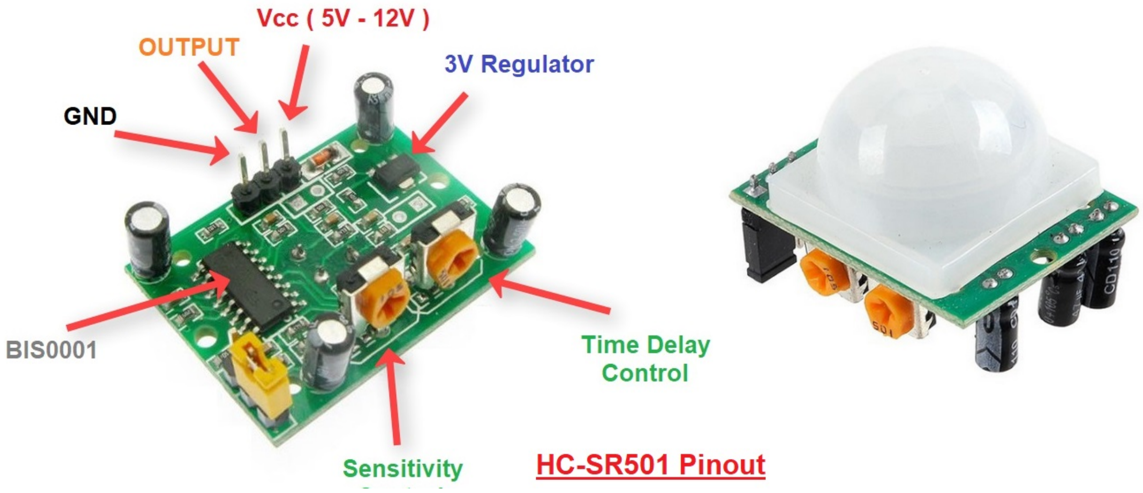
International Institute of Information Technology
Introduction to IoT
Lab 5

Overview:

In this lab session you will learn to use a motion sensor to detect an object and flag off the detection information over WiFi to a server and use that information to activate a buzzer connected to esp32.

Motion Sensor:



HC-SR501 Pinout

The PIR (Passive Infrared) Motion Sensor Detector Module HC SR501 allows you to sense motion. It is almost always used to detect the motion of a human body within the sensor's range. It is often referred to using “PIR”, “Pyroelectric”, “Passive Infrared” and “IR Motion” sensors.

HC-SR501 is basically a motion detector sensor, which uses infrared waves for detection of an object. It is an automatic control device, also has large sensitivity and high reliability. It is used in auto-sensing control devices, where we need to perform motion detection.

Specifications:

- Wide Working Voltage Range: DC 4.5V- 20V

- Current Drain: <60uA
- Detection Angle: <140°
- Detection Distance: 3 to 7m (can be adjusted)
- Blockade time: 2.5s (Default)
- Work temperature: -20-+80°C

Pinout:

- Vcc-

  Input voltage is +5V for typical applications. Can range from 4.5V- 12V.

- High/Low Output (Dout)-

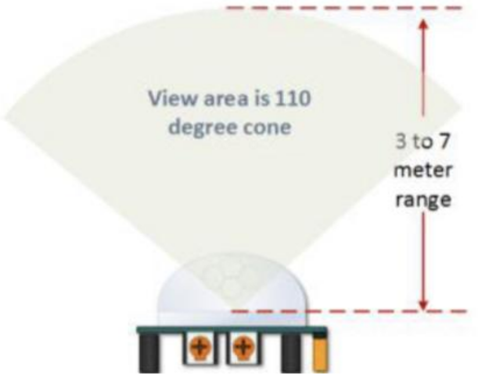
  Digital pulse high (3.3V) when triggered (motion detected), digital low(0V) when idle(no motion detected).

- Ground-

  Connected to ground of circuit.

Components:

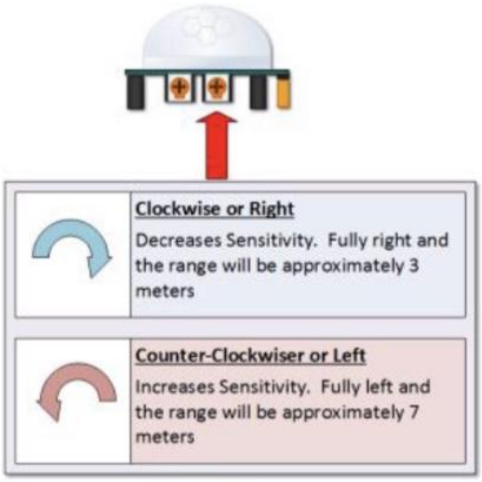
- Time delay control- Orange colored screw to regulate delay time.
- Sensitivity control- Orange colored screw to regulate sensitivity.
- Regulator- An IC (HT7133-1) that regulates voltage flow.
- BIS0001- a PIR controller that works on analog mixing digital techniques.



The device will detect motion inside a 110 degree cone with a range of 3 to 7 meters.

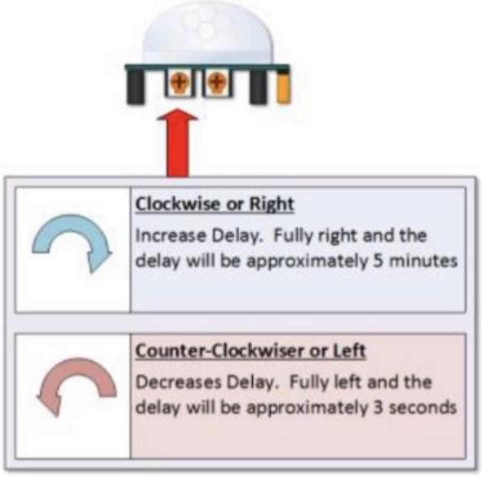
PIR Range (Sensitivity) Adjustment

As mentioned, the adjustable range is from approximately 3 to 7 meters.


Clockwise or Right
Decreases Sensitivity. Fully right and the range will be approximately 3 meters
Counter-Clockwiser or Left
Increases Sensitivity. Fully left and the range will be approximately 7 meters

Time Delay Adjustment

The time delay adjustment determines how long the output of the PIR sensor module will remain high after detection motion. The range is from about 3 seconds to five minutes.


Clockwise or Right
Increase Delay. Fully right and the delay will be approximately 5 minutes
Counter-Clockwiser or Left
Decreases Delay. Fully left and the delay will be approximately 3 seconds

The output of this device will go LOW (or Off) for approximately 3 seconds AFTER the time delay completes. In other words, ALL motion detection is blocked during this three second period.

For Example:

Imagine you’re in the single trigger mode (see below) and your time delay is set to 5 seconds.

- The PIR will detect motion and set it high for 5 seconds.
- After five seconds, the PIR will sets its output low for about 3 seconds.
- During the three seconds, the PIR will not detect motion.
- After three seconds, the PIR will detect motion again and detected motion will once again set the output high and the output will remain on as dictated by the Time Delay adjustment and trigger mode selection.

(Note that default delay and sensitivity are sufficient to perform this experiment. Don't regulate the controller unnecessarily as its very sensitive)

WiFi module on ESP32:

ESP32 comes with a wifi and bluetooth module embedded in it. This WiFi module can connect to your WLAN or mobile hotspot. This is to be used to start a local host on your system which can be further accessed by devices on your WLAN or mobile hotspot. The later aim is to make this web server accessible anywhere in the world over the internet.

Experiment Part 1: Use PIR motion sensor to detect motion and update the info at a webpage using server approach: (Please refer part 0 in the last page)

Required Hardware:

- Breadboard
- ESP32
- PIR Motion Sensor
- Jumper Wires

Circuit Connections:

- Connect PIR sensor to input pin on esp32.
- Connect VCC to Vin and GND to ground on esp32.

Required Libraries:

- WiFi.h (builtin) [Documentation for library]
- WebServer.h in **WiFiWebServer** on arduino library manager.

Pseudocode:

```
1. Include library and define ssid and password for your WLAN or hotspot as const char*.
2. Define a server as WebServer server(80);
3. In void setup()
    a. Use Serial.begin().
```

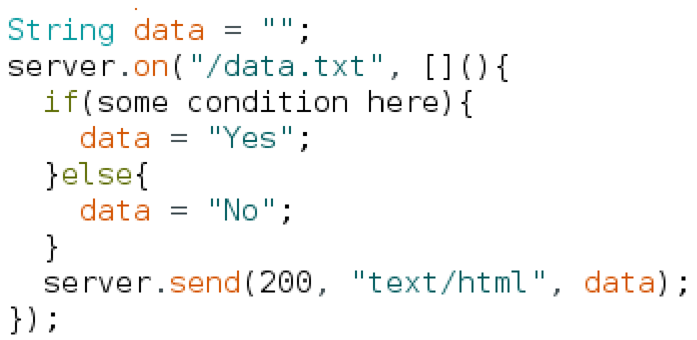
b. Define pin connections for buzzer and LED using pinMode().

c. Print the name of ssid connecting to and and update connecting status on serial monitor using appropriate words.

d. Use WiFi.begin(ssid, password); to begin the connection and WiFi.status() != WL_CONNECTED; [Read Documentation for meanings of different flags] to check connection status and WiFi.localIP(); to get the ip to be connected, print all the statuses on the serial monitor. **Print** WiFi.localIP(); **on serial monitor to get a localIP. Copy this localIP and paste into your browser to get the webpage.**

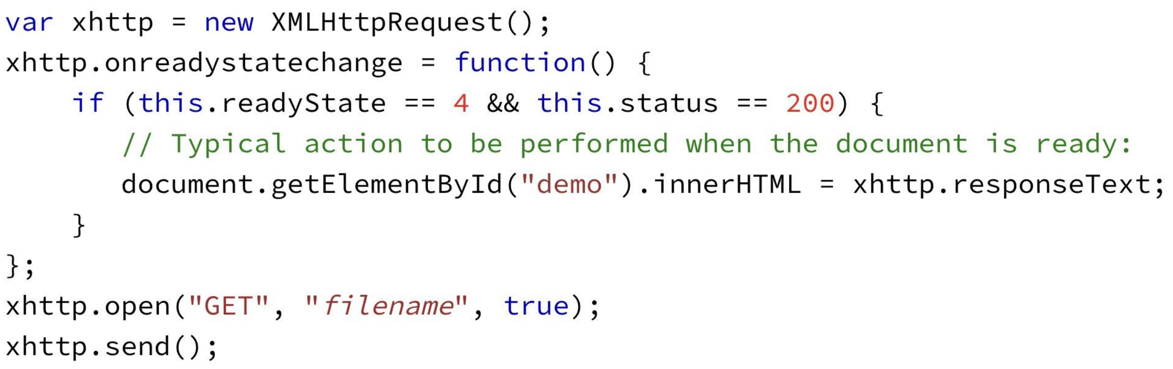
e. Use server.on() to start your server. Pass necessary string arguments. Suppose you want to send a string str_new through the server then include server.send(200, "text/html", data); here ‘200’ means gateway, (404 would mean not found as you already know). ‘text/html’ means the type of data and the last argument will be the string str_new in this case.

f.



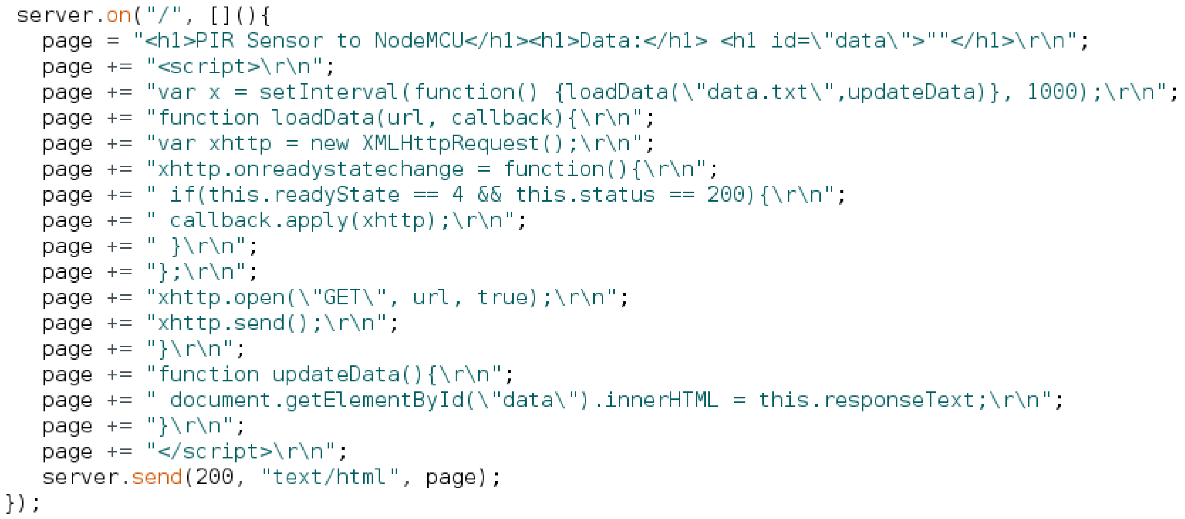
```
String data = "";
server.on("/data.txt", [](){
  if(some condition here){
    data = "Yes";
  }else{
    data = "No";
  }
  server.send(200, "text/html", data);
});
```

g. Use this same method to pass HTML/JS inputs to the server. We have to make a string that contains HTML code for the web page. JavaScript can be inserted in HTML using <script> tag. All modern browsers have a built-in XMLHttpRequest object to request data from a server. This is used to update webpage without reloading it. It can be used to directly receive and send data to server in background.



```
var xhttp = new XMLHttpRequest();
xhttp.onreadystatechange = function() {
    if (this.readyState == 4 && this.status == 200) {
       // Typical action to be performed when the document is ready:
       document.getElementById("demo").innerHTML = xhttp.responseText;
    }
};
xhttp.open("GET", "filename", true);
xhttp.send();
```

h.



```
server.on("/", [](){
  page = "<h1>PIR Sensor to NodeMCU</h1><h1>Data:</h1> <h1 id=\"data\">""</h1>\r\n";
  page += "<script>\r\n";
  page += "var x = setInterval(function() {loadData(\"data.txt\",updateData)}, 1000);\r\n";
  page += "function loadData(url, callback){\r\n";
  page += "var xhttp = new XMLHttpRequest();\r\n";
  page += "xhttp.onreadystatechange = function(){\r\n";
  page += " if(this.readyState == 4 && this.status == 200){\r\n";
  page += " callback.apply(xhttp);\r\n";
  page += " }\r\n";
  page += "};\r\n";
  page += "xhttp.open(\"GET\", url, true);\r\n";
  page += "xhttp.send();\r\n";
  page += "}\r\n";
  page += "function updateData(){\r\n";
  page += " document.getElementById(\"data\").innerHTML = this.responseText;\r\n";
  page += "}\r\n";
  page += "</script>\r\n";
  server.send(200, "text/html", page);
});
```

i.

j. server.begin() to begin the server. Print all statuses on serial m

4. In void loop() update motion sensor readings and include server.handleClient(); print all the statuses on the serial monitor.

Expected output:

You must show PIR sensor reading (digital) on a webpage. This value can be a boolean expression or just text for example “Motion Detected” or “No Motion Detected”. Pseudocode is just for your ease to understand what is to be done. Deviating from pseudocode but still fulfilling the requirements won’t incur any penalty.

Experiment Part 2: Buzz the buzzer and light up an LED through a webpage using client approach: (Please refer part 0 in the last page)

Required Hardware:

- Breadboard
- ESP32
- Buzzer
- LED (of any colour)
- Jumper Wires

Circuit Connections:

- Connect LED and Buzzer with similar output pins in parallel fashion on esp32.

Required Libraries:

- WiFi.h (builtin) [Documentation for library]

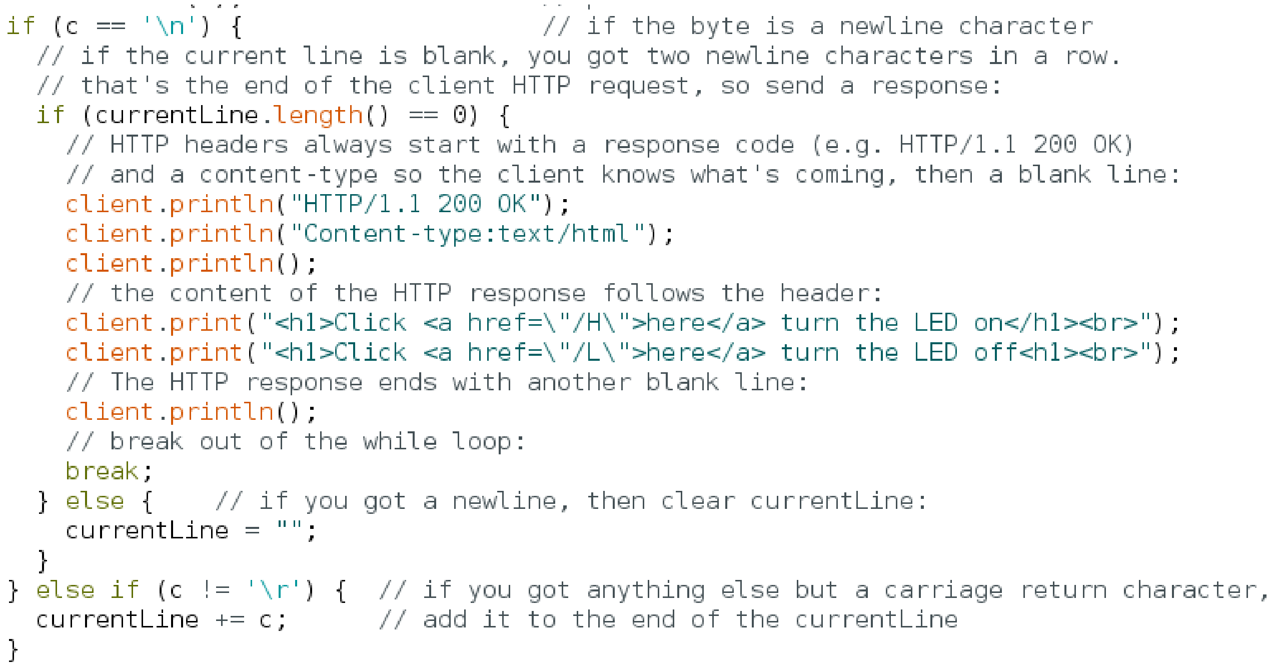
Pseudocode:

1. Include library and define ssid and password for your WLAN or hotspot as const char*.
2. Define a server as WiFiServer server(80);
3. In void setup()
    a. Use Serial.begin().
    b. Define pin connections for buzzer and LED using pinMode().
    c. Print the name of ssid connecting to and and update connecting status on serial monitor using appropriate words.
    d. Use WiFi.begin(ssid, password); to begin the connection and WiFi.status() != WL_CONNECTED; [Read Documentation for meanings of different flags] to check connection status and WiFi.localIP(); to get the ip to be connected, print all the status on serial monitor. **Print WiFi.localIP(); on serial monitor to get a localIP. Copy this localIP and paste into your browser to get the webpage.**
    e. server.begin() to start the server.
4. In void loop()
    a. Make a client using WiFiClient client = server.available();
    b. Use if (client) {}, then make a blank string String currentLine = “”; then use while (client.connected()) {} and if (client.available()) {} along with appropriate serial monitor outputs.

c. Make a character char c = client.read(); and Serial.write(c);

d. Understand and follow the following code snippet to make an html page.

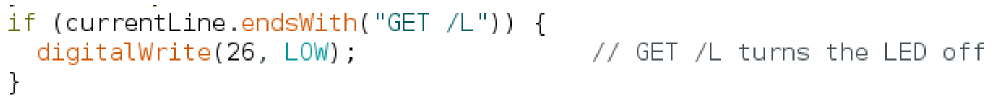
e. The client.print function sends data in HTML format to the local host and this HTML input is read by the browser to show the output on screen as if it's an HTML document. Note that here you do not have an HTML doc. This is just done by passing HTML codes to your local host using client.print.



```
if (c == '\n') {                    // if the byte is a newline character
  // if the current line is blank, you got two newline characters in a row.
  // that's the end of the client HTTP request, so send a response:
  if (currentLine.length() == 0) {
    // HTTP headers always start with a response code (e.g. HTTP/1.1 200 OK)
    // and a content-type so the client knows what's coming, then a blank line:
    client.println("HTTP/1.1 200 OK");
    client.println("Content-type:text/html");
    client.println();
    // the content of the HTTP response follows the header:
    client.print("<h1>Click <a href=\"/H\">here</a> turn the LED on</h1><br>");
    client.print("<h1>Click <a href=\"/L\">here</a> turn the LED off<h1><br>");
    // The HTTP response ends with another blank line:
    client.println();
    // break out of the while loop:
    break;
  } else {    // if you got a newline, then clear currentLine:
    currentLine = "";
  }
} else if (c != '\r') {  // if you got anything else but a carriage return character,
  currentLine += c;      // add it to the end of the currentLine
}
```

f. Look into the request from the client to light the LED and buzz Buzzer.

g. Here /L creates a next page to the link. Suppose you get 10.62.35.34 as your localIP. The above snippet will make 10.62.35.34/L as a webpage that shows that currently output is on LOW.



```
if (currentLine.endsWith("GET /L")) {
  digitalWrite(26, LOW);                // GET /L turns the LED off
}
```

Similarly use ("GET /H") for HIGH

h. Use client.stop(); to stop connection from the existing client and print on serial monitor.

Expected output:

You must make links (or Buttons) for controlling LED and Buzzer on a webpage using HTML. Pseudocode is just for your ease to understand what is to be done. Deviating from pseudocode but still fulfilling the requirements won't incur any penalty.

Experiment Part 0: Turn your localIP or localhost into a global link using 3rd party applications:

Ngrok provides a real-time web UI where you can introspect all HTTP traffic running over your tunnels. Replay any request against your tunnel with one click.

https://ngrok.com/ for documentation.

Steps:

1. Signup for ngrok.
2. Look into https://dashboard.ngrok.com/get-started/setup for setup.
3. Create a link from running in the command terminal
   `./ngrok http <your local ip>`
   For example `./ngrok http 10.62.35.34`
4. Send the link to your respective TA to get your setup verified.

If you face difficulties in using ngrok, you may use other applications like localtunnel etc. Please see their documentation.