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GitHub Link: <https://github.com/Felix-Jr056/TECHIN514A-Wi26.git>

Screenshot of serial monitor displaying the number of Bluetooth devices detected using MCU as BLEScanner

The screenshot shows the Visual Studio Code interface with the following details:

- EXPLORER**: Shows the project structure for "Wireless BLE".
- main.cpp** is the active file in the **EDITOR**.
- TERMINAL**: Displays the output of the "platformio device monitor" task, listing 131 discovered Bluetooth devices.
- OUTPUT**: Shows build logs.
- DEBUG CONSOLE**: Shows build logs.
- PORTS**: Shows serial port configuration.
- PROBLEMS**: Shows no problems.
- Build Task**: PlatformIO Device Monitor.
- Upload Task**: PlatformIO Device Monitor.
- zsh Wireless**: PlatformIO Device Monitor.
- PlatformIO Device Monitor**: PlatformIO Device Monitor.
- PlatformIO Device Monitor**: PlatformIO Device Monitor.

```
#include <Arduino.h>
#include <BLEDevice.h>
#include <BLEUtils.h>
#include <BLEScan.h>
#include <BLEAdvertisedDevice.h>

int scanTime = 5; //In seconds
BLEScan* pBLEScan;

class MyAdvertisedDeviceCallbacks: public BLEAdvertisedDeviceCallbacks {
public:
    void onResult(BLEAdvertisedDevice advertisedDevice) {
        Serial.printf("Advertised Device: %s\n", advertisedDevice.toString().c_str());
    }
};

void setup() {
    Serial.begin(115200);
    Serial.println("Scanning...");
    BLEDevice::init("");
    pBLEScan = BLEDevice::getScan(); //create new scan
    pBLEScan->setAdvertisedDeviceCallbacks(new MyAdvertisedDeviceCallbacks());
    pBLEScan->setActiveScan(true); //active scan uses more power, but get results faster
    pBLEScan->setInterval(100);
    pBLEScan->setWindow(99); // less or equal setInterval value
}

void loop() {
```

Advertised Device: Name: , Address: 5b:37:f2:8d:4d:b9, manufacturer data: 4c001608003798a6e7f57a2e, rssi: -87
Advertised Device: Name: , Address: 46:e9:64:f0:4c:78, manufacturer data: 4c001005731c659b7, txPower: 0, rssi: -87
Advertised Device: Name: , Address: 04:4b:ed:b5:49:3b, manufacturer data: 4c001005801438a9b1, txPower: 12, rssi: -97
Advertised Device: Name: , Address: ebe7:fe:ab:7c:c6, manufacturer data: 4c0012020001, rssi: -95
Advertised Device: Name: , Address: 4b:83:a:f:df:b7:a6, manufacturer data: 4c0009081366ba12c9591b58160800f1354856b2ef18, rssi: -99
Advertised Device: Name: , Address: 70:a1:63:11:1b:89, manufacturer data: 4c0010073a1f43db2cbf38, txPower: 8, rssi: -10
Advertised Device: Name: , Address: cb:60:d3:5a:f:c:68, manufacturer data: 4c0012020002, rssi: -92
Advertised Device: Name: , Address: d4:9e:bd:7a:6d:b1, manufacturer data: 4c0012020003, rssi: -93
Advertised Device: Name: , Address: dd:07:b3:c8:95:3f, manufacturer data: 4c0012026420711069a9924a40b6912a6985ed9d132621620, rssi: -92
Advertised Device: Name: , Address: d9:0c:3d:b8:82:10, manufacturer data: 4c0012020003, rssi: -95
Advertised Device: Name: , Address: cc:2b:76:72:f0:9d, manufacturer data: 4c0012020000, rssi: -98
Advertised Device: Name: , Address: 68:f5:63:a6:d8:99, manufacturer data: 4c0012020041df163378, txPower: 12, rssi: -98
Advertised Device: Name: , Address: 68:f5:63:a6:d8:99, manufacturer data: 4c0012020000, rssi: -87
Advertised Device: Name: , Address: cd:53:1b:57:c8:91, manufacturer data: 4c0012020002, rssi: -94
Advertised Device: Name: , Address: e1:72:91:d0:3f:de, manufacturer data: 4c0012020002, rssi: -96
Advertised Device: Name: , Address: 68:ae:41:ee:a4:49, manufacturer data: 4c001005341cd7ae1, txPower: 12, rssi: -93
Advertised Device: Name: , Address: e8:a0:e0:19:c:25, manufacturer data: 4c0012020001, rssi: -86
Advertised Device: Name: , Address: 04:4b:ed:b5:a8:ea, manufacturer data: 4c0010050110b28bba, txPower: 12, rssi: -95
Devices Found: 131
Scan done!

Screenshot of the serial monitor of client device to show a successful connection with server device.

The screenshot shows the terminal window of VS Code with the following output:

```
* Executing task: platformio device monitor
Device Name: Yuwen and Yunxiao
Forming a connection to 98:3d:ae:ac:0c:f2
- Created client
- Connected to server
- Found our service
- Found our characteristic
The characteristic value was: Hello World
We are now connected to the BLE Server.
Setting new characteristic value to "Time since boot: 51"
Notify callback for characteristic 471cb5b7-a5a9-4a19-a309-401ae5e95733 of data length 11
data: Hello World
Setting new characteristic value to "Time since boot: 52"
Notify callback for characteristic 471cb5b7-a5a9-4a19-a309-401ae5e95733 of data length 11
data: Hello World
Setting new characteristic value to "Time since boot: 54"
Notify callback for characteristic 471cb5b7-a5a9-4a19-a309-401ae5e95733 of data length 11
data: Hello World
Setting new characteristic value to "Time since boot: 55"
Notify callback for characteristic 471cb5b7-a5a9-4a19-a309-401ae5e95733 of data length 11
data: Hello World
```

Screenshot of the serial monitor of server device to show the raw and denoised sensor data.

The screenshot shows the PlatformIO IDE interface. The top navigation bar includes tabs for PIO Home, main.cpp (active), main2.cpp, and platformio.ini. Below the tabs, the code editor displays C++ code for a BLE server. The code defines a BLE server, characteristics, and a buffer for sensor data. It also includes definitions for HC-SR04 pins, sensor raw and denoised distance calculations, moving average filter parameters, and distance thresholds. A custom service UUID is defined as "471cb5b7-a5a9-4a19-a309-401ae5e95733". The bottom part of the interface features a terminal window showing the output of the 'platformio device monitor' task. The terminal logs numerous BLE transmission events for distances ranging from 10.12 cm to 258.88 cm. On the right side, there are icons for Build, Upload, and Monitor.

```
src > C:\main.cpp [bufferIndex]
8 BLEServer* pServer = NULL;
9 BLECharacteristic* pCharacteristic = NULL;
10 bool deviceConnected = false;
11 bool oldDeviceConnected = false;
12 unsigned long previousMillis = 0;
13 const long interval = 1000;
14
15 // HC-SR04 Pin Definitions for XIAO ESP32C3
16 // D0 = GPIO2, D1 = GPIO3
17 #define TRIG_PIN 2 // D0 on XIAO ESP32C3
18 #define ECHO_PIN 3 // D1 on XIAO ESP32C3
19
20 // Sensor readings and processed data
21 float rawDistance = 0.0;
22 float denoisedDistance = 0.0;
23
24 // Moving Average Filter parameters
25 #define FILTER_SIZE 5
26 float distanceBuffer[FILTER_SIZE];
27 int bufferIndex = 0;
28 bool bufferFilled = false;
29
30 // Distance threshold for BLE transmission (in cm)
31 #define DISTANCE_THRESHOLD 30.0
32
33 // Custom UUIDs for this device
34 #define SERVICE_UUID "471cb5b7-a5a9-4a19-a309-401ae5e95733"
35 #define CHARACTERISTIC_UUID "471cb5b7-e5a0-4a10-a200-401ae5e05722"
PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL PORTS + ... | ☰ x
* Executing task: platformio device monitor
Duration: 15695 us | Raw Distance: 258.88 cm | Denoised Distance: 60.05 cm
Duration: >= 30cm or invalid, not transmitting via BLE
Duration: 756 us | Raw Distance: 12.97 cm | Denoised Distance: 62.65 cm
Duration: >= 30cm or invalid, not transmitting via BLE
Duration: 657 us | Raw Distance: 12.27 cm | Denoised Distance: 62.29 cm
Duration: >= 30cm or invalid, not transmitting via BLE
Duration: 681 us | Raw Distance: 11.68 cm | Denoised Distance: 61.93 cm
Duration: >= 30cm or invalid, not transmitting via BLE
Duration: 664 us | Raw Distance: 11.39 cm | Denoised Distance: 61.24 cm
Duration: >= 30cm or invalid, not transmitting via BLE
Duration: 629 us | Raw Distance: 10.79 cm | Denoised Distance: 11.62 cm
BLE Notify - Distance: 11.62 cm (< 30cm threshold)
Duration: 618 us | Raw Distance: 10.60 cm | Denoised Distance: 11.14 cm
BLE Notify - Distance: 11.14 cm (< 30cm threshold)
Duration: 594 us | Raw Distance: 10.19 cm | Denoised Distance: 10.93 cm
BLE Notify - Distance: 10.93 cm (< 30cm threshold)
Duration: 563 us | Raw Distance: 9.66 cm | Denoised Distance: 10.52 cm
BLE Notify - Distance: 10.52 cm (< 30cm threshold)
Duration: 596 us | Raw Distance: 10.12 cm | Denoised Distance: 10.27 cm
BLE Notify - Distance: 10.27 cm (< 30cm threshold)
Build T... ✘
Upload... ✓
Monitor... ☰
```

Screenshot of the serial monitor of client device to show the current, maximum, and minimum data transmitted from server device.

The screenshot shows the Visual Studio Code (VS Code) interface with the following details:

- Explorer:** Shows the project structure under "XIAO-BLUETOOTH-CLIENT".
- Editor:** The main editor displays the file "main.cpp" with code related to BLE services and characteristics.
- Terminal:** The terminal window shows the output of a task named "platformio device monitor". It displays distance data received from a device:
 - Distance Data Received
Data Count: 8
Current Distance: 11.14 cm
Maximum Distance: 11.62 cm
Minimum Distance: 2.61 cm
 - Distance Data Received
Data Count: 9
Current Distance: 10.93 cm
Maximum Distance: 11.62 cm
Minimum Distance: 2.61 cm
 - Distance Data Received
Data Count: 9
Current Distance: 10.52 cm
Maximum Distance: 11.62 cm
Minimum Distance: 2.61 cm
 - Distance Data Received
Data Count: 10
Current Distance: 10.27 cm
Maximum Distance: 11.62 cm
Minimum Distance: 2.61 cm
- Sidebar:** A sidebar on the right says "Build with Agent" with a message: "AI responses may be inaccurate. Generate Agent Instructions to onboard AI onto your codebase."
- Status Bar:** The status bar at the bottom shows the current file is "Default (xiao-bluetooth-client)", and the code editor settings are set to "Auto".