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CpE 403:1001

December 13, 2017

IOT WITH VIBRATIONAL SENSORS

PROBLEM STATEMENT:

The problem was that laundry was being left in the washer or dryer for longer than needed because the owner had forgotten to gather them. To remedy this a reminder of the laundry status had to be sent. Thus, the goal of this project was to inform the user via email, when the laundry was finished. To check if the washing machine was on, a vibration sensor can be used. When connected to a microcontroller the amount of vibration coming from the washer can be detected. This way when the vibrations begin we know the machine is running. When the vibrations stop we know that the washer is done. This is when the microcontroller would send a message to the BeagleBone Black. The BeagleBone would in turn send an email out to the user. While this project could have been accomplished with a single microcontroller the BeagleBone was included to allow the project to expand to accommodate more nodes.

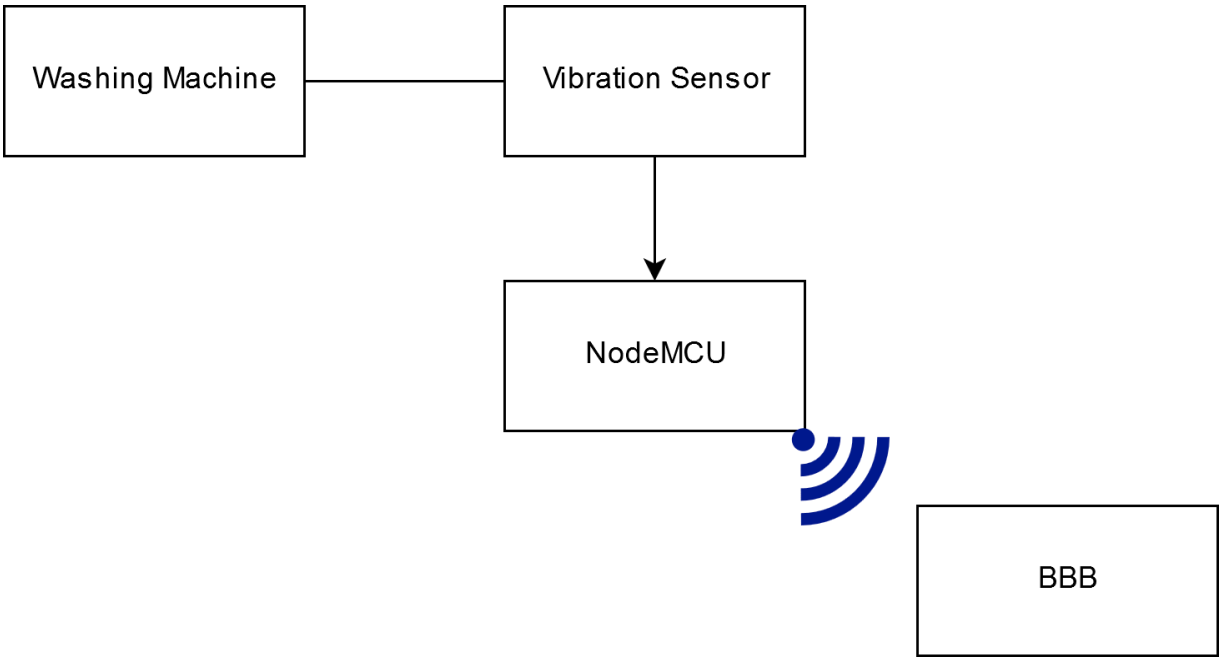

Fig. 1. Block Diagram for Project

PRE-REQUISITES:

Before the BeagleBone can be used as a condenser it must first be installed with an MQTT broker like Mosquitto. To do this we must first get the right debian repository by adding "deb http://httpredir.debian.org/debian stretch main contrib non-free" to the list of sources located in /etc/apt/sources.list. Then the following commands must be run:

apt-get update
apt-get install mosquitto
apt-get install mosquitto-clients

Afterwards the Debian repository we added earlier must be removed or commented out. Then the Mosquitto configuration file located at /etc/mosquitto/mosquitto.conf must be edited and the following lines added:

allow_anonymous true
listener port 1883

The first line allows new connections without requiring a log in. The second line sets he default port to listen on. After these steps the BeagleBone must be restarted to allow the new configuration to be enabled and to start the MQTT server.

The NodeMCU's setup requires installing the following Arduino libraries:

ESP8266 HttpClient
ESP8266 WiFi
Adafruit MQTT Library
PubSubClient

With these libraries the NodeMCU can automatically connect to the wifi with a given ssid and password as well as send messages to the MQTT server.

IMPLEMENTATION DETAILS:

BeagleBone:

The BeagleBone's server is created by running a bashscript. What this script does is listen on the default port for topic labeled "wash" and looks for the message "wash". The server is also setup to close as soon as it receives a message so that the output can be piped into grep. This is done with this command: `mosquitto_sub -t wash -C 2 | grep "wash";`

When this command returns a non-null string then Wash is printed to the screen and an email sent. As shown below:

```
echo "Wash"
cat wash.txt | sendmail -t
```

These steps are looped infinitely until the scrip is closed. To expand the server to accomidate for more nodes all that must be added is more "if" commands using grep. This way the script could check for both washer and dryer.

NodeMCU:

The NodeMCU code uses multiple define parameters to allow the code to be changed easily for a new user. Before the setup can take place a Mosquitto client must be created with the following commands:

```
WiFiClient espClient;
PubSubClient client(espClient);
```

The setup for the code begins by initializing UART with a baudrate of 9600. Then connecting the client to a host server with this command:

```
client.setServer(HOST, PORT); //connect to server
```

The wifi connection is created by doing the following:

```
WiFi.begin(WIFI_SSID, WIFI_KEY);
```

The vibration sensors adc value is taken 10 times and averaged over the course of 100ms. This value is then compared an experimentally obtained vibration level 50. While the value is below 50 it continues to be checked until it finally goes over 50. When a value over 50 is obtained this

means that the washer has started its spin cycle. Now the value is continuously checked until it goes under 50 again. When this occurs that means the washing machine is done and must be put into the dryer. The following lines accomplish this:

```
while (vibrationvalue <50){
  sensor_average(vibrationvalue);
  delay(10000);
}
while (vibrationvalue >= 50){
  sensor_average(vibrationvalue);
  delay(10000);
}
```

When these two while loops are completed then we know the washing machine is done so a message must be sent to the BeagleBone to email the users. So a connection to the Mosquitto server must be created and checked. If the connection is not successful, then an error is printed, and the attempted message is discarded. Should the connection be successful then the message "wash" is sent with the topic "wash". The following steps are shown below:

```
if(client.connect("ESP8266Client")) //set client
  Serial.println("connected");
Serial.println("loop");
if(client.loop()) //if connected
  {
  Serial.println("publishing");
  client.publish(topic, "wash", true); //send wash
  Serial.println("Publishing done");
  }
else
  Serial.println("error not connected");
```

OUTCOMES, RESULTS AND CONCLUSIONS:

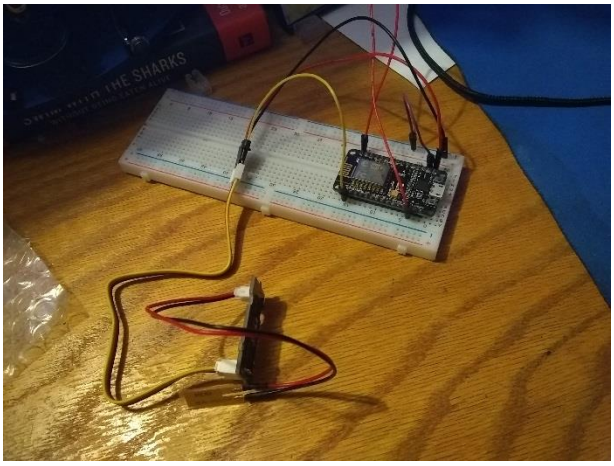

Fig. 2. Setup of the NodeMCU and Vibration sensor sitting on desk.

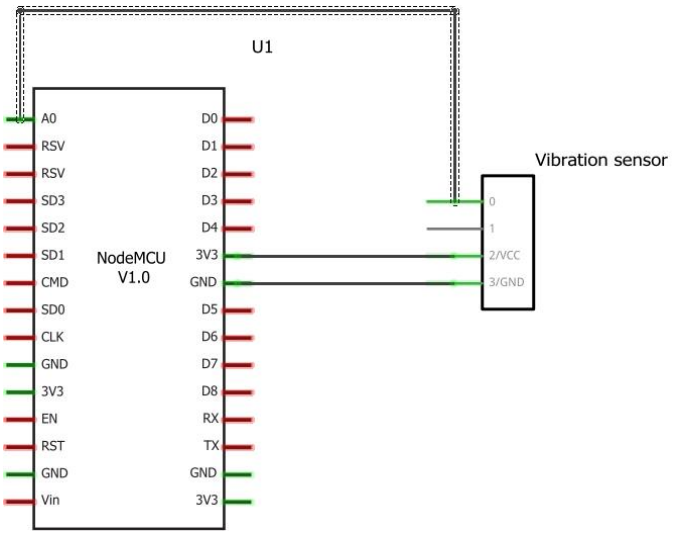

Fig. 3. Setup of the NodeMCU and Vibration showing pin connections

Fig. 4. The BeagleBone connected with power and ethernet.

The project as a whole was a success, but it did have a problem. While the vibration sensor could pick up the vibrations caused by the washer, it could only do so when placed between the lid and the frame. If the sensor was attached anywhere else, it would not function. This can be problematic as the sensor could be splashed with water and it is unknown if the sensor is water proof.

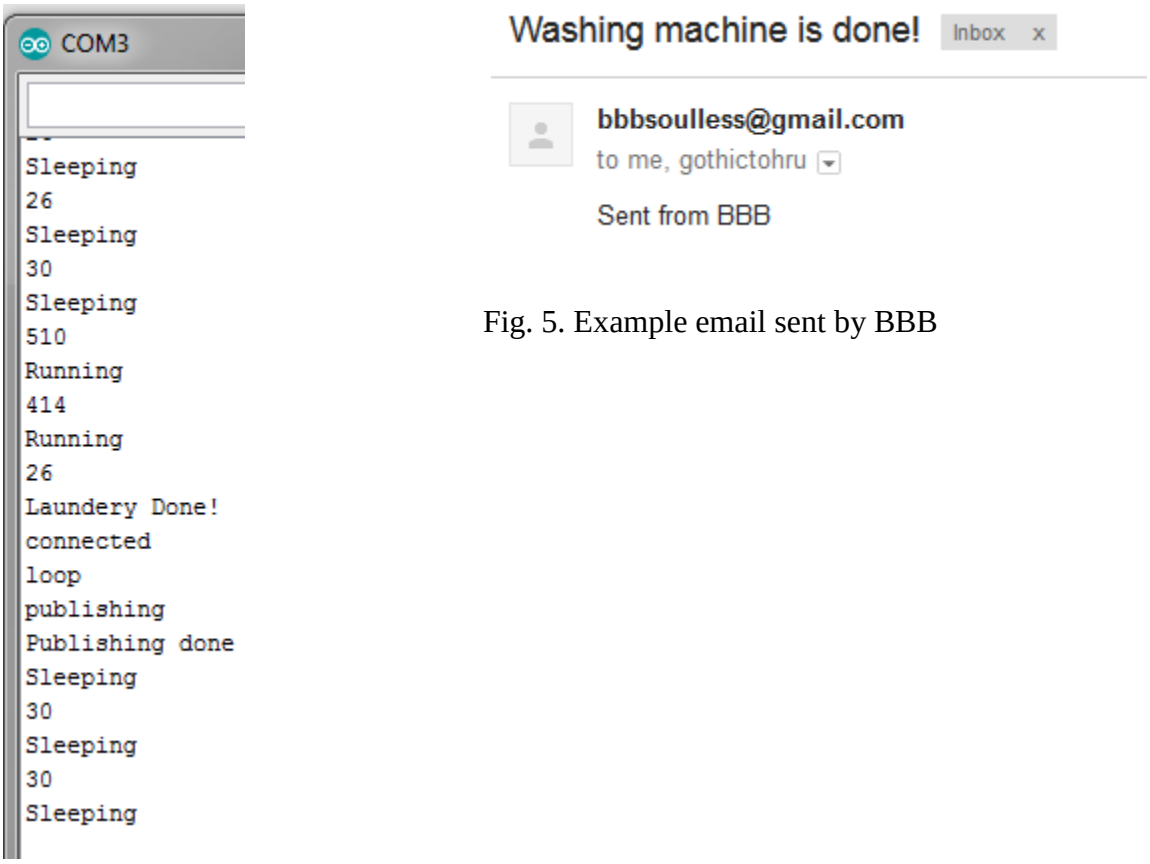

Fig. 5. Example email sent by BBB

Fig. 6. Output of NodeMCU showing low and high vibrations then sending a MQTT message

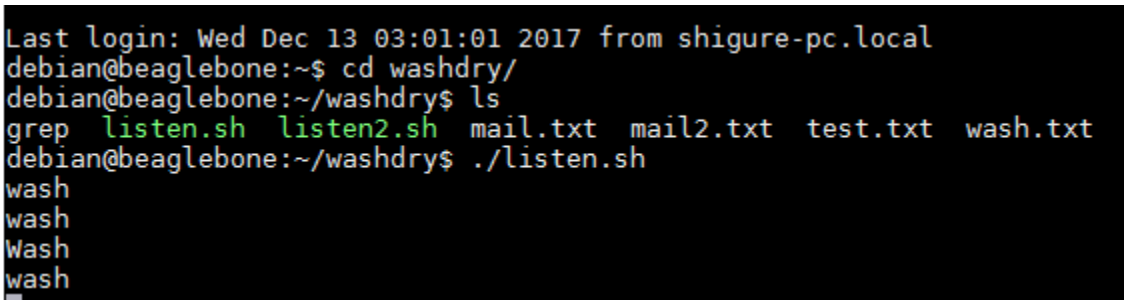

Fig. 7. BBB running the created script and displaying outputs.

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