Monitoring Baby Conditions in the Baby Box Based On Iot Technology

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Abstrac-Baby box is needed for baby safety and for baby's physical health maintenance. A baby box equipped with a mat is a comfortable baby bed. Several conditions make babies feel uncomfortable such as bedwetting. If left unchecked, it can irritate the baby's skin inducing disease including eczema, spots, and other skin irritation. Based on the problems, a detection device for baby bedwetting and crying was made. Baby bedwetting devices used moisture sensor and water sensor placed under the mattress. The baby's urine is absorbed by the baby's bed and touches the water sensor. By using the system, it is expected that the baby can sleep well and there is no irritation to the skin**.**

Keyword –moisture sensor, water sensor, baby condition, IOT, nodemcu

Introduction

A baby box is a box equipped with a baby bed that serves to keep the baby sleeping in the place safely and comfortably. The comfort of the baby bed needs to be considered so that the baby can grow optimally. If the baby bed is uncomfortable, the baby is easily disturbed and has sleeping disturbance. To avoid this, baby monitoring was designed with early detection of baby bedwetting and baby crying. Baby bedwetting must be detected as early as possible so that the baby's pants can be replaced immediately because if left unchecked it can irritate the baby's skin. Baby crying must be detected immediately because if it is not handled immediately it can affect the baby's mental health.

Several research on baby monitoring have been conducted by previous researchers. The baby incubator studied by Koli equipped with several sensors such as temperature, humidity, and heart rate sensors. This intelligent incubator is controlled using Arduino and can be monitored using the web. When the incubator temperature and humidity change and the baby's heart rate is disturbed, the incubator immediately sounds an alarm [1]. Cloud computing was investigated by Putranto for medical records used for infant nutrition. Medical records stored in cloud computers can be accessed by using a PC or laptop and mobile handphone. The stored medical data records are weight, height and nutrition needed [2].

The intelligent Infant Incubator was researched by Sendra used for premature babies. This incubator was equipped with temperature and humidity sensors and weight sensor to determine the baby weight, and the motion sensor to find out the baby movements. This incubator was connected to the network using LoRa [3]. The sensor system was investigated by Purwiyanti to monitor premature babies in the incubator. The ultrasonic sensor was used to calculate the length of the baby. The heart rate sensor was used to monitor the baby's heart rate and the weight sensor was used to measure the baby's body weight. The three sensors were used to monitor the development of premature babies [4].

Digital intelligent parents studied by Hemalatha was used to monitor babies. Sound sensor, temperature, humidity, heart rate, baby movement, and force sensor were used to monitor the development of babies controlled by using Raspbery, whose data were sent to the internet so that it could be monitored via cellphone or notification from email [5]. Body temperature monitoring was examined by Zakaria to monitor baby's body temperature. LM35 sensor was used to measure the baby's body temperature measured on the baby's foot. This system used an Espresso lite microcontroller to process temperature data and transmitted to the internet via Wi-Fi and monitored with android to measure the baby's body temperature [6].

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The intelligent cradle system was examined by Joshi by using android to monitor the baby. This smart cradle system used videos to monitor babies. Cradle swings when it hears the baby crying. Humidity and noise sensors were used to detect baby crying. A camera was placed near the cradle and used for baby monitoring videos [7]. Monitoring heart rate and oxygen level examined by Patke were used for health parameters. The heart rate sensor and the oxy-meter sensor were used to determine the health parameters of the baby. The data from sensors were processed using signal conditioners then converted into digital data using the ADC. The data from the ADC were processed by a microcontroller then sent to the cloud server. Heart rate and oxygen level in infants can be monitored using an Android Mobile [8].

Remote monitoring is used to monitor the condition of the baby in the baby's box. The monitoring has been investigated by previous studies such as the Global System for Mobile Communications examined by Bharathkumar V. which is used for remote monitoring. Global System for Mobile Communications is used to send cheap digital measurement data using a microcontroller. The LM35 sensor is used to measure temperature and the DHT 11 sensor is used to measure humidity. PIC 16F877A type microcontroller is used to process sensor data which are then emitted using Global System for Mobile Communications via SMS [9]. The remote monitoring system using Internet of things technology examined by Spano to monitor electrocardiogram (ECG). There are many ECGs connected via wireless networks used to monitor the heart. A belt-shaped ECG sensor was used to examine a patient's heart. The sensor data were processed using bandpass filters, anti-analising filters and converted into digital data using ADC. ECG data in the form of digital data were processed by a microcontroller then transmitted to the Internet using wireless zigbee. ECG data on the internet can be accessed by connecting a computer to an IP address [10].

Communication using the Wireless Sensor Network was examined by the Lijun Liu for monitoring the greenhouse system environment. The green house monitoring system consists of a CC2540 microcontroller, a radio frequency zigbee transmitter, a sensor Temperature, humidity and light intensity. SHT11 sensors was used forTemperature and humidity sensors emitted using zigbee communication. The light intensity sensor using BH1750 was transmitted to the monitoring center using zigbee. The data from temperature, humidity, and light intensity sensors were monitored centrally [11]. The urban climate monitoring system was examined by Shete using a raspbery PI microcomputer. This system monitored temperature, humidity, air pressure, carbon monoxide and air pollution conditions. BMP180 sensor was used for Pressure and temperature sensors, DHT22 for air humidity sensor and BH1750 for light intensity sensor. All sensor data are processed using Raspbery PI and then transmitted to public IP using MQTT Broker. The data from MQTT Brokers can be accessed using mobile phones or laptops [12].

The home automation and monitoring system was investigated by Chaudhuri using IoT technology. This system consists of on and off control of lights, movement detection using a PIR sensor, smoke detection using the MQ2 Gas sensor, temperature detection of the house using the LM35 sensor, and the SMS communication system using GSM. The internet was connected with Arduino [13]. The energy monitoring system was examined by Luan using IoT technology. This system monitored energy by using water, oil, air, and electrical sensors. The data from the sensor were sent using rs485 to the computer. The data were then sent to the server and the database server through the network. This monitoring system can be accessed through computers connected to the network servers and the database servers [14].

A baby condition monitoring system has been previously investigated using temperature and humidity sensors transmitted using wireless technology and GSM technology. Monitoring can only be used in the local area network and in the condition that the GSM signal is fulfilled. In this paper IOT technology is presented to monitor the baby's body temperature, room humidity, and the baby's bed wetting. The baby condition monitoring was equipped with the detection of baby bedwetting monitored remotely using IoT technology with a web server. This system was equipped with a baby crying detection sensor so that when the baby cries, the mp3 player played a song to calm the baby..

Research Method

The baby box was equipped with a humidity sensor, a temperature sensor [15], a crying sensor[16]–[18], a coping sensor, musical rhythms from an MP3 player, and a fan controlled with a Wemos microcontroller as shown as shown in Figure 1. The figure shows three systems namely input system, control system and output system. The input system is a system to determine the condition of the baby which includes temperature [19], humidity, sound, and wet sensors [20]–[22]. The input system in the baby monitoring system was processed by the control system using a Wemos microcontroller that requires low power. The data obtained by the microcontroller was monitored using internet technology [23] to control the fan [24] and the Dplayer.

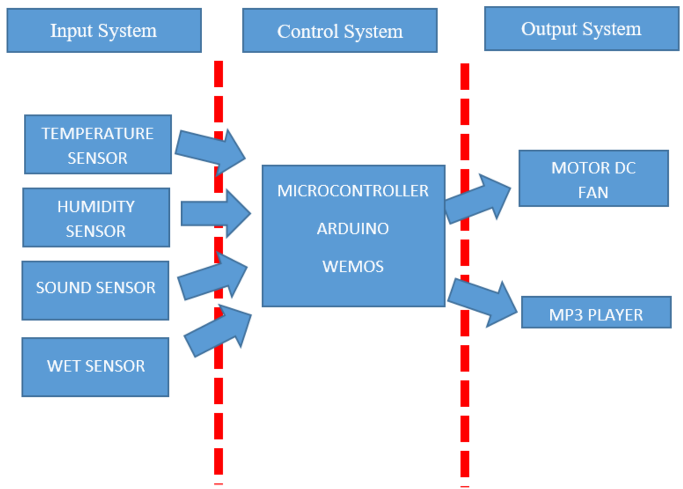

Figure 1. A baby's condition monitoring system block diagram

1) Input subsystem

Input subsystem is a subsystem for the inputs of temperature, humidity, sound [25]–[27], and wet sensors shown in Figure 2. The figure shows that the Wemos type Arduino microcontroller is used to read sound, temperature [28], humidity and wet sensors. The temperature and humidity sensors using SHT11 [29], [30] are connected to the Wemos microcontroller using I2C communication. The sound and wet sensors are connected to the microcontroller using a comparator.

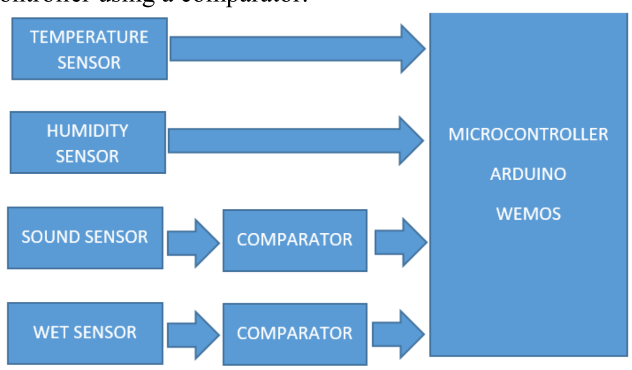

Figure 2. Sensor system and control system block diagram

2) Control subsystem

Control subsystem [31] is a subsystem used to read the data of the sensor, process and issue used for monitoring using mobile media, controlling fans and MP3 players. Figure 3 shows the microcontroller system to monitor the baby condition using a Wemos type microcontroller Arduino. This microcontroller is equipped with a communication system using wireless [32]–[44] and web servers. This microcontroller also requires low power [45].

Figure 3. Control system block diagram

3) Output subsystem

The output subsystem is a subsystem used to interface controls with several controlled hardware such as DC motors [46] and MP3 players shown in figure 4. The figure shows the Wemos [47]–[51] type Arduino microcontroller is used to control the DC motor and MP3 player. The DC motor rotates to run the fan when

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the room temperature is above 35 degrees Celsius and the stops rotating when the room temperature is below 35 degrees Celsius. The MP3 player is run by the microcontroller when the sound sensor detects a crying.

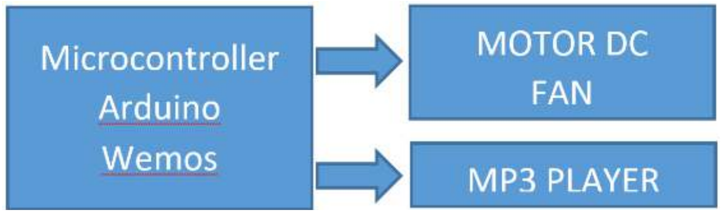

Figure 4. Block system output diagram.

Result and Discussion

The monitoring system tool test was conducted in stages as shown in Figure 5 started from the subsystem test to the whole system test. It can be seen in the figure that there are three systems in monitoring the baby condition namely the input system, control system and output system. The input system consists of a temperature and humidity sensor of SHT11, a sound sensor and a wet sensor.

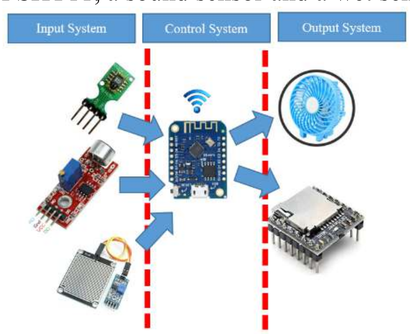

Figure 5. Baby condition monitoring system

1) Subsystem testing

A subsystem testing is needed to avoid damaged components to be used. The subsystem testing on the components of temperature, humidity, sound and wet sensors was carried out using digital multimeter, thermometer and air humidity measuring instruments.

a. SHT11 sensor testing

Temperature and humidity sensors are tested in an AC room. The test used the SHT11 sensor connected to a microcontroller whose data are transmitted to the computer. This test was carried out by taking five samples of temperature and humidity data comparing with temperature data of 220C and humidity data of 64% as shown in Table 1.

TABLE I. TEMPERATURE AND HUMIDITYTABLE

No	Temperature Sht11 (c)	Temperature (c)	Humidity (%)Sht11	Humidity (%)
1	22.76	22.1	64.88%	64.00%
2	22.77	22	64.59%	. 64.00%
. 3	. 22.88	. 22.1	. 63.97%	. 64.00%
. 4	. 22.83	. 22	. 64.40%	. 64.00%

b. Sound sensor testing

Sound sensor testing was performed by playing various kinds of baby cries in the recording. The sound sensor circuit consists of the pre-amp circuit shown in figure 6 (a) and the comparator circuit shown in figure 6 (b). Figure 6 (a) shows that the condenser is connected to the pre-amp circuit using an inverting circuit. The output of the pre-amp is inserted into the comparator circuit which is then processed by the microcontroller.

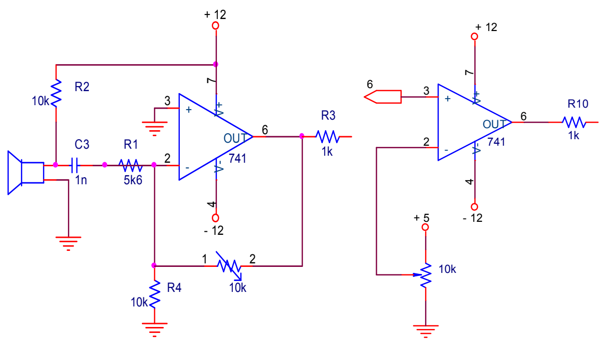

Figure 6.A series of (a) pre-amp, (b) Comparator

This test was carried out by taking five data samples of baby crying that have been recorded as shown in Table 2. It can be seen that when the recording does not play the sound of baby crying, the comparator shows 0.00 Volt and when it plays the baby crying in a weak sound the voltage increases to 4.70 V. While, when it the sound is louder, the comparator voltage value is 4.9 V.

TABLE II. SOUND SENSOR

No	Baby Crying Sound	Pre-amp condition	Comparato r condition
1	Quiet	- 0, 03 V	0,00 V
2	Rather Weak Sound	- 0, 10 V	4,90 V
3	Weak Sound	- 0, 19 V	4,90 V
4	Rather Loud Sound	- 0, 30 V	4,90 V
5	Loud Sound	- 3, 73 V	4,90 V

c. Wet sensor testing

The wet detection sensor is assembled using electrode elements as shown in figure 7. The figure shows that the wet sensor circuit is designed using three transistors connected to an electrode sensor. When the wet sensor detects a wet, the LED light is on.

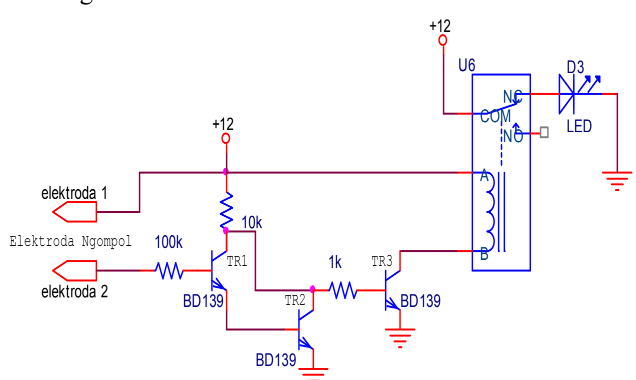

Figure 7.Wet sensor circuit

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The wet sensor test is carried out by pouring water little by little on the bed pad so that the pad becomes wet as shown in table 3. It is seen that when the bed is dry the voltage measured is 0.45 V and when the bed is wet the voltage is 2.5 V inducing the LED light to be on.

TABLE III. WET SENSOR

No	Baby mattras	Voltage
1	Dry	. 0,45 V
2	Rather dry	. 2,56 V
3	Wet	. 3,90 V

3) System Testing

The system was tested by integrating the entire system consisting of; input subsystems, control subsystems and output subsystems into a united system, operating the system, testing the system functions, and observing the output or the operating system results as shown in table 4. The table shows that when the SHT11 subsystem is the input, the output is the fan relay on that is run by the microcontroller subsystem. When the sound sensor subsystem is the input, the output is the MP3 Player relay on that is run by the microcontroller subsystem, and when the wet sensor subsystem is the input, the output is the buzzer relay on that is run by the microcontroller subsystem.

TABLE IV. SYSTEM TEST RESULTS

No	Input Media	Output Media	Output
1	SHT11S ubsystem	Fan Subsystem	Fan Relay On
2	Sound Sensor Subsyste m	MP3Player Subsystem	Relay On
3	Wet Sensor Subsyste m	Microcontro ller Subsystem	Relay On

Conclusion

Based on the results and discussion, it can be concluded that a system for monitoring the condition of the baby has been realized by monitoring the temperature, humidity and sound. When the room temperature increases, the DC motor moves the fan to cool the baby cot. The high temperature discomforts the baby and makes the baby cry. The baby crying is detected by the sound sensor leading the microcontroller to turn on the MP3 Player to play music and comfort the baby. When the baby is wet, the MP3 player turns on the diaper change sound. By using the system, the baby feels more comfortable and by detecting the bedwetting, it avoids the skin irritation due to the baby's urine and keeps the baby health.

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