

## Smart Infant Incubator

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**Abstract** - We propose a solution called "Smart Infant Incubator" which aims at enhancing the maintenance of new born in various hospitals to make it much better and safer. The main idea of the project is to implement an ESP32-based intelligent environment monitoring system in the incubator from which it measures the humidity and temperature data on the spot where the incubator is placed. The system uses sensors like DHT11 for live temperature and humidity readings, an intelligent alert system and it is integrated with the Rainmaker platform for remote monitoring. The power system is given special attention which includes a Li-ion cell and a charging module to charge the cell. Safety features such as overcharge protection for the battery are also added. The report gives a clear picture of the steps that were performed in the project to accomplish the goals and also the results and analysis of the project. The prototype can be very useful in improving the nursery wards where we will consider this technology to be integrated with the incubators which will be very useful in maintaining the newborns safely.

### 1. INTRODUCTION

The early stages of human life, infancy, are the most sensitive ones, and it require careful watch throughout the whole journey. For the last couple of decades, researchers have been trying to introduce a solution to these problems. The Smart Infant Incubator is a step to advance early-life care. This project is made to portray a system in which a new idea of a smart environmental monitoring system is utilized to improve the environment for premature infants, hence increasing the lifespan and reducing the possibility of a rise in the multiple disorders in these neonates. Smart Infant Incubator project introduces a new approach towards caring the premature infants by improving the environmental conditions and aesthetically; we present a new idea to monitor a microcontroller-based device which is an intelligent user-friendly incubator that supervises and maintains preterm or premature babies by providing an appropriate and thermally stable environment through this environment monitoring system. Smart Infant Incubator aims at making the best possible use of all fresh and advanced electronics, sensing, and communication technologies for designing different sections following the desired outputs. At the heart of this project is the ESP32, a crucial part that helps us achieve our basic needs. Here, we exploit the enormous power of the ESP32 microcontroller, which supports a collection of synchronous motors. This microcontroller orchestrates a thermostat along with humidifier, heater, cooler and humidifier that are taken into account a part of this project. One of the main intended functions is to monitor humidity and temperature of every section and then control the thermostat, at the same time with heater, cooler, and humidifier. Therefore, a DHT11 sensor is used to measure the

temperature and humidity in the room of the Incubator. All these variables act as crucial clues to the external environment, to ensure that the baby remains in the right environment for its development and health. Achieve Enhanced Safety and Alert Mechanism with Smart Baby Incubator with an intelligent alert system, if the predefined threshold values are crossed, the alert letting the caregiver know is generated real-time. The Rainmaker Smart Baby Incubator enables remote monitoring as well through Rainmaker platform, so that you can have the environment data in real time and react basis the alerts that are sent to you via the Rainmaker app.

### 2. SYSTEM IMPLEMENTATION

**A. ESP32-** First, The ESP32 is a highly adaptable and potent microcontroller made by Espressif Systems. It falls into the same class as the ESP8266 and ESP8285 but with significantly improved features. One of its key attributes is the dual-core processor that allows it to handle various applications effectively. In addition, it comes with pre-installed Wi-Fi and Bluetooth networks, hence suitable for IoT projects.

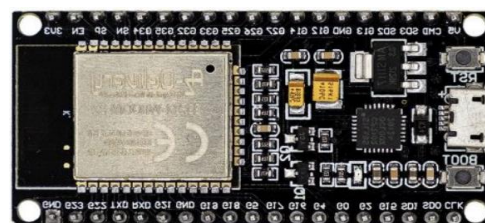


Fig -1: ESP32

The ESP32 has a wide range of peripherals including GPIO (General Purpose Input/Output) pins, analog-to-digital converters and support for different communication protocols such as UART, SPI, or I2C. This flexibility allows it to easily integrate with many sensors and other external devices which makes it fit for various projects like home automation or industrial use. In addition to its low power consumption and effective processing capabilities, the ESP32 is also known for being ideal in battery-powered and energy-efficient applications. Moreover, it has an on board flash memory for program storage with additional storage options possible through the external SPI flash chip. Generally speaking, due to its sturdy performance, extensive feature set, and cost-effectiveness, it has become widely popular both among hobbyists and professionals alike.

**B. DHT11 Sensor** - An affordable, reliable and simple DHT11 is a widely utilized sensor in electronic projects for measuring temperature and humidity. It became famous because of the direct digital signal output, which makes it easy to use in different applications without going through the intricate calibration process.

This can be traced back to its calibrated digital outputs that make the DHT11 have reliable readings that are appropriate for climate monitoring, weather stations and environmental sensing. The main specifications of DHT11 are that it has an operating voltage range from 3.5V to 5.5V, low power consumption in both measurement and standby states, temperature range from 0°C to 50°C with an accuracy of  $\pm 1^\circ\text{C}$ .

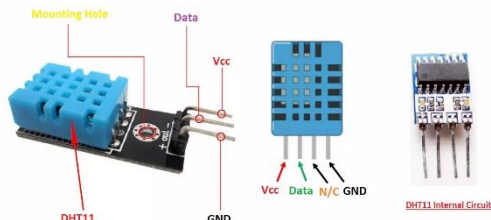


Fig -2: DHT11 Sensor

Similarly, its humidity range is between 20% and 90% with an accuracy of  $\pm 1\%$ . The DHT11 is very user-friendly as it uses a very simple interface that normally necessitates only one digital pin for communication with microcontrollers thereby being used by many hobbyists, learners or even experts. With affordability, ease of integration and reliability considerations; this makes such devices very popular among many users interested in temperature & humidity monitoring applications.

**C.MQ2 Sensor** - The, the MQ-2 gas sensor is a device that can be used for versatile purposes since it is designed to detect different kinds of gases which are present in air. This sensor's sensitive layer which functions according to resistance change, responds by altering its resistance when exposed to gases. Thus this shift in resistance is measured so as to determine the level of methane, propane, carbon monoxide and smoke. One of the key features of the MQ-2 sensor is that it can respond to a wide range of gases hence applicable in various fields where gas detection is important. It has efficient running with a power supply of 5V making it compatible with most microcontroller systems.



Fig -3: MQ2 Sensor

This sensor detects gas leakage issues and monitors air quality among other related safety gadgets because it is sensitive and universally usable. Environmental monitoring and gas detection projects cannot be complete without such a cheap but reliable component. In summary, this means that the MQ-2 Gas Sensor gives valid and dependable detection for different types of gases than many other devices hence being an indispensable tool for ensuring safety as well as environmental monitoring for multiple applications.

Nodemcu ESP 32 with  
DHT11  
MQ-2 Smoke Sensor

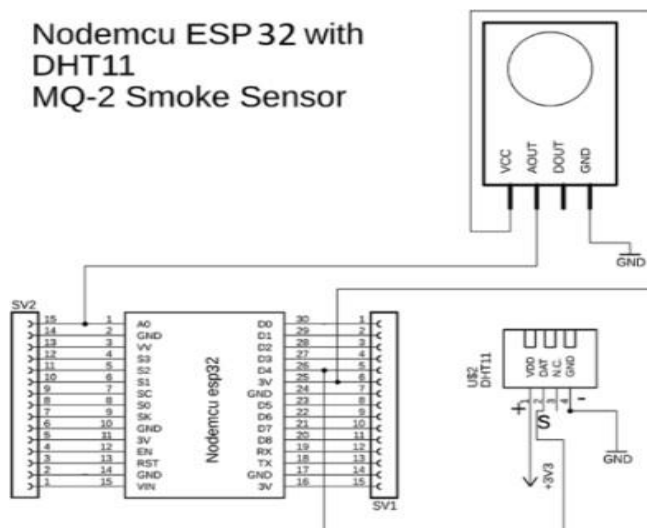


Fig -4: Circuit Building

## ADVANTAGES

1. Remote Monitoring through Rainmaker: Integration with Rainmaker enables caregivers to monitor the incubator remotely and receive alerts through a mobile application.
2. Intelligent Alert System: Immediate notifications of critical conditions, allowing swift caregiver intervention and enhancing infant safety.
3. Efficient Power System: Reliability is ensured by a Li-ion cell with a dedicated charging module, providing a sustainable power source.
4. Safety Measures: Implementation of safety features like overcharge protection and low voltage cutoff for secure incubator operation.
5. Integration of Multiple Technologies: Seamless blending of sensor data acquisition, alert systems, remote monitoring, and power management for a comprehensive solution.
6. Real-time Environmental Monitoring Continuous tracking of temperature and humidity to ensure an optimal environment for the infant.

## APPLICATIONS

1. The smart agricultural robot, equipped with a 2S lithium-ion battery pack, solar power compatibility, 100 RPM geared motors, L293D motor driver, Node MCU for remote control, seed sprayer, and wide, rugged types, finds applications in precision farming.
2. It excels in tasks such as targeted seeding, spraying, and cultivation due to the precision provided by the 100 RPM geared motors and L293D motor driver.
3. The robot's automated irrigation capabilities, facilitated by the seed sprayer and versatile attachments, ensure controlled and uniform water distribution across agricultural fields.
4. Its innovative seed sprayer attachment allows for efficient and uniform seed dispersal, optimizing planting processes across various crops.
5. Remote monitoring and control through the Node MCU enable farmers to manage the robot efficiently, providing real-time oversight of agricultural activities.
6. Sustainability is a key aspect with the integration of a 2S lithium-ion battery pack and a 12W solar panel, offering alternative and renewable power sources for reduced environmental impact.

7. Wide, rugged tires enhance the robot's adaptability to varied terrains, making it suitable for deployment in fields with uneven surfaces or challenging topographies.

### 3. FUTURE SCOPE

1. Neonatal Intensive Care Units (NICUs): Continuous monitoring and alerts for medical staff in hospital NICUs.
2. Home-Based Infant Care: Remote monitoring for parents and caregivers, ensuring a safe environment at home.
3. Health Clinics and Pediatric Facilities: Advanced monitoring solution to enhance infant care in healthcare facilities.
4. Community Health Initiatives: Utilization in community health programs, especially in areas with limited healthcare infrastructure.
5. Research and Development: Platform for researchers and developers exploring innovative solutions in infant care and healthcare technology.
6. Incubator Rental Services: Integration into incubator rental services for temporary, technologically advanced infant care.
7. Healthcare Innovation Competitions: Ideal for participation in healthcare innovation competitions, showcasing advancements in early-life care technology.
8. Education and Training: Educational tool in medical institutions for training healthcare professionals in neonatal care.
9. Tele-health Services: Support for telehealth initiatives, providing real-time data and alerts for remote healthcare consultations.
10. Humanitarian Aid Missions: Deployment in humanitarian aid missions to offer advanced infant care solutions in regions with limited access to healthcare facilities.

### 4. CONCLUSIONS

In conclusion, the "Smart Infant Incubator" project stands as a testament to the intersection of technological innovation and compassionate healthcare solutions. By incorporating real-time environmental monitoring, an intelligent alert system, and integration with the Rainmaker platform, the incubator offers a comprehensive approach to infant care, particularly in Neonatal Intensive Care Units (NICUs) and home-based settings. The project's future scope suggests exciting possibilities, from enhanced sensor integration and machine learning algorithms to global connectivity and wearable devices. As it continues to evolve, the incubator holds the potential to redefine standards in neonatal care, providing caregivers with advanced tools for monitoring, ensuring infant safety, and fostering a nurturing environment for early development. The commitment to future enhancements, collaboration with healthcare institutions, and adherence to regulatory standards position the "Smart Infant Incubator" as a promising and impactful innovation in the realm of healthcare technology.

### REFERENCES

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