Design and Development of Smart Medicine Box

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Abstract
The Smart Medicine Box is successfully designed in helping the introvert patients taking their medicine without help of others. This project is to develop a robotic device that can assist patient to take medicine alone by implementing an IOT apps system for controlling the Smart Medicine Box where it will overcome an emotional disturbance experience by the introvert patients. There are four sensors such as PIR, IR, temperature and ultrasonic sensors use for the project. The purpose of PIR sensor is to detect hand movement near the device, while IR sensor is to detect the line follower on the floor. The LM 35 acts as the detection of the temperature inside the box and the ultrasonic acts as the detection of the obstacle in front of the device. The MIT Apps Invention 2 is used to develop an apps and collect the data from sensors through Arduino microcontroller. A proof of concept design has implemented and demonstrated successfully.

Keywords— Arduino, MIT Apps Invention 2, IOT system, PIR sensor

1. INTRODUCTION

According to Health Facts 2015 in Hospital Kuala Lumpur (HKL), the number admission of the patients for 2015 are 131, 639 while 128, 836 is the number admission of the patients in 2014 [1]. The increasing number of patients will increase the number of ward needed to cater all. Therefore, the nurses will be busy to handle the patients at the same time.

Nowadays, the nurses still used the manual method to give the medicine to the patients. They will go to the patient’s bed for three times per day and give the medicine to the patients. By using this method, the nurses will waste the time because they should go to the patients’ ward one by one. Besides, they also cannot monitor the patients properly because they do not have enough time because they will busy to monitor the other patients. So, the patients will skip the medicine by throwing them in the dustbin. Some patients who are introverts prefer to be alone. Introverts are known for gaining energy from spending time alone [2]. Usually, they will stay in the private ward and do not like to share that ward with another person. Introversion is the common ways of defining personality types that describe how individuals derive their energy, process information, and respond to stimulation.

For this problem, there is no specific solution that can help the nurse to solve this problem. They just can give the advice to take the medicine and monitor them if they have enough time to do that. This project is developed to help the problem occur with introvert patients. The smart medicine box is to solve and help the nurse to handle the introvert patients specifically.
2. METHODOLOGY

The design process of our project started with the decision making of the project title. The group members brainstormed together to come up with a suitable project. After deciding on one specific title, consultation with the lecturer was done, and the lecturer approved our title. We proceed to the proposal part of the project. The literature review was done, and all requirements for the proposal was analyzed. After completing the literature review, the proposal was complete. Therefore, after completing the proposal, we make an analysis on the system that we are going to use; software and hardware designing process can take place. We then test the prototype for any problem and the presentation will take place with a full report to submit.

2.1 Functional block diagram

From the block diagram, the input of power supply, 12V is needed to activate the system. Then the Arduino will act as a controller and the detection will be work by sensors which are PIR motion sensor, temperature sensor, ultrasonic sensor, infrared sensor to gives the output to apps controller. next, the servo motor will be used in the box to drop the medicine, DC motor will move from one place to another place when receiving the command from the microcontroller. Lastly, buzzer and LED will act as an output to give a warning if it faces the obstacle.

![Functional block diagram](image)

**Figure 1** : The Block of Smart Medicine Box

2.2 Theory and calculations

In this project, Proteus 8 professional has been used to build the simulation of the project. It is the best software for simulation because it contains a lot of electronic components that can be run virtually on the computer. This software can calculate and show the currents and voltages needed by the electronic components on the board.

Line follower system is used for the smart medicine box. So that it can move the box from one place to another. On another side, the photodiode is used with the photodetector for tracking line based on the light reflection by using infrared sensor module. If it is no light detection on the photodetector, the microprocessor will give the command to the DC motor to reroute the track. From this module, the uniform movement of the product can be maintained. In this system, 3V-6V DC motor is used to make use of DC supply of the system.
In addition, the project that had been built, it is related to robotic technology that may reduce nurse burden in handling their patient in the hospital. The title for this project is smart medicine box really related to the problem faced by hospital staff nowadays. To build the robotic system some sensor needs to consider, especially ultrasonic sensor, an infrared sensor, PIR sensor and temperature sensor.

Firstly, the ultrasonic sensor module is used to detect the obstacle of the surroundings, and automatically stop the DC motor. In fact, by doing this the project can avoid any collision with other things especially human. The sensor consists of 4 pins, which VDD pin, GND pin, Trigger pin, ECHO pin and connect to the high-performance 8-bit microcontroller. VDD pin act as an input voltage to the sensor, and GND pin to stabilize the circuit. The most importance pins are Trigger pin and Echo pin to control the range for the obstacle to be detected.

The voltage needed for this sensor to operate are around 4.95 V to 5.05 V with 15mA working current. This ultrasonic sensor used for safety purposes to avoid the project harming the surrounding. Ultrasonic functioning based on the speed of sound around 340 $m_\text{s}^{-1}$ or 29 microseconds per centimeter. The trigger will cause ping to travel out of the ultrasonic sensor and the distance can be altered by setting the speed of sound range from 0 $m_\text{s}^{-1}$ until 340 $m_\text{s}^{-1}$in the c programming of the Arduino command.

Next, the infrared sensor uses to differentiate the amount of light absorb after it is reflected from the obstacle. This project used IR sensor for line follower purposes. The threshold used for the infrared sensor is 300 to distinguish the black and white color of the track. The IR sensor operated at 5 V supply with input output pin. It has one IR LED to send the light signal from the system and one photodiode that converts light into current. This current will send through the signal pin to the Arduino board.

When the IR receiver does not receive a signal, the potential at the inverting input goes higher than that non-inverting input of the comparator IC (LM339). Thus, the output of the comparator goes low, but the LED does not glow. When the IR receiver module receives signal to the potential at the inverting input goes low. Thus, the output of the comparator (LM 339) goes high and the LED starts glowing. Resistor R1 (100), R2 (10k) and R3 (330) are used to ensure that minimum 10 mA current passes through the IR LED Devices like Photodiode and normal LEDs respectively. Resistor VR2 (preset=5k) is used to adjust the output terminals. Resistor VR1 (preset=10k) is used to set the sensitivity of the circuit Diagram.

Otherwise, for the temperature sensor, LM 35 is used to detect the temperature changes, especially in medicine storage container in the smart medicine box. This component used analog signal to transmit the signal to the Arduino board. It has 3 pins which VCC pin for voltage input, analog out pin for signal output and ground pin. The temperature can be calculated from the signal value as follows:

$\text{Temperature} \ (\degree C) = \left( \frac{\text{signal value}}{1024.0} \right) \times 500 \quad (1)$

This formula (1) is to get the Celsius value from 10-bit analog value. Lastly, we are using voltage divider rule to get an output 3.3 V for Bluetooth input.

In the design, the ultrasonic sensor is used to detect any obstacle for the product to move and it will control the DC motor to rotate or stop. When the ultrasonic sensor detects the obstacle, the LED and buzzer will switch on and alert the person or living obstacle to moving away from the track and the product will continue moving by following the track.
Next, LM35 component is used to detect temperature changes in the medicine box for protection. If the temperature is too high for the medicine, it will cause a chemical reaction in the medicine and change the properties. This may cause more problems to the patient.

In this design, we used two PIR sensors for two conditions which one for morning purpose and another for evening purpose. First PIR sensor, will control the servo motor to rotate 90° angle to drop the medicine from the box when it detects patients’ hand. This condition is used in the morning for patients to consume the medicine. Next PIR sensor, is used to control the servo motor to rotate at 180° angle in the evening.

Lastly, we used the Wi-Fi module to connect the device and the smartphone for communication or sending the medical condition to the nurse on duty. In this simulation, RX module and TX module is used to show the Wi-Fi module function in protest simulation because there is no Wi-Fi library in the software. On the smartphone, the temperature of the medicine box will be displayed and the number of the medicine consumption by the patient will be recorded. Virtual terminal shown in Figure 16, is the purpose output that will be shown.

3. RESULT AND DISCUSSION

3.1 Proteus simulation results

The reason used this sensor is to detect the changes of the temperature in medicine box. The virtual terminal on the proteus simulation will show the detected temperature and the output. Thumbs touch was used to stimulate the sensor of LM 35 and the output reappears on the virtual terminal. Next, the motion stated as shown in the figure above show two motions. The motion belongs to two PIR sensor. The first one for PIR sensor one used to drop the medicine in the morning and another one used to drop the medicine in the evening. The distance at the fourth line is set in range or distance of the ultrasonic sensor to detect an obstacle. If the distance below 150 cm, the LED and buzzer will turn on to warn the user or obstacle. During this moment, the DC motor will stop the product movement due to the detection of an obstacle.

Servo motors are used to rotate the medicine output from the medicine box where we set two conditions which are 90° and 180°. When running the simulation, first rotation shows 90° then turn back to zero and continue to 180° for the second condition and back to 0° and stop the rotation of servo motor. The reason why it rotates because of the PIR sensor detect the hand or obstacle that trigger the sensor to send the input to the microcontroller and cause the servo motor to rotate. The rotation will halt about 20 seconds because the delay time is 20 seconds in the programming coded. Medicine will drop for two section which is during morning and evening only.

3.2 Mit Apps Inventor 2 Display & Programming

The MIT apps inventor 2 that used in this project is to monitor the temperature of the medicine and the medicine’s consumptions. The data can be collected directly from the data storage and sending to and can be displayed directly as well as accurately on the smartphone that running the Android operating system. This is due to the APK file that cannot be installed on the smartphone that running the Microsoft operating system and IOS. The MIT apps inventor 2 that use in this project are consists from screen 1 until screen 4.

MIT apps inventor is programmed to send the data from the Bluetooth data storage to Arduino Mega. Lastly, we want to use the Wi-Fi module to connect the device and the smartphone for
communication or sending the medical condition to the nurse on duty. The problem faced during simulation is we cannot know the exact IP address for Wi-Fi connection except try the Wi-Fi module hardware exactly on the board. Based on the real design the voltage divider is used to get an input of 3.3 V for the input of the Tx Wi-Fi module. The reason for voltage divider is used because the Wi-Fi module only operated on a 3.3V supply only more than that it will damage the system. After a lot try and error we move to use Bluetooth to get the output because we have a lack of time to complete the project. Luckily, we managed to get the output from the device and appeared on the applications that we used.

Figure 2: The home page of MIT Apps Inventor 2 & its programming (Screen 1)

Figure 3: MIT apps inventor page & programming at screen 2

Figure 4: MIT Apps Inventor Page & Programming at Screen 3

Figure 5: MIT Apps Inventor Page & Programming at Screen 4

i. **Screen 1**

Displays the home page that contain the button for nurse’s schedule, nurses in-charge and a button for temperature running.

ii. **Screen 2**

The detail that needs to enter by a nurse in order proceed by their schedule. After entering their name, duty period and date, the data will collect and save. This data is need as it’s important to know whose nurse that responsible at the time need by the patient to take their medicine either in morning or evening So, this page is to ensure nurse has responsible to their duty.

iii. **Screen 3**

Displays the Bluetooth functions as a connector to Arduino Mega after receives the data from MIT Apps Inventor 2.

iv. **Screen 4**

Displays the result of medicine’s temperature as the temperature is detected by the Temperature’s Sensor (LM35). After the result was showed, the nurse can choose to disconnect the Bluetooth by the button that contains in this screen.

3.3 Application on the device.

The experimental setup of our project is to test all sensors functioning, safe moderate testing for the balancing and the movement of the base part. Then, for the combination of all circuit to the product,
or integration as a complete system. The results are satisfactory considering that all the sensors are working as required.

![Image](image_url)

**Figure 6:** The Complete Prototype of Smart Medicine Box

Figure 6 above shows the complete prototype of Smart Medicine Box for final presentation by using four type of sensor that operated with their functions. This device is successfully achieved as the result that we want.

### 4. CONCLUSION

In conclusion, this device can help and give advantage to the nurses. The main objective for this innovation is to monitor the consumption of medicine intake for intrinsic patients. It is practical in the morning and evening but also can be used at night. This device is controlled by using Bluetooth system, so the nurse does not need go to the personal ward to give the medicine. This system is a very good to apply in the hospital because it can make the nurse job easier besides making the patients more comfortable to stay at the hospital.

### 5. REFERENCES

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