Linux sensor device driver programming with 96Boards

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Preview

• 5 min – ROHM Semiconductor, the company introduction
• 5 min – Basic for Sensor UPM driver
• 5 min – Basic for Sensor Input driver and Android HAL driver
• 5 min – Basic for Sensor IIO driver
• 5 min – Giveaway – Rohm’s sensor Mezzanine board

Goal of this session
To share the overview of several options to implement sensors on 96Boards.
ROHM Semiconductor, the company introduction
| IC                  | Memory                  | Sensors & MEMS          |
|                    | Amplifiers & Linear     | Display Drivers         |
|                    | Power Management        | Motor / Actuator Drivers|
|                    | Clocks & Timers         | Interface / Communication|
|                    | Switch & Multiplexer & Logic | Audio & Video          |
|                    | Data Converter          |                          |

<table>
<thead>
<tr>
<th>Discrete Semiconductor</th>
</tr>
</thead>
<tbody>
<tr>
<td>SiC(Silicon carbide) Devices</td>
</tr>
<tr>
<td>IPMs</td>
</tr>
<tr>
<td>Transistors(Bipolar, MOSFET, IGBT)</td>
</tr>
<tr>
<td>Diodes</td>
</tr>
<tr>
<td>LEDs / LED Displays</td>
</tr>
<tr>
<td>Laser Diodes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Passive / Module</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resistors</td>
</tr>
<tr>
<td>Tantalum Capacitors</td>
</tr>
<tr>
<td>Optical Sensors</td>
</tr>
<tr>
<td>IrDA / Remote Control Receiver Modules</td>
</tr>
<tr>
<td>Power Modules</td>
</tr>
<tr>
<td>Wireless Communication Modules</td>
</tr>
<tr>
<td>Contact Image Sensor Heads</td>
</tr>
<tr>
<td>Printheads</td>
</tr>
</tbody>
</table>
Finland Software Development Center

Located in Oulu, Finland, "the Nordic Silicon Valley".

- Software R&D team for all ROHM products
- 17 experts
- Supporting customers globally

<table>
<thead>
<tr>
<th>Drivers</th>
<th>GUI/CLI Apps</th>
<th>Algorithm</th>
<th>Hardware</th>
</tr>
</thead>
</table>
| ▪ MCU/DSP firmware  
  ▪ Real Time OS drivers  
  ▪ Linux kernel drivers  
  ▪ Android HAL drivers  
  ▪ Windows UMDF drivers  
  ▪ Sensor Hub drivers  
  ▪ ARM mbed drivers  
  ▪ Arduino libraries  
  ▪ Logo certifications | ▪ Windows GUI Apps  
  ▪ Android GUI Apps  
  ▪ Python based CLI applications  
  ▪ Windows console applications  
  ▪ Linux console applications | ▪ Python based prototyping  
  ▪ Matlab based modelling  
  ▪ Big data and Machine learning based development  
  ▪ System-C based ASIC development | ▪ Evaluation board design and manufacturing  
  ▪ 3D model mechanics design and manufacturing  
  ▪ System evaluation |

Open Source Distribution site in GitHub
https://github.com/RohmSemiconductor
## Software related devices in ROHM

### Sensors
- Accelerometer
- Gyroscope
- Magnet sensor
- Barometer
- Heart rate sensor
- Sonar sensor
- Light sensor
- RGB sensor
- Proximity sensor
- Hall sensor
- Temperature sensor

### Actuators
- Optical image stabilizer
- Lens control driver
- Auto focus driver
- LED driver
- Piezo inkjet driver

### Powers
- Power Management IC for Intel Core/Atom
- Power Management IC for NXP iMX
- Power Management IC for Renesas R-Car
- Battery charger
- Coulomb counter
- Wireless power charger

### Interfaces
- Display timing controller
- USB2.0/3.0
- NFC
- Wi-Fi
- Bluetooth 4/5
- Sub-GHz radio
- Cellular IoT
Basic for Sensor UPM driver
UPM Driver - Overview


- UPM runs in user space and it access hardware via APIs of MRAA, [https://github.com/intel-iot-devkit/mraa](https://github.com/intel-iot-devkit/mraa)

- UPM and MRAA are originally developed by Intel, but it also supports a wide range of hardware such as ARM(96Boards), MIPS.

- MRAA is a C based Linux library for low speed I/O communication with bindings for C++, Python, Node.js & Java.
UPM/MRAA in system block diagram

- **app**
  - Sensor UPM driver
  - C/C++
  - python
  - java
  - node.js
  - UPM
  - MRAA

- **user**
  - SPI
  - I2C
  - GPIO
  - SPI subsys
  - I2C subsys
  - GPIO subsys

- **kernel**
  - SPI
  - I2C
  - GPIO

- **hw**
  - Physical sensor
  - I2C/SPI/GPIO
  - 96board
How to implement UPM/MRAA on 96Boards

• "Programing I2C devices with libmraa and libupm"
  https://www.96boards.org/blog/programing-i2c-devices-libmraa-libupm/

• “Our path to libmraa on 96Boards - Part 1“ - (from part-1 to part-7)
  https://www.96boards.org/blog/path-libmraa-96boards-part-1/

• Rohm UPM sensor drivers in GitHub.
  https://github.com/RohmSemiconductor/UPM-sensor-drivers
Basic for Sensor Input driver and Android HAL driver
Sensor Input driver and Android HAL driver - Overview

- Android provides “Sensor API” as well as “SensorManager”. However, the “Sensor HAL” and sensor drivers in Linux kernel are not provided by Android, so these two parts are needed in order to make sensors work.

- Input Subsystem in Linux kernel is a generic Linux framework for all input devices like keyboard, mouse, touchscreen, etc. It has been used for sensors as well. [https://www.kernel.org/doc/html/v4.12/input/index.html](https://www.kernel.org/doc/html/v4.12/input/index.html)

- Sensors became common devices in Linux based system, especially in smartphone, before Linux kernel prepare established APIs for sensors. It might be a reason why many sensor providers have been using Input Subsystem for sensors in Android.
Sensor Input driver in Android system

- **Framework**
  - Sensor API
    - Sensors HAL
      - Input
      - IIO
      - Custom

- **HAL**
  - Input
  - IIO subsys
  - Custom

- **Kernel**
  - Sensor Input driver

- **HW**
  - Physical sensor
  - I2C/SPI/GPIO
  - 96board

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Sensor HAL driver in Android system

**Framework**
- Sensor API
- Sensors HAL
- Input
- IIO
- custom

**HAL**
- Input subsys
- IIO subsys
- custom
- I2C/SPI/GPIO

**Kernel**
- Sensor Input driver
- Input subsys
- IIO subsys
- custom
- I2C/SPI/GPIO

**Hardware**
- Physical sensor
- 96board
- I2C/SPI/GPIO
How to implement Sensor Input driver and Android Sensor HAL driver on 96Boards


- Rohm’s Sensor Input drivers in GitHub https://github.com/RohmSemiconductor/Linux-Kernel-Input-Drivers
Basic for Sensor IIO driver
IIO, Industry Input and Output subsystem - Overview

• The IIO is intended to provide support for ADCs, DACs, and Sensors such as Accelerometers, Gyroscopes, Pressure sensors, Magnetometers, Color sensors, Light sensors, Proximity sensors, and so on.

• Hwmon subsystem and Input subsystem have been used for sensors, but Hwmon is very much directed at low sample rate sensors used in applications such as fan speed control and temperature measurement, and Input is originally focused on human interaction input devices. The overall aim of IIO seemed to be to fill the gap between the somewhat similar hwmon and input subsystems.
Sensor IIO driver in Android system

Frame
work

HAL

kernel

hw

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How to implement IIO driver and Android Sensor HAL driver on 96Boards

• Interfacing Grove Digital Light I2C Sensor Application Note,

• IIO driver for Rohm’s optical proximity sensor RPR-0521RS,
  https://git.kernel.org/pub/scm/linux/kernel/git/torvalds/linux.git/tree/drivers/iio/light/rpr0521.c?id=98c2f10d2366ec7128c254c775d4e6969a705ecd
Give away : Rohm Sensor mezzanine

• 96Boards compatible

• Support Rohm 5 pin sensor boards x 2 slots

• Support Kionix 14 pin sensor boards x 2 slots

• Support Grove sensors x 2 slots

• Not in sales, just for Linaro Connect 2019
Rohm 5 pin sensor boards

- Heart rate sensor BH1792GLC
  - [https://www.rohm.com/sensor-shield-support/heart-rate-sensor2](https://www.rohm.com/sensor-shield-support/heart-rate-sensor2)
- Accelerometer KX224-1053
  - [https://www.rohm.com/sensor-shield-support/accelerometer](https://www.rohm.com/sensor-shield-support/accelerometer)
- Pressure sensor BM1383AGLV
  - [https://www.rohm.com/sensor-shield-support/pressure-sensor](https://www.rohm.com/sensor-shield-support/pressure-sensor)
- Magnetic sensor BM1422AGMV
  - [https://www.rohm.com/sensor-shield-support/magnetic-sensor](https://www.rohm.com/sensor-shield-support/magnetic-sensor)
- ALS and Prox RPR-0521RS
  - [https://www.rohm.com/sensor-shield-support/ps-als-sensor](https://www.rohm.com/sensor-shield-support/ps-als-sensor)
- Color sensor BH1749NUC
  - [https://www.rohm.com/sensor-shield-support/color-sensor](https://www.rohm.com/sensor-shield-support/color-sensor)
- Hall sensor BD7411G
  - [https://www.rohm.com/sensor-shield-support/hall-sensor](https://www.rohm.com/sensor-shield-support/hall-sensor)
- Temperature sensor BD1020HFV
  - [https://www.rohm.com/sensor-shield-support/temperature-sensor](https://www.rohm.com/sensor-shield-support/temperature-sensor)
Thank you so much!

Please see the team introduction video on Youtube.
https://www.youtube.com/watch?v=MQqmPvGkGRQ