Analysis and Design of Safety Perambulator System via Wi-Fi and Blynk Application

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Abstract—The paper is to demonstrate the analysis and design of a safety perambulator system using Wi-Fi and the Blynk application. This system is built around the idea of wireless communication between the microcontroller and the user’s smartphone. Based on the findings of the study, this system has the potential to address the issue of caregiver negligence in looking after children in public places. In addition, capable of resolving the issue of baby safety and loss in Malaysia and elsewhere. The ESP8266 NodeMCU is the main microcontroller used. This microcontroller is used so that all sensors can interact and exchange data with one another. This project employs four sensors: a Passive Infrared (PIR) sensor, a Force Sensitive Resistor (FSR) sensor, a Global Positioning System (GPS) module, and a Digital Humidity and Temperature (DHT11) sensor. All these sensors will communicate with one another via the Blynk app. The system can perform the primary function for which it was designed and analysed: tracking and monitoring. This system can help caregivers in terms of safety when in a crowded or public place, and it is also convenient because it can be monitored using a smartphone.

Keywords – wireless; ESP8266 NodeMCU; PIR sensor; FSR sensor; GPS module; DHT11; Blynk application; perambulator.

I. INTRODUCTION

The first stroller invented was in 1733 by William Kent. The stroller was created to be clam shaped and it was richly decorated and meant to be driven by a small animal such as a goat[1]. Benjamin Potter Crandall saw this stroller and he decorated and meant to be driven by a small animal such as a goat[1]. Benjamin Potter Crandall saw this stroller and he came up with the idea to create a stroller that could carry a baby. He is the first person in America to sell his innovation[2]. In the 21st century, there are many missing children in Malaysia. This is due to the negligence of caregivers to children which is likely to occur anywhere for example in shopping malls, playgrounds, recreational parks, grocery stores, saloons, train stations or LRT stations and many more places that can threaten the life of a child. In fact, this issue has also been widely published on social media, news, and newspapers either for the knowledge of the Malaysian community or as a precaution to all guardians and parents in Malaysia. In addition, the Royal Malaysia Police (PDRM) has released statistics related to missing children. Statistics reported by the Royal Malaysian Police Missing Children Portal show that the number of missing child cases in 2020 was 4 and this number increased to 11 in 2021[3]. The Internet of Things is a network that connects anything to the Internet using predefined protocols and information sensing equipment to facilitate data interchange and communication in order to achieve intelligent recognition, placement, trace, monitor, and administration[4]. The ESP8266 NodeMCU has been used in this system as the main microprocessor or in other words to function as a mastermind. All sensors will communicate with this Wi-Fi microcontroller via GPIO pin and analog pin. Where the GPS module will use the RX and TX pins to transceiver data received from the satellite to the digital GPIO pins 1 and 2 of the ESP8266 NodeMCU[5]. With this concept, caregivers can monitor the condition and position of the perambulator and the baby in it.

II. METHODOLOGY

The system uses 3 sensors and one module as input. While on the output side there are four outputs including smartphone users. The main part of this system is the microcontroller where the system uses the ESP8266 NodeMCU as the microcontroller. This microcontroller has a built -in Wi-Fi module. The user's smartphone will
communicate with the microcontroller via Blynk to receive and send data to each other. The system will be supported with an additional voltage supply of 9V for the input voltage on the microcontroller and 9V to be supplied to the relay to activate the fan. All sensors and modules used as inputs only use a voltage range between 3.3V-5V to start operating.

A. Hardware

Figure 1: Block Diagram of Safety Perambulator

The system uses 3 sensors and one module as input. While on the output side there are four outputs including smartphone users. The main part of this system is the microcontroller where the system uses the ESP8266 NodeMCU as the microcontroller as shown in figure 1. This microcontroller has a built-in Wi-Fi module. The user’s smartphone will communicate with the microcontroller via Blynk to receive and send data to each other. The system will be supported with an additional voltage supply of 9V for the input voltage on the microcontroller and 9V to be supplied to the relay to activate the fan. All sensors and modules used as inputs only use a voltage range between 3.3V-5V to start operating.

B. Flowchart of The System

Function A is temperature system. Temperature management systems monitored using DHT11. The reading data from the DHT11 sensor such as the minimum temperature to turn on fan which is 32.9°C will be stored in a variable temperature. When the temperature reading has been recorded or detected by DHT11 then the temperature reading will be stored in variable temperature and executed by ESP8266 NodeMCU, thus the temperature reading will be sent into Blynk application via virtual pin V8 for display on caregivers smartphone. Furthermore, the temperature reading will be used as an active and deactivate fan. The condition set in the source code is that if the temperature is greater than or equal to ambient_temp which is set at 33°C it will activate the relay and turn on the fan simultaneously send a message to the Blynk application to display "Fan Is ON". While if the temperature is less than ambient_temp, the relay will deactivate and turn off the fan thus send a message to the Blynk application to display "Fan Is OFF". If these two conditions are FALSE, then the sensor will read again the temperature reading to get the result either below or above 33°C. Additionally, these two conditions are in looping operation which it keep operate if the microcontroller not switch off. Simultaneously, the source code will execute the next condition of sensor which is FSR sensor in function B.

Function B is for FSR system, the operation of push button in Blynk application and FSR sensor reading. First, is to wait for readings of data ‘1’ and ‘0’ from the Blynk application. If the system receives signals such as ‘1’ the reading will be stored into the variable pinValue2. Thus, FSR sensor will be mode ‘ON’ and when there is pressure on FSR sensor in the form of Numeric Digital Output like 274(1Kg), 426(2Kg) and 559(3Kg) it will be stored into the fsrreading variable. In this function B, there are two conditions, first for Blynk where virtual push button application and second for FSR sensor reading. Where, if pinValue2 receive signals ‘1’ from Blynk application, buzzer will be in ON mode and continue to read readings in Numeric Digital Output unit from FSR sensor which is if variable fsrreading greater than 300 the condition is TRUE, thus buzzer will turn OFF and when the reading is less than 300 condition is FALSE which is the buzzer will turn ON. While, if the pinValue2 receives ‘0’ signals from the Blynk application, the buzzer will be in OFF mode.

Based on figure 2, each sensor needs to be included in their respective libraries to make each sensor work correctly. For the program, each sensor library needs to be declared first as an example of a GPS library where the typical library used is "TinyGPS ++, H". Next, the pin for each sensor must be declared based on the hardware connection between sensor, module, and microcontroller such as pins for GPS module namely Rx and Tx will be declared on digital pins D1 and D2 on microcontroller ESP8266 NodeMCU and pin for FSR sensor on analog pin A0 at ESP8266 NodeMCU. Furthermore, all parameters in this system will be set in the source code based on the condition of each sensor. A calibration for each sensor is for the sensors to operate accurately and error free. Meanwhile, at the end of the flowchart A and B are functions for each component to measure and analyze the transmit and receive data. During the loop connection in the flowchart, this is caused by receiving signals by the ESP8266 NodeMCU that are transmitted from the Blynk application to switch ON and OFF the buzzer and PIR system. Both functions A, B, C and D will be placed in a void loop where each function will always do a looping process.
While the function C is for the PIR system the system will wait for signals like ‘1’ and ‘0’ from the virtual push button in the Blynk application, if there are signals sent from the Blynk application, the signals data such as ‘1’ and it will be stored in the pinValue variable. Next, the PIR sensor reading that detects infrared radiation emitted from the baby's body will be stored in the pirreading variable. The PIR system has three conditions. Where the first condition is when the PIR system receives signals ‘1’ from Blynk application the condition is TRUE then the PIR system is ON, thus the PIR sensor will start making readings by detecting infrared radiation. If pirreading is equal to ‘1’ the condition is TRUE Blynk application will notify "Your baby is here". If condition is FALSE which is ‘0’. Blynk application will notify "Your baby is not here". Furthermore, if the system does not receive push button signals from Blynk where pinValue equal to ‘0’ then the PIR system will be in OFF mode.

Lastly, the function D is the Global Positioning System (GPS) module will detect the total number of satellites successfully detected and with this satellite tracking the GPS module can transmit and receive data from satellites for the latitude and longitude of the perambulator. When the GPS module successfully detects signals from satellites, the signals data will be stored in the variable’s latitude, longitude and no_of_satellites. Thus, by using this data it will be transmitted to virtual pins V1, V2 and V3 in Blynk apps via wireless connection. Latitude, longitude and no_of_satellite data will be displayed in Blynk apps in the form of digital values and simultaneously the map which is the platform in Blynk apps will include the location of perambulator where black pin is perambulator location and caregiver's smartphone location is green pin.

III. RESULT

A. Prototype

Figure 3: Prototype Front View

Figure 3 shows a prototype from the front view that has been equipped with the entire system, which is consists of three types of sensors, one module, ESP8266 NodeMCU microcontroller, buzzer, LED, relay, DC motor and fan. This prototype is using three wheels and to control the prototype caregivers need to control handler to control the front wheel.

B. Passive Infrared (PIR) Sensor Operation

PIR sensor is functioning to detect element of infrared radiation[6]. Blynk application will notify caregivers if PIR does not detect any infrared radiation in the perambulator. For example, if there is the presence of a baby in the perambulator Blynk will notify “Your Baby Is Here” and “Your Baby Is Not Here” as shown in figure 4.

C. Fan and GPS Operations

<table>
<thead>
<tr>
<th>Condition</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Above 33°C</td>
<td>Fan will turn on</td>
</tr>
<tr>
<td>Below 33°C</td>
<td>Fan will turn off</td>
</tr>
</tbody>
</table>

Table 1: The Condition of the temperature detected and decision

Table 1 shows the condition in which the fan will turn on and off. According to the code that has been programmed into the microcontroller, DHT11 sensor will be assigned to detect the ambient temperature where if the temperature exceeds 33°C the fan will turn on and simultaneously send a notification to the Blynk application that is "Fan Is ON". Whereas if the temperature is set less than 33°C the fan will automatically turn off and instantly send a "Fan Is OFF" notification to the Blynk application. Notifications are sent to inform caregivers whether the fan needs to be kept on or closed to save battery energy used by the system.

Ambient temperature readings were taken outside the home area during the evening at 2:00 pm to 2:16 pm. The temperature reading shows as in the graph in figure 5 shows the temperature increased from 28.70°C to reach 34.20°C. However, in the 14th minute the temperature reading dropped slightly from 33.90°C to 33.50°C. This is because, DHT11 has detected unstable temperature changes at that time, and it is likely due to the wind that is able to disrupt the temperature at that time. This temperature reading was recorded in 16
minutes because at this time 2 pm the temperature can be both either hot temperature which is above 33°C and normal temperature below 33°C. Furthermore, the data was taken only 16 minutes are because its only want to observe the condition of the system is working well or not, besides to make sure the fan is working as expected result or not. The graph shows that when the temperature reaches 33.1°C the output is binary '1' which means the fan has been turned on automatically. Meanwhile, when the temperature reading drops to 32.2°C the output becomes binary '0' which means the fan has been turned off automatically. The average change in temperature reading taken to change is 0.9°C.

<table>
<thead>
<tr>
<th>Weight Reading (Kg)</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Buzzer and red LED will on</td>
</tr>
<tr>
<td>0.05</td>
<td>Buzzer and red LED will on</td>
</tr>
<tr>
<td>1.0</td>
<td>Buzzer and red LED will on</td>
</tr>
<tr>
<td>2.0</td>
<td>Buzzer off and green LED will on</td>
</tr>
<tr>
<td>3.0</td>
<td>Buzzer off and green LED will on</td>
</tr>
<tr>
<td>4.0</td>
<td>Buzzer off and green LED will on</td>
</tr>
<tr>
<td>5.0</td>
<td>Buzzer off and green LED will on</td>
</tr>
</tbody>
</table>

Table 3: Weight reading and decision

Weight readings in kilograms were recorded as shown in table 3. Seven different weight readings were taken to conduct data analysis on FSR sensor operations. The experiment was tested using weight of the packet of the sugar which is one packet sugar are equal to 1kg. Therefore, in this experiment 5 packet sugar was used to get the reading.

IV. CONCLUSION

In conclusion, the prototype of Safety Perambulator System was successfully built by using ESP8266 NodeMCU Wi-Fi microcontroller-based system. This system was developed inspired by Internet of Things (IoT) concepts and solutions to baby safety in public places. IoT technology has been applied in the system by using wireless communication to monitor the safety of the baby in the perambulator in a public place from the caregiver's smartphone, even with additional features for the comfort of the baby when in the perambulator. By using Wi-Fi microcontroller in caregivers can monitor from a distance up to 10m if in a space without obstacle and it also depends on the Wi-Fi strength which is Received Signal Strength Indicator (RSSI) and the user's internet signal.

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D. Force Sensitive Resistor (FSR) Sensor Operation

Source code has been written and used to set limits or conditions for a sensor. Therefore, the condition for this FSR sensor is set as shown in table 2 where below 2Kg weight for example 1Kg, 500gram, 47gram, 600gram etc. The detected decision to be made by the microcontroller is to turn on the buzzer and turn on the red LED where it means baby weight was not successfully detected in the perambulator. Meanwhile, if the weight reading detected is between 2Kg to 10Kg, the decision to be made by the microcontroller is to deactivate the buzzer and activate the green LED where it means that the FSR sensor successfully detects the weight of the baby in the perambulator. When the detected weight has exceeded the limit of 10Kg it is able to damage the FSR sensor thus the sensor cannot detect the weight[7]. According to the datasheet issued by interlink electronics maximum force sensitive is 10.0N where the reading in kilograms is equivalent to 10Kg.

<table>
<thead>
<tr>
<th>Condition</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Below 2 Kg</td>
<td>Buzzer and red LED will on</td>
</tr>
<tr>
<td>Range between 2 Kg to 10 Kg</td>
<td>Buzzer off and green LED will on</td>
</tr>
<tr>
<td>Above 10 Kg</td>
<td>Not detected</td>
</tr>
</tbody>
</table>

Table 2: Condition of the weight and decision