Indoor Position with IVY5661 96Boards

Bo Dong
bdong@ucrobotics.com
96boards@ucrobotics.com
Agenda

1. Brief introductions
2. About IVY5661
3. IVY5661 Indoor Position Solution
4. Use cases
5. Demo
uCRobotics is a Hi-tech company which focuses on Intelligent Platform, System Integration, and the development of Embedded System, etc.

1. Brief Introduction
   What is uCRobotics?

   uCRobotics is the manufacturer of Bubblegum-96 which is the 4th intelligence development platform based on the Linaro Standard.

   3D cloud printing solution, Robotics solution, big data solution

   Contribution in open source projects
IVY5661 IE 96Boards

Powered by Unisoc Connectivity SoC UWP5661
## 2. About IVY5661

**Specification**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SoC</strong></td>
<td>UWP5661@28nm</td>
</tr>
<tr>
<td><strong>CPU</strong></td>
<td>ARM Cortex-M4 Dual Core</td>
</tr>
<tr>
<td><strong>Clock freq</strong></td>
<td>416MHz</td>
</tr>
<tr>
<td><strong>Storage</strong></td>
<td>32Mbit</td>
</tr>
<tr>
<td><strong>Wi-Fi</strong></td>
<td>IEEE802.11ac 2x2</td>
</tr>
<tr>
<td><strong>Bluetooth</strong></td>
<td>Bluetooth 5</td>
</tr>
<tr>
<td><strong>USB</strong></td>
<td>2 x Micro USB</td>
</tr>
<tr>
<td><strong>Expansion Interface</strong></td>
<td>UART/I2C/SPI/I2S/GPIO</td>
</tr>
<tr>
<td><strong>LED</strong></td>
<td>4 user LED</td>
</tr>
<tr>
<td><strong>Button</strong></td>
<td>2 reset and user button</td>
</tr>
<tr>
<td><strong>Power Source</strong></td>
<td>Micro USB</td>
</tr>
<tr>
<td><strong>OS Support</strong></td>
<td>Zephyr</td>
</tr>
<tr>
<td><strong>Size</strong></td>
<td>60 x 30mm</td>
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</table>
Connect smart phone and IVY5661 through Bluetooth. Configure IVY5661 to link it with known Wi-Fi router and set the password and ssid for the Wi-Fi channel which is broadcasted by IVY5661.
Bluetooth mesh networking enables many-to-many (m:m) device communications and is optimized for creating large-scale device networks. It is ideally suited for building automation, sensor network, asset tracking, and other IoT solutions that require tens, hundreds or thousands of devices to communicate with one another.
With UniSoC UWP5661 inside and Zephyr deployed, IVY5661 can be used in intelligent household, IP camera, repeater Wi-Fi amplifier. We used Wi-Fi on IVY5661 to make indoor position happened.
3. IVY5661 Indoor Position Solution

Theory

- How to get the distance between STA and AP?
  - Through RTT (Run-Trip Time) protocol.
3. IVY5661 Indoor Position Solution

Theory

- You can use the Wi-Fi location functionality provided by the Wi-Fi RTT (Round-Trip-Time) API to measure the distance to nearby RTT-capable Wi-Fi access points and peer Wi-Fi Aware devices.
- If you measure the distance to three or more access points, you can use a multilateration algorithm to estimate the device position that best fits those measurements. The result is typically accurate within 1-2 meters.
3. IVY5661 Indoor Position Solution

Theory

Relative distance : d1 meter
Known

Relative distance : d2 meter
Known

Relative distance : d3 meter
Known
3. IVY5661 Indoor Position Solution

Theory

\[(x1-x)^2+(y1-y)^2=d1^2\]
\[(x2-x)^2+(y2-y)^2=d2^2\]
\[(x3-x)^2+(y3-y)^2=d3^2\]
3. IVY5661 Indoor Position Solution

Implement

```c
aberr = 0;
do {
  for (i = 0; i <= 2 * la; i++) {
    for (j = 0; j <= 2 * lb; j++) {
      if (cax_abeyance1[i] == cbx_abeyance1[j]) {
        if ((cay_abeyance1[i] > (cby_abeyance1[j] - aberr - abcerr)) &&
            (cby_abeyance1[j] + aberr + abcerr)) {
          cabx_abeyance1[abrequery] = cax_abeyance1[i];
          caby_abeyance1[abrequery] = cay_abeyance1[i];
          abrequery++;
        }
      }
    }
  }
  if (abrequery < loopnum) aberr++;
} while (abrequery < loopnum);
```
3. IVY5661 Indoor Position Solution

Implement

do
{
    for(i = 0; i <= 2*la; i++)
    {
        for(j = 0; j <= 2*lc; j++)
        {
            if(cax_abeyance1[i] == ccx_abeyance1[j])
            {
                if((cay_abeyance1[i] > (ccy_abeyance1[j] - acerr - abcerr)) && (cay_abeyance1[i] < (ccy_abeyance1[j] + acerr + abcerr)))
                {
                    cacx_abeyance1[acrequery] = cax_abeyance1[i];
                    cacy_abeyance1[acrequery] = cay_abeyance1[i];
                    acrequery++;
                }
            }
        }
    }
}
3. IVY5661 Indoor Position Solution

Implement

for(i = 0;i < abrequery;i++)
{
    for(j = 0;j < acrequery;j++)
    {
        if(cabx_abeyance1[i] == cacx_abeyance1[j])
        {
            requery1 = 1;
            printf("final result is (%f,%f)\n",cabx_abeyance1[i],caby_abeyance1[i]);
            put_coordinate(cabx_abeyance1[i],caby_abeyance1[i]);
        }
    }
    if(requery1 == 0)
    {
        loopnum++;
        abcerr++;
    }
    if(loopnum == 10)
    {
        printf("check input figure is right\n");
    }
} while(requery1 ==0);

printf("finish\n");
3. IVY5661 Indoor Position Solution

- Support three dimension position.
  - Provide space position to implement positioning with different floor.
- Deploy with access points swarm.
  - Redundant ranging data processing
- Improve ranging data accuracy.
  - Bluetooth RSS position as reference
  - Location data smoothing

To be continued
3. IVY5661 Indoor Position Solution

- Easy to deploy
- Low Cost
4. Indoor Position Solution Use Cases

Shopping Mall & Airport

Shopping Mall

Airport & Train station
4. Indoor Position Solution Use Cases

Industrial Scene
4. Indoor Position Solution Use Cases

Robotics

➔ Original: Use depth image based VSLAM to position.
  ● Works well in small area.
  ● Failed to localization in large area, for example, airport.

➔ Improved: Use IVY5661 indoor position system to navigate between big scenes. Then use VSLAM to navigate accurately in a specificate area.
Thank you

Bo Dong
bdong@ucrobotics.com
96boards@ucrobotics.com
https://github.com/uCRDev