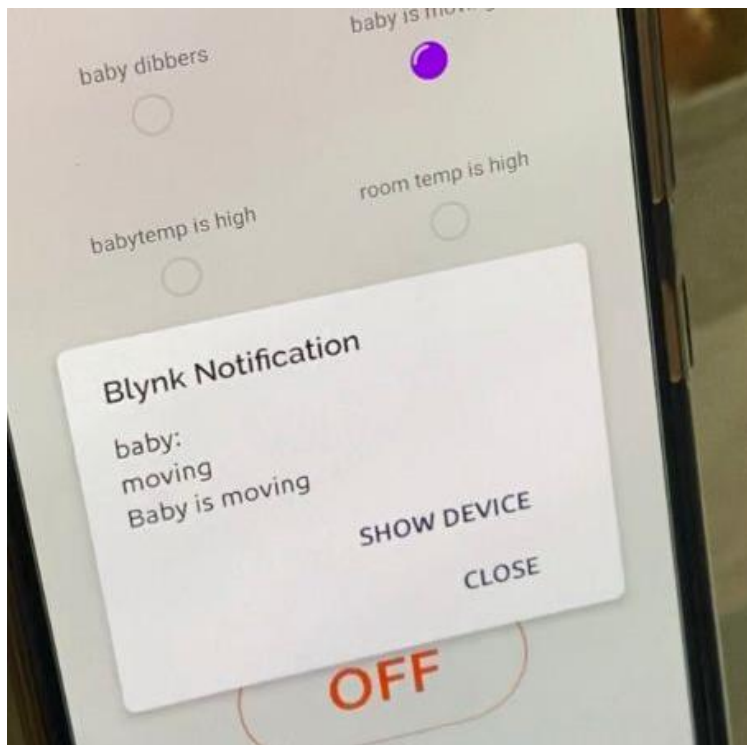
Also, an email will be sent to the mother for the movement, and the temperature.

These are screenshots for the notifications.

Email messages:



Notifications:



4:47

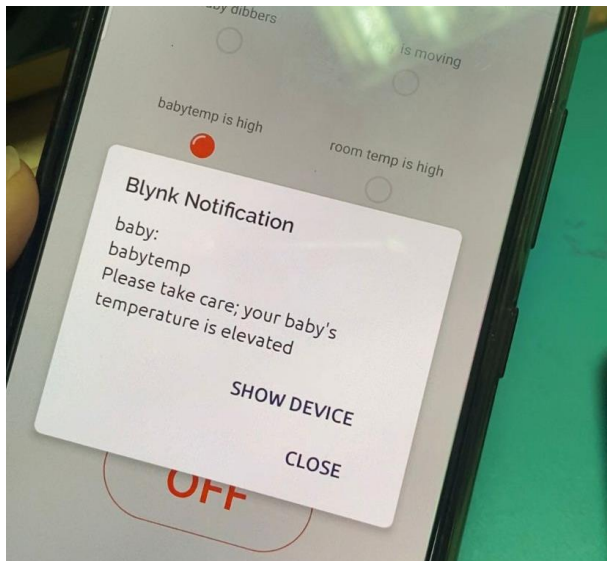
Saturday, 26 August



Blynk Notification

9m ago

firstproject:
CRY
your Baby is crying



5 Results and Discussion.

Here, we will present the outcome and delve into the complex aspects of the "ComfortSense Baby Bed" venture. This initiative centered around designing a versatile and user-friendly monitoring system for infants, prioritizing the comfort and ease of use for both the baby and mother.

The Diaper Status Monitoring: the system senses moisture, thereby identifying when the baby requires a diaper modification.

And the automating repetitive checks gives the mother a greater sense of comfort.

The Baby Movement and Video Monitoring: as it provides real-time video streaming, the system is incredibly reliable.

So, keeping a watchful eye, this feature grants peace of mind and guarantees safety.

Cry Detection and Response Options: with cry detection capabilities integrated, the mother selects two responses.

The ability to adapt to the baby's needs with ease makes this feature a vital tool for mothers, providing a range of options for calming and nurturing their little one.

Temperature Control: With precision, the system regulates the room temperature within a designated scope and tracks the baby's body temperature.

By doing this, a comfortable environment is established for the baby, protecting against excessive heat and keeping track of the baby's health.

Sunlight Protection: detecting sunlight, the system seamlessly deploys a protector to shield the baby.

By deflecting direct sunlight, this feature underscores the system's devotion to baby protection.

For the User Application: Mothers can now effortlessly access relevant information and receive timely notifications with the aid of a user-friendly mobile application.

Streamlining the monitoring process, this application grants mothers seamless access to crucial details regarding their baby's well-being, allowing prompt actions to be taken.

Meeting its objectives through a multi-faceted approach, the project demonstrated the effectiveness of its key features. Safety, ease of use, and mental tranquility are just some of the potential advantages for mothers and their babies.

6 Conclusion and Future Work.

6.1 Conclusion.

In summary, the "ComfortSense Baby Bed" marks a substantial breakthrough in the realm of baby monitoring technologies. Comfort, safety, and accessibility are improved through the integration of various sensors and features.

By incorporating essential features like diaper status monitoring, baby movement detection, cry response options, temperature control, sunlight protection, and a user-friendly mobile app, the ComfortSense Baby Bed enables mothers to adequately oversee and tend to their infants.

Through this project, mothers may feel more confident and self-assured knowing they can trust the system to support their infant care. Modern living demands, and the "ComfortSense Baby Bed" responds by offering practical features through a mobile app.

Put simply, the "ComfortSense Baby Bed" revolutionizes the realm of baby care by accommodating the demands of infants and their guardians. Successful implementation and the prospect of benefits make this innovation in baby monitoring and care worth noting.

6.2 Future Work.

1- creating a two ways talking system.

2- adding image processing system to analyze the baby's expressions if he is sad, happy, ETC.

And of course we are open to new creative ideas to add to our project later on.

7 References.

[1] Arduino. *Arduino*. Accessed 2023. url: <https://www.arduino.cc/>.

[2] GitHub.different libraries, for example, url: <https://github.com/espressif/arduino-esp32/tree/master/libraries/ESP32>.

[3] Youtube. Various channels like, url: <https://www.youtube.com/@miliohm>.

[4] The strategist article, url: <https://nymag.com/strategist/article/best-baby-monitors.html>.

[5] Best products website, url: <https://www.bestproducts.com/parenting/baby/g40918426/best-baby-monitors/#product-42dc4c38-b7e0-4b3d-a69c-1f9c5bfb2f08>.