Development of Incubation System for Premature Baby Care

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***Abstract*— The proposed work is focused at development of Incubation system for premature Baby Monitoring System based on the IoT. A prototype is developed which gives a reliable and efficient baby monitoring system that can play a vital role in providing better infant care. The system monitors vital parameters such as temperature, pulse rate, moisture condition and weight of the baby. This information can be accessed by their parents and doctors with alarm triggering system to initiate the proper control actions through IoT based Mobile application.**

Keywords*— *Internet of Things (IoT)

I. INTRODUCTION

In recent times the death rate of premature babies is a major problem across the world. Cheaper technology development in this direction is to be done. The sudden death rate of premature babies without any previous notable medical conditions in increasing. The cause may be undetectable after performing examining the medical records of the infants. It is revealed that the body temperature, sleeping position of the baby and carbon monoxide exposure are the serious causes which leads to sudden teaths. By monitoring parameters like CO2 level, heart rate, weight, temperature, humidity continuously an effective solution could be designed to detect the causes and intimate the parents and caretakers about the seriousness so that preventive action could be taken without any delay. The wireless automatic infant monitoring device has been developed to address the need. The application of wireless communication technology has greatly improved the human life quality. This enhances the healthcare quality through the real time surveillance and detection of abnormalities in newborn baby that could otherwise be overlooked. Therefore, frequently monitoring those health parameters can minimize the death rate. Modeling and simulation is carried out at the design stage before deployment of prototype model.

The IoT permits vital parameters measured and controlled remotely across wireless network creates opportunities for saving precious life newborn babies. Further direct integration of the physical world into computer-based systems and resulting in enhanced performance and ease the monitoring. Therefore collection, recording and analyzing of data streams is much faster and accurate. It is an effective systematic approach to 24*7 surveillance of the baby's condition [1].

A. Objectives

- Selection of sensors and controller necessary for various factors consideration for the health care of the baby.
- Selection proper software to simulate the model before prototype model
- Prototype design for monitoring of the baby to monitor and control the heart rate, temperature, Humidity, CO_2 level and weight of the baby within the incubator continuously.
- To facilitate IoT to interfacing mobile application to analyze the real time data remotely
- Design of Mobile application to collect the data from the IoT cloud interface to analyze the data 24*7.

II. METHODOLOGY

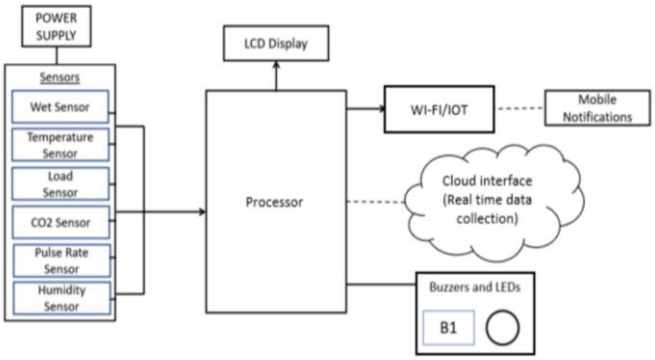


Fig. 1. Block diagram of proposed Method

The proposed model consists of monitoring system which utilizes multiple sensors to measure the various parameters in incubator. Infants less than 37 weeks gestational age and/or less than 2 kg body weight must be placed in the incubator that can provide humidification within 24-48 hours of life. Humidity values for gestational age infants less than 37 weeks are in the range between 64% to 94%. CO2 sensor measures concentration of CO2 content in the incubator. To check the baby's growth, load cells are used to check the weight of the baby and is essentially a force transducer or force sensor. It is used to measure weight[4].

TABLE I. CRITICAL PARAMETERS

Sensor Name	Range	Status
Temperature	35 – 37	Normal
Humidity	70 – 90 %	Normal
Heart rate	120 - 160	Normal
Wet sensor	DRY	Normal

A. *Hardware requirements*

a) Raspberry pi: The Raspberry Pi is a very cheaper version of computer that runs Linux, but it also provides a set of general purpose input/output pins, allowing you to control electronic components for physical computing and explore the Internet of Things (IoT).

b) Temperature Sensor: The DHT11 is a basic, ultra low-cost digital temperature and humidity sensor. It uses a capacitive humidity sensor and a thermistor to measure the surrounding air, and spits out a digital signal on the data pin

c) Heart rate sensor: The basic heartbeat sensor consists of a light-emitting diode and a detector like a light detecting resistor or a photodiode. The heartbeat pulses cause a variation in the flow of blood to different regions of the body.

Fig. 2. Fig. 2. Heart rate sensor

d) CO_2 level sensor: A carbon dioxide sensor measures gaseous carbon dioxide levels by monitoring the amount of infrared (IR) radiation absorbed by carbon dioxide molecules. Measuring carbon dioxide is critical in monitoring many industrial processes and indoor air quality.

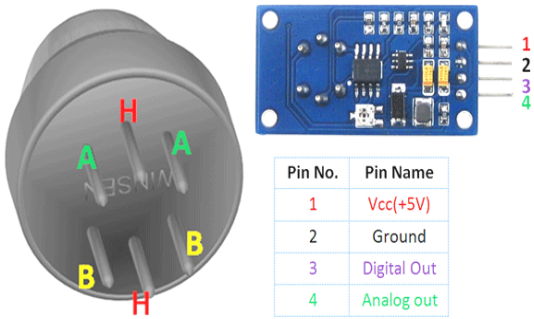


Fig. 3. CO_2 level sensor

e) Wet sensor: A small charge is placed on the electrodes and electrical resistance through the sensor is measured. As moisture decreases, water is drawn from the sensor and resistance increases. Conversely, as moisture increases, resistance decreases.

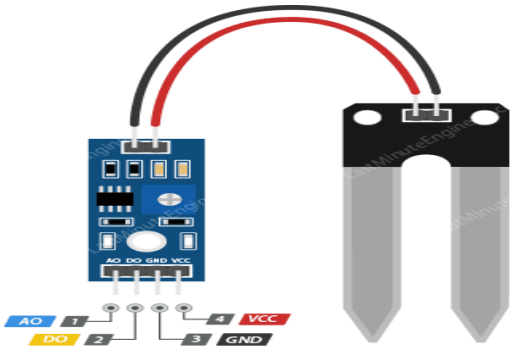


Fig. 4. Wet sensor

f) Buzzer: A buzzer or beeper is an audio signaling device, which may be mechanical, electromechanical, or piezoelectric (piezo for short). Typical uses of buzzers and beepers include alarm devices, timers, and confirmation of user input such as a mouse click or keystroke.

g) LCD: A liquid-crystal display (LCD) is a flat-panel display or other electronically modulated optical device that uses the light-modulating properties of liquid crystals combined with polarizers. LCDs are used in a wide range of applications, including LCD televisions, computer monitors etc.

B. *Software requiremts*

a) TinkerCAD: Tinkercad is a free, online circuit simulation Modeling program that runs in a web browser, known for its simplicity and ease of use. It can be used to build circuits. Here program option is available through codes

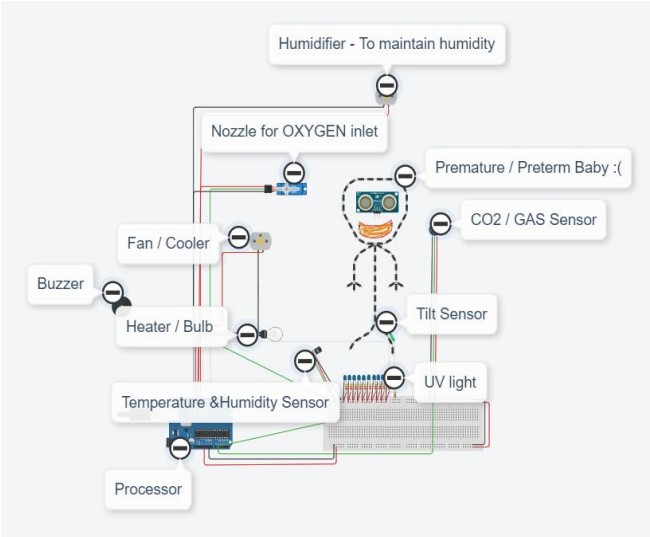


Fig. 5. Layout of TinkerCAD simulation model

b) ThingSpeak: is an open-source Internet of Things (IoT) application and API to store and retrieve data from things using the HTTP and MQTT protocol over the Internet

or via a Local Area Network. It enables the creation of sensor logging applications. It is an IoT analytics platform service that allows you to aggregate, visualize, and analyze live data streams in the cloud. You can send data to ThingSpeak from your devices, create instant visualization of live data, and send alerts

III. PROTOTYPE MODEL

In the Fig.6 shows the prototype model with all interfaces and sensors and system is running. Various situation were created and tested satisfactorily for worst case scenario and working satisfactorily

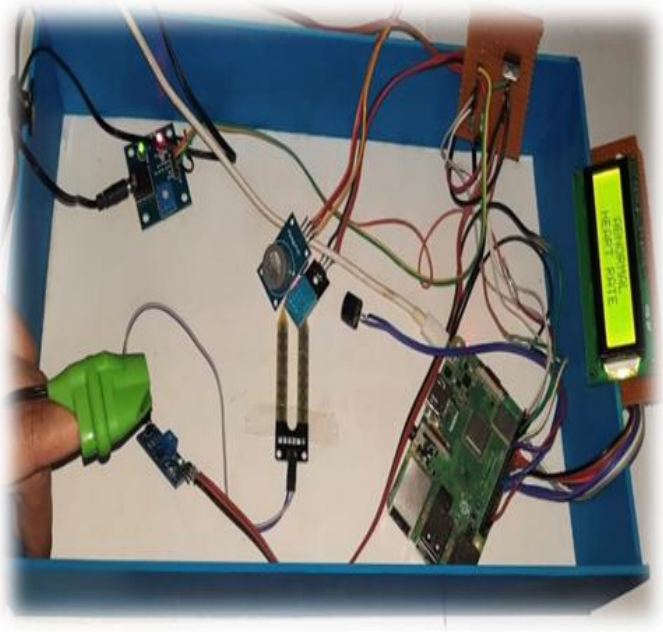


Fig. 6. Prototype Model of Incubation system

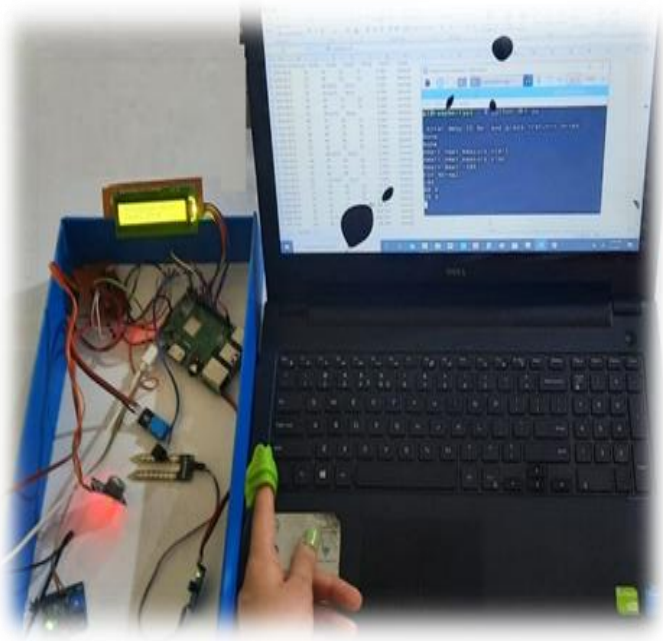


Fig. 7. Prototype Model of Incubation system

Fig. 8. Bkynk App displaying different conditions

Fig 8 shows the indication of different instances of measured parameters in Blynk app, it is used to interface ESP8266, ESP32, NodeMCU, Particle Photon, Raspberry Pi, and other microcomputers with the smartphone over the Internet. Blynk app displaying different conditions in Mobile App

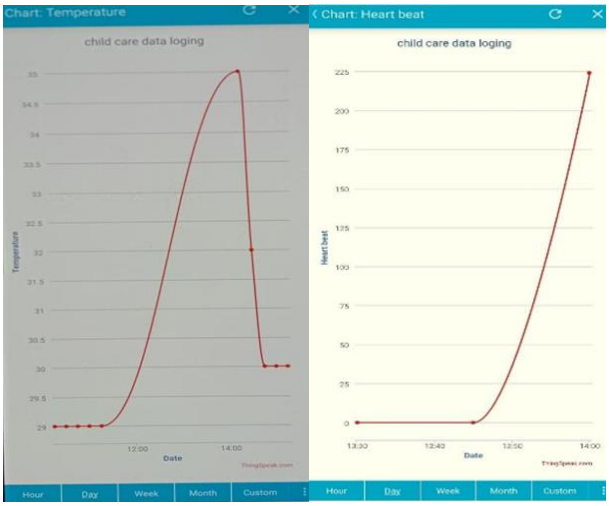
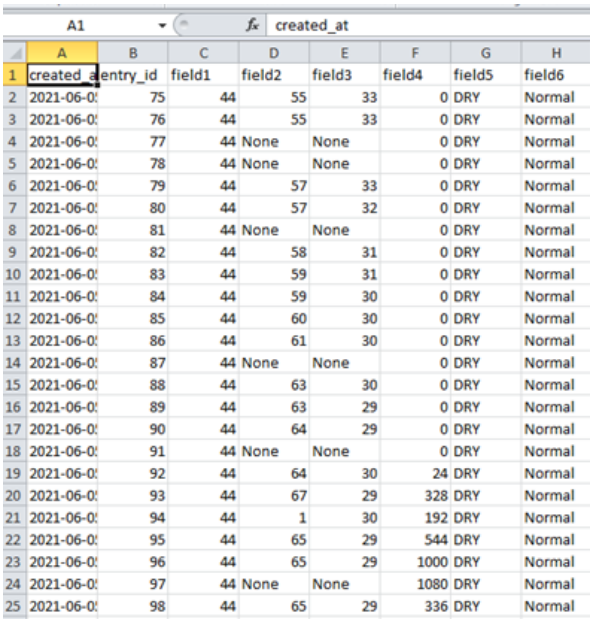


Fig. 9. Analysis of Temperature and Heart beat data in Mobile App



	A	B	C	D	E	F	G	H
1	created_a	entry_id	field1	field2	field3	field4	field5	field6
2	2021-06-0	75	44	55	33	0	DRY	Normal
3	2021-06-0	76	44	55	33	0	DRY	Normal
4	2021-06-0	77	44	None	None	0	DRY	Normal
5	2021-06-0	78	44	None	None	0	DRY	Normal
6	2021-06-0	79	44	57	33	0	DRY	Normal
7	2021-06-0	80	44	57	32	0	DRY	Normal
8	2021-06-0	81	44	None	None	0	DRY	Normal
9	2021-06-0	82	44	58	31	0	DRY	Normal
10	2021-06-0	83	44	59	31	0	DRY	Normal
11	2021-06-0	84	44	59	30	0	DRY	Normal
12	2021-06-0	85	44	60	30	0	DRY	Normal
13	2021-06-0	86	44	61	30	0	DRY	Normal
14	2021-06-0	87	44	None	None	0	DRY	Normal
15	2021-06-0	88	44	63	30	0	DRY	Normal
16	2021-06-0	89	44	63	29	0	DRY	Normal
17	2021-06-0	90	44	64	29	0	DRY	Normal
18	2021-06-0	91	44	None	None	0	DRY	Normal
19	2021-06-0	92	44	64	30	24	DRY	Normal
20	2021-06-0	93	44	67	29	328	DRY	Normal
21	2021-06-0	94	44	1	30	192	DRY	Normal
22	2021-06-0	95	44	65	29	544	DRY	Normal
23	2021-06-0	96	44	65	29	1000	DRY	Normal
24	2021-06-0	97	44	None	None	1080	DRY	Normal
25	2021-06-0	98	44	65	29	336	DRY	Normal

Fig. 10. Downloaded data from Thinkspeak cloud

A unique Id will be created for every individual child and data is stored in the excel sheet along with the sensor parameter data values. This helps to record and study the child parameters even from a remote location and thereby ensured of proper nurturing of the baby shown in Fig. 9. The Microsoft excel CSV file can be exported by the parents/guardian or doctors/caretakers in an easy manner through thingspeak platform as shown in Fig.10.

IV. CONCLUSION

The concept of incubator is successfully demonstrated considering all standard parameters. IoT sends the message to parents and Doctors through Mobile notifications under abnormal conditions 24*7. The main advantage is that it is simple to use, user friendly, and no harm to baby as it is non-contact-based baby monitoring system. RaspberryPi module is used which provides more advantage as compared to Arduino and other processors. An IoT approach for infant monitoring system using multiple sensors provides several advantages as compared to the traditional method and it is cost effective compared to the incubators available in present market.

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