DESIGN OF MONITORING TOOL FOR BABY WHILE SLEEPING BASED ON INTERNET OF THINGS USING NODEMCU ESP8266

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ABSTRACT

During sleep, the baby's body produces three times more growth hormone than when the baby is awake. Because the baby's brain growth reaches its peak during sleep, deep sleep is very important for its growth. This monitoring tool monitors sleeping babies by utilizing load cell sensors to detect the presence of babies and sound sensors to detect baby cries, NodeMCU ESP8266 as the control center, and the Blynk IoT platform as a user interface connected to the internet. Design of monitoring tool for baby while sleeping based on internet of things using NodeMCU ESP8266 has been completed and can work well to monitor the presence of babies and detect baby cries. Load cell sensors can calculate the baby's weight of 0–20 kg. When the detected baby's weight is lower than (<) 2 kg, the device will send a notification "BABY IS NOT IN PLACE." When the detected weight is higher than (>) 2 kg, then the device will send a notification "BABY'S SLEEPING." The sound sensor can detect sound sources with a distance of 0–50 cm. When the sound sources are 0–50 cm away, the tool will notify "BABY'S CRYING." When the sound source's distance is higher than (>) 50 cm, the sound will not be detected, and the device does not send any notification to the Blynk application.

Keywords: *Blynk IoT, Load Cell, NodeMCU ESP8266, Sound Sensor*.

INTRODUCTION

In the current era of globalization, the development of science and technology is very rapid, especially the development of the internet. Internet of Things (IoT) is a concept that aims to expand the benefits of continuously connected internet connectivity, along with the ability to control data sharing, and so on (Al Hakim et al., 2021; Al Hakim, Arief, et al., 2020; Giaffreda et al., 2015; Mandler, Benny; Marquez-Barja, Johann; Campista, Miguel Elias Mitre ; Cagáňová, Dagmar; Chaouchi, Hakima; Zeadally, Sherali; Badra, Mohamad; Giordano, Stefano; Fazio, Maria; Somov, Andrey; Vieriu, 2009). The use of the IoT concept is generally applied in several fields that require continuous data information, such as monitoring or controlling (Arafat, 2016; Popa et al., 2019; Rateni et al., 2017; Setiawan et al., 2020; Yusuf et al., 2020)

During sleep, the baby's body produces three times more growth hormone than when the baby is awake. Because the baby's brain growth reaches its peak during sleep, deep sleep is very important for its development (Gola, 2009). According to Sekartini & Adi (2006), with the number of respondents 285 babies, data obtained 51.3% of babies experience sleep disorders, 42% of baby nights are less than 9 hours, and babies wake up more than three times at night with a long time waking up more than an hour.

The role of IoT in everyday life is very diverse, one of which is as a monitoring tool. IoT is useful for making human work easier with the system. The running system will replace the human role for a while so that the work will still run (Al Hakim et al., 2021; Pangestu et al., 2020, 2021; Putri et al., 2018). This study seeks to take advantage of the role of IoT to make baby monitoring tools that can be applied to families at home.

RESEARCH METHOD

Several soldering, tin, and multimeter tools are used to support the manufacture, observation, and testing of baby monitoring tools while sleeping. Smartphone-based on Android and laptop. Materials needed in research including NodeMCU ESP8266 microcontroller, sound sensor, load cell sensor, jumper cables, USB cable, Breadboard, and Arduino IDE software.

This research was conducted based on important stages that were carried out oriented towards indicators of success in connecting the NodeMCU ESP8266 microcontroller and other devices so that it could be used to solve multi-objective problems. To achieve these indicators, the stages of this study begin with analyzing issues regarding infant monitoring. Then needs analysis, namely all the research needs from journals, literature books, tools, and materials. This research was followed by a system design using the NodeMCU ESP8266 microcontroller and the sensors used. After that, create a program using the Arduino IDE 1.8.5 and the Blynk android application (Blynk, n.d.). Testing tools with program code that is designed and an internet connection and finally making reports and concluding the experiment results.

This system works when the NodeMCU ESP8266 microcontroller detects the presence of a baby with the help of a load cell sensor, detects the baby's cry around the sound sensor, then sends the data to the Blynk Server in TCP/IP format to be displayed on the smartphone. Cloud-service (internet) by utilizing Wi-Fi becomes the connection center between the system and the Blynk application; with this, the system can run as expected. The following block diagram for this system can be seen in Figure 1.

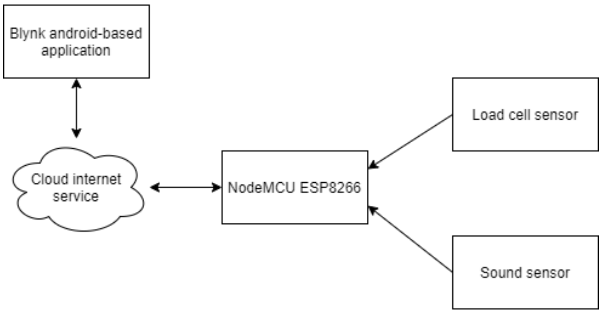

Figure 1. Block diagram for the system when running.

RESULTS

This research uses the method of *black-box testing* as a testing system. Black box testing is a research method based on checking design details. This test is intended to limit software functionality internally and ensure internal operations are following specifications (Al Hakim, Rusdi, et al., 2020; Al Hakim, Setyowisnu, et al., 2020).

Testing of the NodeMCU ESP8266 Microcontroller

Testing is done by connecting the microcontroller to the PC USB connection by using a USB cable. If the LED on the microcontroller blinks once, it indicates that the microcontroller is functioning after checking the hardware, then testing the microcontroller program. Testing is done by uploading the default Arduino software program (*Arduino IDE*) with "*Blink*," shown in Figure 2. It can be stated that it is working properly when the LED flashes according to the program's command that has been uploaded.

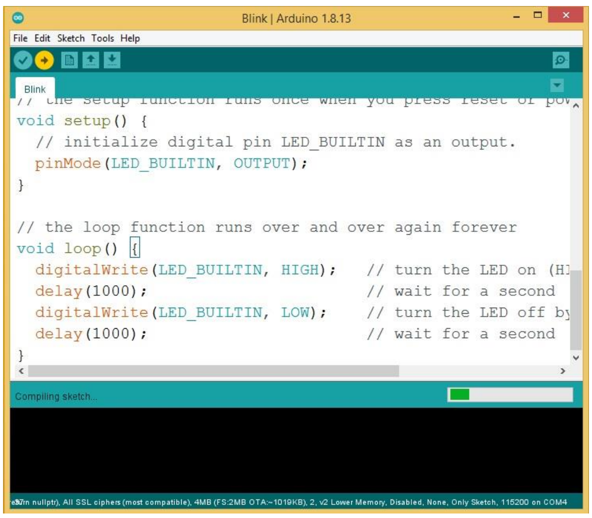

Figure 2. Testing program by *Arduino IDE* software.

Testing the Blynk Application

This study uses the *Blynk Android* application to display output. *Blynk* is a smartphone application for iOS or Android used to control Arduino, Raspberry Pi, ESP8266, WEMOS D1, and other connected modules (Sanusi, 2018). The testing result can be seen in Figure 3.

Figure 3. Blynk is connected when testing an application successfully (System in Indonesian).

Load Cell Sensor Testing

Load cell sensor testing by connecting the load cell sensor pin to the microcontroller pin can be seen in Figure 4.

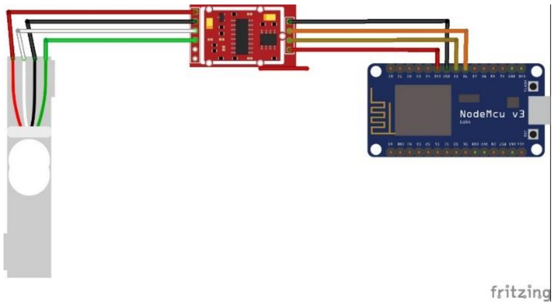

Figure 4. Circuit wiring.

After the load cell sensor is coupled to the microcontroller, upload the source code.

Sound Sensor Testing

This study uses a sound sensor to detect the cries of a sleeping baby. Useful sensor testing is done by connecting the good sensor pin to the microcontroller pin, as shown in Figure 5.

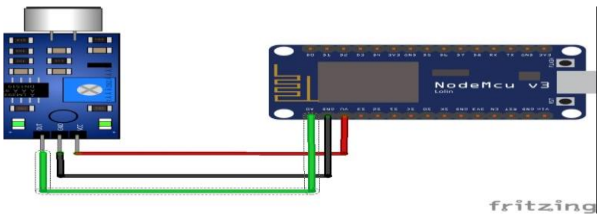

Figure 5. Sound sensor circuit illustration.

The next stage is to write the code program. This IoT-based baby sleep monitoring tool with a NodeMCU microcontroller uses the Blynk-IoT platform and the *Arduino IDE* integration program as a compiler. The tool program is based on the Blynk source code, load cell sensors, and sound sensors in the Arduino library. Next, the program is uploaded to the microcontroller using a USB cable.

System Testing Results

The system needs testing to observe and ensure the functionality and performance of the tool. Testing is done by operating the device and then paying attention to the version of each component of the instrument, such as load cell sensors, sound sensors, and NodeMCU microcontroller. The schematic of a series of devices can be seen in Figure 6.

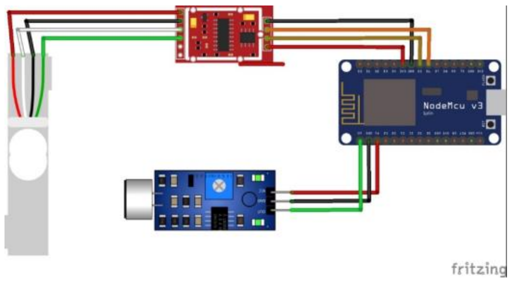

Figure 6. Schematic design of the system.

System testing is done by matching the performance of the component device with the command program being executed. Besides, analysis is carried out by checking the data sent on the tools and data received on the IoT platform to determine which tools work efficiently and effectively.

DISCUSSION

Based on the research results through *black-box* testing techniques, the compartment box consisting of a microcontroller, HX711 module, sound sensor, and IoT platform parts can work as planned. The performance of the two regions where the data read and sent from the compartment box is the same as the data received on the IoT platform, for the load cell sensor test results can be seen in Table 1.

Table 1. Load cell sensor test results

Date Test	Load (Kg)	Sensor Value (Kg)	Blynk view
02/02/2021	0.50	0.52	Baby Not in Place
02/02/2021	1.00	1.05	Baby Not in Place
02/02/2021	1.50	1.53	Baby Not in Place
02/02/2021	2.00	2.09	Sleeping Baby
02/02/2021	2.50	2.51	Sleeping Baby
02/02/2021	3.00	3.06	Sleeping Baby
02/02/2021	3.50	3.55	Sleeping Baby
02/02/2021	4.00	4.10	Sleeping Baby
02/02/2021	4.50	4.59	Sleeping Baby
02/02/2021	5.00	5.07	Sleeping Baby
02/02/2021	5.50	5.58	Sleeping Baby
02/02/2021	6.00	6.12	Sleeping Baby
02/02/2021	6.50	6.54	Sleeping Baby
02/02/2021	7.00	7.09	Sleeping Baby
02/02/2021	7.50	7.51	Sleeping Baby
02/02/2021	8.00	8.04	Sleeping Baby
02/02/2021	8.50	8.57	Sleeping Baby
02/02/2021	9.00	9.07	Sleeping Baby
02/02/2021	9.50	9.60	Sleeping Baby
02/02/2021	10.00	10.13	Sleeping Baby

Suppose the load cell sensor detects an object weighing 2 Kg or higher. In that case, the microcontroller will signal to the Blynk application that the baby is in a place with a notification that the baby is sleeping. However, if the detected object's weight is below 2 kg, a notice will appear that the baby is not in place. Figure 7 is a display of load cell sensor results.

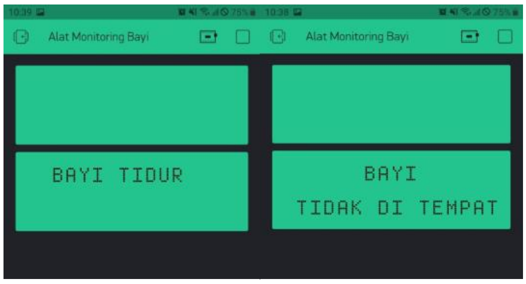

Figure 7. Display of load cell sensor test results (system in Indonesian).

After the load sensor has been tested, the next testing for the sound sensor. The useful sensor test results can be seen in Table 2.

Table 2. Sound sensor test results

Date Test	Sound Source	Distance with Sensor	Blynk view
01/02/2021	Trial 1	5 cm	Baby crying
01/02/2021	Trial 2	10 cm	Baby crying
01/02/2021	Trial 3	15 cm	Baby crying
01/02/2021	Trial 4	20 cm	Baby crying
01/02/2021	Trial 5	25 cm	Baby crying
01/02/2021	Trial 6	30 cm	Baby crying
01/02/2021	Trial 7	35 cm	Baby crying
01/02/2021	Trial 8	40 cm	Baby crying
01/02/2021	Trial 9	45 cm	Baby crying
01/02/2021	Trial 10	50 cm	Baby crying
01/02/2021	Trial 11	55 cm	Not detected
01/02/2021	Trial 12	60 cm	Not detected
01/02/2021	Trial 13	65 cm	Not detected
01/02/2021	Trial 14	70 cm	Not detected
01/02/2021	Trial 15	75 cm	Not detected
01/02/2021	Trial 16	80 cm	Not detected
01/02/2021	Trial 17	85 cm	Not detected
01/02/2021	Trial 18	90 cm	Not detected
01/02/2021	Trial 19	95 cm	Not detected
01/02/2021	Trial 20	100 cm	Not detected

If the sound source is within 0–50 cm, the microcontroller will signal the Blynk application with a crying baby notification. However, if the distance between the sound source and the sensor is more than 50 cm, the sound will not be detected, and no message will appear on the Blynk application. Figure 8 shows the sensor readings sent to the Blynk application.

Figure 8. Display of sound sensor test results (system in Indonesian).

CONCLUSION

Based on the results of research on the design of a sleep monitoring device for babies during sleep based on IoT with the MCU ESP 8266 microcontroller, it can be concluded that the tool for detection of the presence of infants (judged by the weight of the baby based on kilograms) can be detected with an accuracy of 90% success. The tool also functions to detect sound sources with a distance of 0 - 50 cm, which is then sent to the Blynk application as a notification "*BABY CRYING*." However, if the sound source distance is more than 50 cm, no sound will be detected, and no information will be sent to the Blynk application

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