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Porting Android Oreo onto Imx6 Processor based Media Accelerated Graphics Innovation Kit with driving an SD card

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Abstract
Nowadays for the embedded devices use of android operating system has become current emerging trend in the market. The most widely used embedded device in industries which built with android OS is mobile phone. The advantage of using android OS compared to other OS is that, it is an open source and responds quickly to functional changes. It is becoming default OS for devices which requires the multimedia support. Porting of android onto ARM processor based platform is very necessary in order to bring the effectiveness of ARM and capability of android onto a product. The proposed work is to port android 8.0(oreo) onto iMX6 processor based Media Accelerated Graphics Innovation Kit (MAIK-II) and testing sd card interface for read or write process.

1. Introduction

Google has developed Android operating system based on linux platform. Nowadays the embedded systems are defined using real time operating system by specific vendors. The current market trend is to use android operating system for mobile phones, tablets etc. android is so popular because of its open source nature allowing user to build application using it and also modify the kernel as per the requirement. Further Google has developed unique products such as android wrist watches, android TVs and more devices each with a specific user interface.

ARM processor is the family of CPUs which is based on Reduced Instruction Set Architecture. The paper specifies the Media Accelerated Graphics Innovation Kit. It is used in many electronic devices such as tablets and smart phones. They require small sized integrated circuit due to their compressed instructions set such as SOC which reduce the memory management and power management constraint by inbuilt support. It has greater performance in terms of speed, cost and accuracy hence it is used in many different embedded applications.

An OS establishes required communication between processor, peripherals and memory to perform a task. In order to improve speed and performance Google updated different android versions and the latest version is 8.0 (oreo). The enormous growth of android OS made developers, to think of porting it onto other embedded platform which as powerful peripherals support and power management. To make use of portability of android, user started porting android OS onto ARM based module. Since android user interface is optimized for the touch display and it can be perfectly developed for the next generation smart devices. Also SD card interface for read or write can be tested with Graphics Innovation Kit. Hence the current work of porting android 8.0 onto a custom board has significant importance in building application in the area of automotive, multimedia and medical applications.

2. Android Architecture

Android is software stack that consists OS, middleware and key applications, which runs on linux based kernel. It is a bundle of packages consisting of linux kernel, HAL framework, application framework, applications. Hardware used is target MAIK-II module . Linux kernel part of architecture includes necessary drivers like display, audio HDMI, LVDS etc. The necessary display drivers is added at kernel level of architecture. LVDS is the display module used for target board with LDB driver which drives the display of resolution 1280 x 800 which also specifies the test passing of sd card.

HAL acts as intermediate between lower level and higher level of architecture. Module has package of library which defines version name and device defines particular hardware implemented. Libraries include set of C/C++ code for particular components. Developers can develop android application in application framework layer. In android architecture the top layer which defines all the basic applications is named as application layer

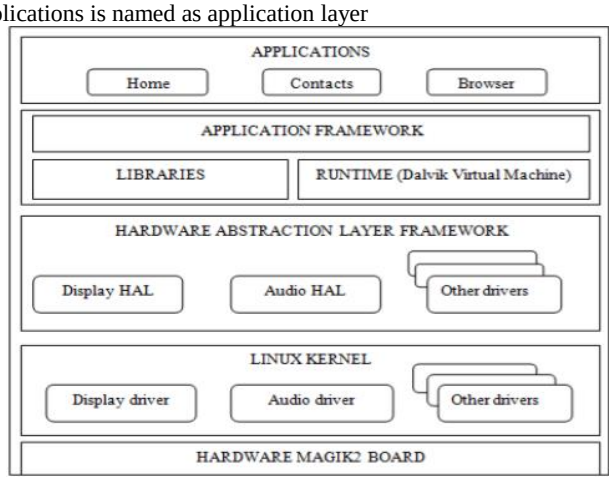

Fig 1: Block diagram of android architecture

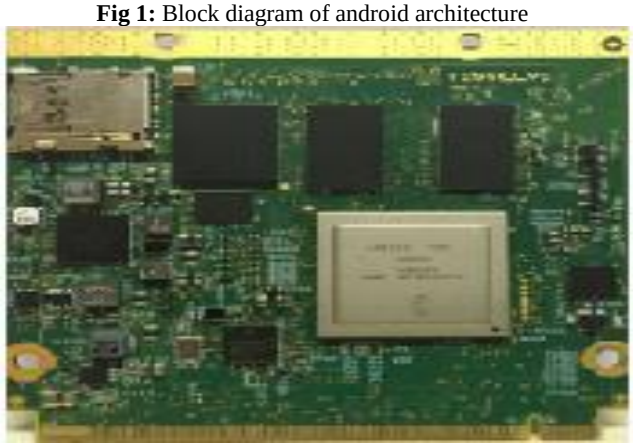

Fig.2: Photograph of Qseven system on module

3. Hardware Platform

3.1 Qseven Module

For porting oreo the target system on module used is Qseven which is a small integrated circuit board. It has many functional units. It also has many advantages as it reduces the cost of building base board and all its functional units. The specific advantage is that the board can be reused for other embedded applications by changing source code as per the target board requirement . The board consists of SOC processor, EMMC memory unit SD card and many peripheral interfaces. Fig 2 shows the photograph of MAGIK-II Qseven module. It has 70mm x 70mm diamension and it uses one 230 pin MXM edge connector to connect all power and signal lanes

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to the carrier board. The frequency of the processor is 1.2GHz, EMMC 4GB to 64 GB.

3.2 iMX6 Processor (SOC)

Processor iMX6 is a system on chip mounted on the Qseven module. The SOC is a small integrated circuit which has CPU and functional units onto the single chip. iMX6 processor is based on ARM cortex A9 reduced instruction set architecture . SOC includes specific number of cores, separate unit for multimedia and image processing, display and camera interface, internal memory, power management, controller and all the peripheral connectivity which are inbuilt such as EMMC, USB, Ethernet, UART, I2C, GPIO etc.LVDS also supported by SOC processor.

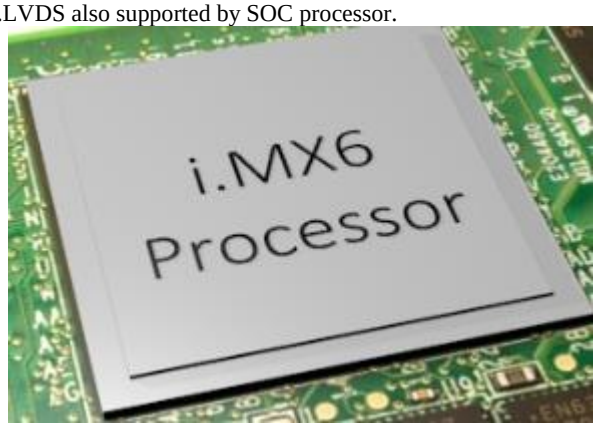

Fig 3: Photograph of iMX6 processor

3.3 Carrier Board

Carrier board is a base board on which SOM module is fixed wit the help of 230 pin MXM edge connector. Carrier board helps in developing end application device. Carrier borad is as shown in fig 4 which also includes other features such as CODEC, controller etc. this moduler approach allows high scalability, upgradability and fast time to market.

Fig 4: Photograph of carrier board

3.4 LVDS Display

LVDS display stands for low voltage differential signaling which is one of the peripheral unabled to carrier board with an ldb driver . It is a device which has low power and high speed for many video and graphics applications. It transmits information as the difference of two voltage on its two wires to the receiver . Proposed work is driving LVDS display of high resolution 1280 x 800 and test passing of SD card read or write process.

Fig 5: Photograph of LVDS display

3.5 Hardware Setup

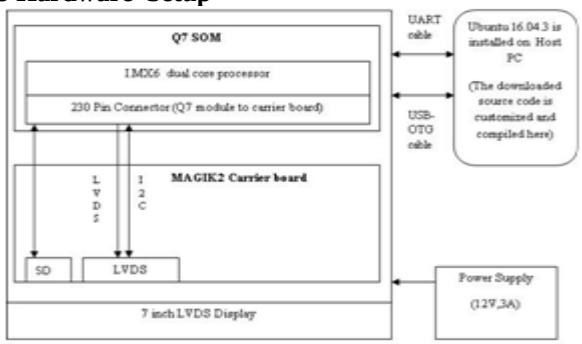

Fig 6: Hardware Setup for porting android

4. Software Implementation

Android porting has three phases as follows

i. Uboot Porting (2017.03)
ii. Linux kernel Porting (4.9.17)
iii. Android file system Porting (8.0)

Each above mentioned phases intern includes steps such as downloading the source code for each phase, extracting tool chain. Relevant changes are done in bootloader , after the customization as per the requirement bootloader is compiled and then the images generated is flashed to the target board.

4.1 Bootloader Porting

Since SABRESD is the reference board the following files are copied to the target board MAGIK-II and modified with following steps . The basic header file is added for magik2q7 from reference SABRESD board is copied to the magik2q7 board.

include/configs/magik2q7.h

The basic board level files are added for magik2q7

board/ freescale/magik2q7/ magik2q7.c
board/ freescale/magik2q7/ Kconfig
board/ freescale/magik2q7/mx6qp.cfg
board/ freescale/magik2q7/MAINTAINERS

The target board configuration is added to Kconfig file

vi arch/arm/cpu/armv7/mx6/Kconfig

```
-----------------------------------------------------------------
 config TARGET_MAGIK2Q7
 bool "Support mx6sabresd"
 select DM
 select DM_THERMAL
 source "board/freescale/magik2/magik2q7/Kconfig"
-----------------------------------------------------------------
```

Now changes in the target board magik2q7 directory includes,

cd board/freescale/magik2q7/

$ vi Kconfig

```
if TARGET_MAGIK2Q7
config SYS_BOARD
default "magik2q7"
config SYS_VENDOR
 default "magik2q7"
config SYS_SOC
  default "mx6"
config SYS_CONFIG_NAME
 default "magik2q7"
endif
$ vi Maintainers
-----------------------------------------------------------------------
M:    shriyanka<shriyaj028@gmail.com >
S:    Maintained
F:    board/freescale/MAGIK2Q7
F:    include/configs/magik2q7.h
F:    configs/magik2q7_defconfig
-----------------------------------------------------------------------
$ vi Makefile
```

The defconfig file is copied from the reference board and modified as,

```
$ vi configs/magik2q7_defconfig
-----------------------------------------------------------------------
CONFIG_SYS_EXTRA_OPTIONS="IMX_CONFIG=board/freescale/MAGIK2Q7/mx6qp.cfg,MX6QP,ANDROID_SUPPORT"
 # CONFIG_DM_PMIC=y
 # CONFIG_DM_PMIC_PFUZE100=y
 # CONFIG_DM_REGULATOR=y
 # CONFIG_DM_REGULATOR_PFUZE100=y
 # CONFIG_DM_REGULATOR_FIXED=y
 # CONFIG_DM_REGULATOR_GPIO=y
 # CONFIG_DM_ETH=y
 # CONFIG_DM_USB=y
-----------------------------------------------------------------
configuration written to .config
```

The path for compiling bootloader is as-
myandroid/Bootable/bootloader/uboot-imx

4.2 Compilation of source code

The steps involved for compilation of source code as follows.

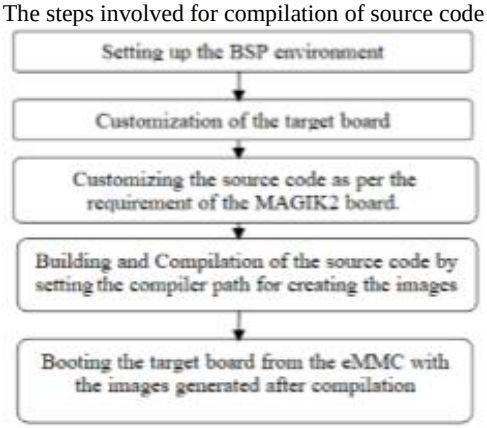

Fig 7: flowchart of compilation of source code

4.3 SD card Interface

Fig 8: Photograph of SD card

```
static iomux_v3_cfg_t const usdhc1_pads[] = {
MX6_PAD_SD1_CLK__SD1_CLK
MX6_PAD_SD1_CMD__SD1_CMD
MX6_PAD_SD1_DAT0__SD1_DATA0
MX6_PAD_SD1_DAT1__SD1_DATA1
MX6_PAD_SD1_DAT2__SD1_DATA2
MX6_PAD_SD1_DAT3__SD1_DATA3
 MX6_PAD_GPIO_1__SD1_CD_B
```

4.4 Flashing the Images

After the compilation of the source code the binary images generated are boot.imx, partion.img, recovery.img, system.img created are copied to MFG tool. OTG cable is connected between computer and targt module and 12V supply is given to the board. As soon as power flows the host systm displays a mssage HID device is detected, only when target board is detected as shown in fig 8. All the images are flashed.

5. Results

SD card test is performed by using different resolution images and video. Fig 9 shows image displayed on LVDS display clears the SD card test. If the image is displayed then it is clear that sd card reads properly. The test is assumed to be passed.

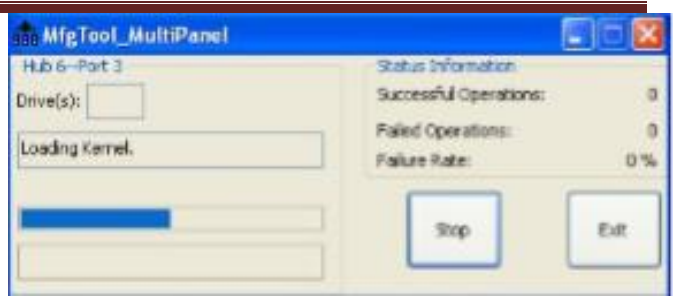

Fig 8: MFG tool terminal panel

Table 1: Test procedure and Results

Test	Image resolution	Expected result	Actual result	Pass/Fail	Remarks
1	SD card is connected to board which contain image of resolution 1280x 800 .jpeg file in it.	The proper image should be displayed.	The image displayed	pass	The test is passed as the image size is 1280 x 800 and test is clear for sd card read write test.
2	SD card is connected to board which contain image of resolution 320 x 800 .jpeg file in it.	The proper image should be displayed.	Image is displayed but not clear	Pass	Since the resolution is less than LVDS display used, the is is displayed but not clear.sd card test is passed ,display test is failed
3	USB pen drive is connected to board which contain image of resolution 1800 x 900 .jpeg file in it .	The proper image should be displayed	The image is clipped off.	Fail	Since the resolution is more than LVDS display used, image is clipped but the sd card test is passed.

6. Conclusions

Android has evolved greatly with mobile devices because of its features like open source nature and rich user interface. Android is being integrated and ported to various embedded devices. The main advantage of using android framework beyond mobile device is that functionality of the android devices. To take advantage of Android, speed and accuracy of the ARM based processor in the current work Android 8.0 is ported onto MAGIK2 ARM based i.MX6 processor. Android is ported onto the target board by three steps as u-boot 2017.03, kernel 4.9.17 and Android 8.0 file system. MAGIK2 is ported with Android OS to drive a LVDS display with different resolution images and video.

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