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Research Article

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I2C Challenges in Stereo Camera Systems

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Abstract: Stereo cameras modules are built using two identical camera modules. These often will have the same I2C [1] address. Camera engineers often face the challenge of optimizing the startup latency for the cameras and the I2C writes of the camera configuration settings take significant time in the overall startup latency. In this paper we will explore techniques in dealing with modules with two sensors of the same type and various optimization techniques to reduce the overall startup latency.

Keywords: Stereo Camera, I2C

Introduction

Stereo camera modules are build using two identical camera modules. Most of these camera modules are programmed over I2C. This begs a question that if two of these modules are present on the same stereo module, they would have the same I2C addresses and in such cases how can the I2C host address them independently as they both would have the same I2C address. One may argue that same I2C address should work if they are stereo, but it purely depends on the host side receiver, like CSI2 and ISP. Refer to Figure 1 where a pair of stereo sensors are connected to the SoC. They both have individual reset lines but reside on the same I2C bus. There are many reasons to do this which will be described in the next session.

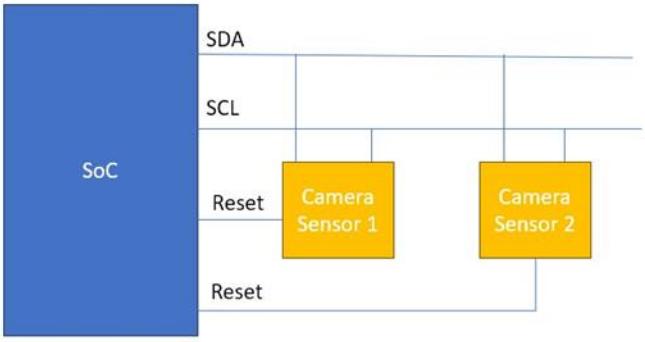

Figure 1: Stereo Camera Connection

Addressing

There are many ways to solve the issue of common addressing, few listed below:

• Place both cameras sensors on different I2C buses. In this case the same I2C address can be used but from different I2C buses. With this configuration however the chances to writing the same data to both sensors would involve invoking an I2C write on both buses.

• Using camera sensor's hardware pin setting to change one of the camera's device address. Such a facility (if available) by configuring certain hardware pins on the sensor to change its device address in hardware.

• Using the camera sensor's hardware SID pin setting to change one of the camera's device addresses. Such a facility (if available) by configuring certain hardware pins on the sensor to change its device address in hardware. For example, one of the sensor SID pins can be connected to logic low and another sensor SID pin can be connected to logic high to have two unique addresses for them.

• If either of the above options are not available, there is also a chance to change the address of one of the sensors using the procedure shown below:
– bring sensor 1 out of reset
–write an I2C register to change the device address
–bring sensor 2 out of reset
–address sensor 2 using it default address
The above steps need to be done every time the sensor is brought out of reset. If the two sensor drivers are independent, then some care must be taken to ensure that the reset sequence of the two drivers is synchronized in a way that the sensors get a unique address every time before use.
Many sensors (that know would be used in the stereo setup) often have a broadcast address. These addresses can be used for write only operation and could be used to program some common settings to both sensors. This is particularly helpful to speedily program the pair of stereo sensors at the same time. Note that read operation can't be performed on broadcast address as it violates the I2C bus convention.

Optimization Techniques
Camera software engineers can follow one or few of the following techniques to reduce the startup latency of the camera. Camera startup latency is the time it takes for the first frame to be delivered by the camera HAL from enabling it.
• Most camera sensors by default support 400 KHz I2C speeds. Some camera sensors support up to 1 MHz and in case if the camera sensor and the application processor supports 1 MHz, set the I2C bus speed to 1 MHz.
• Use I2C chaining. This helps to avoid wasting cycles and chain the I2C transactions together and saves I2C write time significantly.
• Recent camera sensors support I3C [2]. If the camera sensor supports I3C switch to I3C interface. Camera sensors with I3C support in the range of 12.5 MHz to 100 MHz.

Conclusion
There are many addressing options when it comes to stereo camera modules and most of them were discussed in this paper. Depending on the type of SoC and stereo camera modules, either one of the techniques may be used to address stereo camera systems.

References
[1]. "i2c." [Online]. Available: https://en.wikipedia.org/wiki/I%C2%B2C [2] "i3c." [Online]. Available: https://en.wikipedia.org/wiki/I3C (bus)