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DM3730 Processor Hardware Debugging on Linux Platform

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Abstract*: Texas Instruments fabricated a single chip DM3730 processor with 45nm technology with improved performance. Less power consumption and imrpoved Graphics features are the key parametes of ARM architecture. DM3730 has 1GHz processor with 0.4mm pitch Package on Package. Design of effective system is facilitated by properly debugging the hardware and software. The system for detection of driver fatigue for its implementation requires coming in contact with the camera to capture driver image, speaker for warning messages, GSM module to disseminate SMS, mouse, internet, keyboarb, etc. for installing different packages. In this paper, DM3730 Processor is tested for different peripherals on Linux Platform.This paper is a part of research work on the project "Development of Non-Intrusive Driver Fatigue Detection &Alarming System to evade on road accidents" sanctioned under Early Career Research Award sponsored by Science & Engineering Research Board, Govt. of India, New Delhi at Vignan Institute of Technology & Science, Vignan Hills, Hyderabad.

Keywords—*DM3730, GS, Camera, Image*.

I. INTRODUCTION

A well designed functional block diagram of DM3730 Processor comprises of main processor blocks namely the camera port for image/video capture, USB ports, system control, three layer processor, external memory, stacked memory, ARM cortex, DSP audio image/video Processor, External Peripheral support link. The board comes with inbuilt 32Kilo Bytes on-chip Read Only Memory and 64Kilo Bytes on-chip Random Acess Memory. The board also supports different memories like Flash memory, Static RAM (SRAM)[1].

A. Board Provisions

Board compatibility can be checked for inaccuracies by dint of specifications. Board specifications are enumerated interms of mechanical and technical standards. Mechanical specifications are enlisted in Table 1

Table I: Mechanical Specifications of Board

Parameter	Specifications
Board Size	8.255 cm by 8.255cm
Maximum Height	Total Board Mass
Board Layers	6
Thickness (PCB)	0.1578cm
Board Weight	Total Board Weight
USB Ports	4
Camera Port	Available
RS232 Port	Available
JTAG Connector	Available

B. Board Features

The board's processor has internet port, usb ports and clocked with a frequency of 1GHz, and 512MB RAM. Further, the camera port is incorporated to the board for helping image/video processing applications to capture image/video through in built imaging cameras.

Below figure shows DM3730 board with parts labelling.

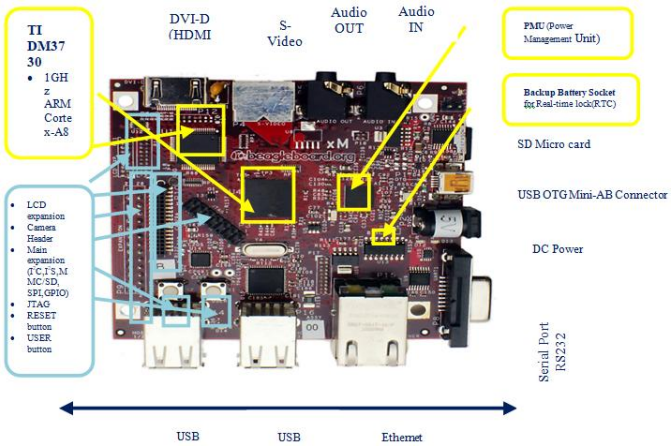

Fig 1: Image of the Board displaying all parts

USB-OTG:USB-OTG cable provides linkage for communication between power source and board. Limited current of 0.005microA which passes through these port which protects it from overload.

USB port: There is a distinct provision in the board for connecting the four peripherals to usb ports. Minimum 3V DC power supply is needed for to function which functions as ON/OFF switch.

INPUT/OUTPUT Stereo Audio connector: The audio port can be read by using 3.5mm audio input/output jack of the board. TPS65950 has CODEC.

RESET button: Can be utilised to reboot and reset the board when board gets more heat or stuck while performning operations.

USER button: Memory card is booted using this button and is needed for the same with NAND flash memory.

LED Indicators: Board comprises of five different green LED'sindicators that are employed by the user for regulating the functioning of the same.

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Audio port consists of a programmed LED connected through I2C interface

- Two LEDs for processor protection are directed by GPIO pins.
- On board LED for power
- Examining the power to USB with one LED.

An addedRed LED present on the board indicates when it receives more voltage then the permissible voltage on the board. If this LED blinks immediately remove the power supply from the board to protect it from damage and connect alternate source for power. [8]

RS232 connector: Female DB9 connector is used to connect RS232 to access onboard transceiver connected via UART3.

Operating System: Open source hardware design and low power levels gives system like performance.

II. STEPS TO PORT OPERATING SYSTEM

Open source operating systems is supported by the board such asubuntu, angstrom linux, windows CE, arch linux, etc. Of the many versions released by Ubuntu, the latest version one supporting the same is Ubuntu 11.10. Operating system. Between different operating systems available Ubuntu being user friendly, is preferred.Graphical User Interface, popularity. Enlisted are the steps followed to install Ubuntu 11.10 on to the formatted 8GB memory card:

Physical Hardware requirements: 8GB memory card, Laptop/Desktop with Ubuntu Operating System and internet facility.

Step (i) **:**All those packages that are prerequisites for O/S installation are installed on memory card. The following linux command is used to install the pre-requisites.
Pre-requisites installation: sudo apt_ get install uboot_ mkimage_btrfs_tools_pv
Step (ii) : Operating system latest image is downloaded from the website using following linux command
www.rcn_ee.net-deb-rootfs-oneiric-ubuntu-11.10-r10_minimal_armel
Step (iii): Check the downloaded image
Checksum_md5sum_ubuntu-11.10-r10_minimal_armel
Step (iv): Extract the files to the required folder
tarxjf ubuntu-11.10-r10_console-armel
Step (v) : Access into the folder where extracted files are stored usinglinux command
cd/ ubuntu-11.10-r10_console-armel.tar.xz
The extracted folder contains a script file named 'setup_sdcard.sh' , which divides the SD card.
Step (vi): Introduce 8GB memory card into the system and to trace the location of the card using
df –h
thememory card location is shown in Figure 2.

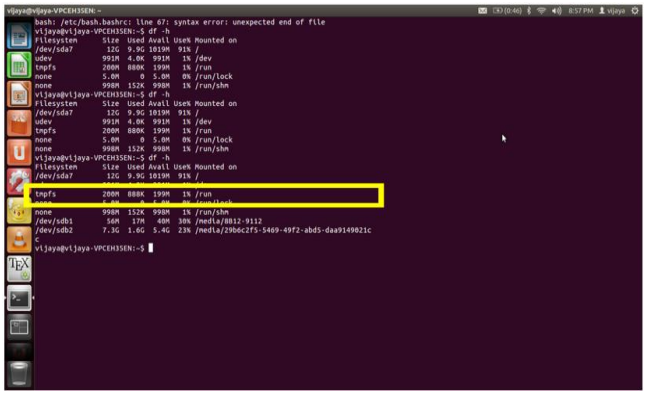

Fig 2: Mounted 8GB SD Card Location

Theinstallation of operating system installation on memory card is given in Step 6 onwards. In order to avoid formatting of other drivers of the system, the SD card location need to be selected accurately.

Step (vi): The below mentioned linux command need to be resorted to for installing the O/S

sudo ./setup-sdcard.sh_mmc /dev/sdb_uboot beagle_xm

It takes closer to 15 min for the O/S to be installed onto the memory card including all necessary packages. If OS installation is successful, then **successful completion** messages will be displayed along with the message prompting for safe removal of the SD Card.

Default user name: ubuntu

password: temppwd

The memory card needs to be taken out of the system and has to be plugged into the board in the proper slot provided for it. **Hardware Debugging**

As discussed in the previous section, one can successfully install Ubuntu 11.10 is installed on to the memory card. Here we would now discuss about connecting the added hardware peripherals needed to develop image processing applications and testing is performed.
Hardware required: Monitor for display, Board with installed OS SD card, 5V DC power supply, USB camera, keyboard and mouse. HDMI cable to connect board to monitor, GSM module for testing purpose and speakers to test audio jack. Using HDMI cable connect board to DVI-D monitor, connect internet to Ethernet port, connect usb keyboard and mouse to usb ports as shown in Figure 3.

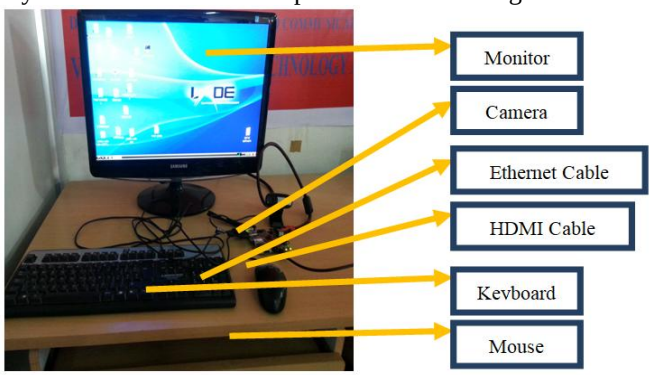

Fig 3: Set up of the Board post Porting OS onto the MicroSD Card

A. Testing of Ethernet Connection

When there is a supply of power, the operating system installed as discussed earlier starts booting up and the console window will appear the way displayed in Figure 3. The default username and password as mentioned in last step are entered to login to the board. The console window does not give user friendly interface as it works on commands. Hence graphical user interface packages need to be installed. Initially console window appears as GUI is not installed. This console window is not user friendly, hence GUI need to be installed. To install Graphical user interface, the board need to be connected to internet facility, hence first the board is configured using following linux commands to connect to internet facility as shown below.

arm@ubuntu:~ $ sudo_ifconfig_a
arm@ubuntu :~$ sudo_dhclient_eth0
arm@ubuntu :~$sudo_ifconfig_a
arm@ubuntu shows the user details at the terminal prompt.
One needs to make use of the previously mentioned linux commands for establishing internet connection using Ethernet Cable. The Operating system needs to be updated and upgraded before installing additional packages.
arm@ubuntu:~ $ sudoapt_get update
arm@ubuntu:~ $ sudoapt_get upgrade
Since the entire board works on memory card, the installation of GUI packages need to be dealt carefully. There are two types of GUI packages available, one is light weight version and second is high end version. Since the board functions on memory card, to save memory, it is preferred to install LXDE version of unbuntu which is light weight.
arm@ubuntu:~$ sudoapt_get install_xfce4
Lot of packages need to be installed, hence it takes 60minutes to complete. After completion, reboot the board, then Light weight LXDE GUI appears on the monitor.

B. Testing of Camera

Estimation of weariness of the driver by making use of selected attributes of the face is the most commonly used non-intrusive method has been selected for this work.The tiredness of the operator of the vehicle is evaluated by resorting to analysis of face and frequency of eye blinks.It is mandatory to ensure monitoring of the face continuously with the use of a sensor which is the USB Camera in this case for capturing the images of the driver.
The usb powered Logitech camera is made use of by plugging it to on board usb ports. There is a need for some complementary packages for allowing camera capture. Following linux command enables the access to camera
arm@ubuntu :~$ sudo apt-get install luvcview

Due to constraint on memory, light weight camera packages are installed. Open source software supports two packages for camera i.e.,luvcview/guvcview which is used to test the camera. Luvcview is preferred as it occupies less memory. It supports mjpeg decoder which is used to save the video as

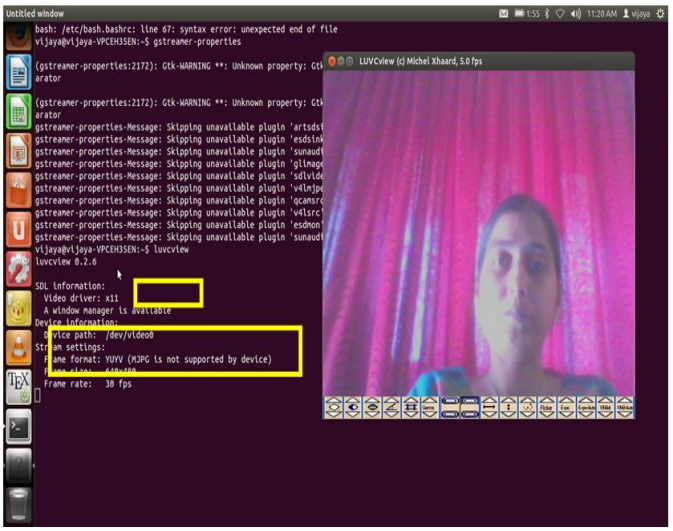

Fig 4: Camera Testing

.AVI file.
arm@ubuntu:~ Luvcview
The above command is used to test the working of camera. The image of the captured person is shown in Figure 4. This command also displays the size of the image and the rate at which the frames are captured.
The Logitech camera used for testing captures the images of size 640x480 at the frame rate of 30fps as shown in figure 4.

C. Testing of Audio Device

One can make use of the board for This board can be used for many image processing applications, one among them is estimation of Driver fatigue by using image processing where camera that is fixed in the front side of the driver captures the images continuously. The problem with the existing driver fatigue detection system is its inability to warn the driver about drowsiness. The same is being tried to be resolved in the proposed work by designing an alert system that would warn the driver of drowsiness and avert road mishaps. The proposed research work is to design driver fatigue detection and alert system where the system can warn the driver during drowsiness condition to avoid on road accidents. This board has in built audio jack where we can directly connect speakers for issuing warning to driver in terms of voice message. The audio can be tested by connection of the speakers with the audio output jack as can be seen in Figure 5with the help of this command

arm@ubuntu :~$ sudo apt_get install gstreamer-properties

One such package for handling audio and video files is Gstreamerwhich happens to be a multimedia package. In order to validate the same, the given command can be used
ubuntu@arm :~$ gstreamer-properties

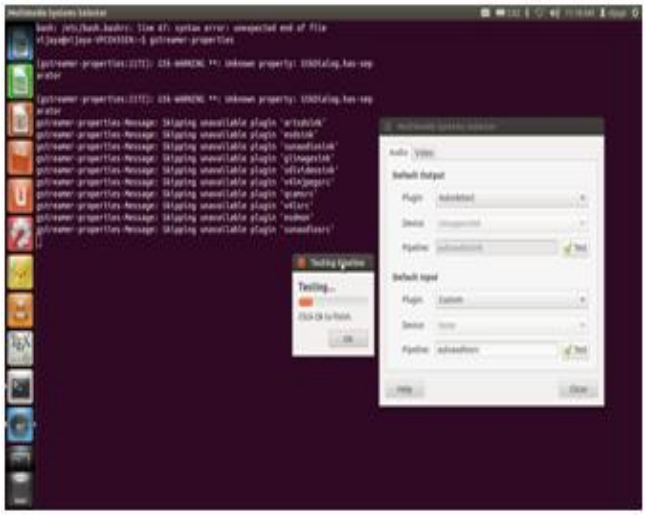

Fig 5: Audio Testing

D. Testing of GSM Module

Some communication software is required to establish communication between GSM module and board. One such software is Minicom which is a text-based communication program in ubuntu used to
establish communication through serial port.It also helps to establish communication between mobiles, routers, etc.It is a free application software available for different operating system. The GSM Module is connected to board through Serial Port as shown in Figure 6.

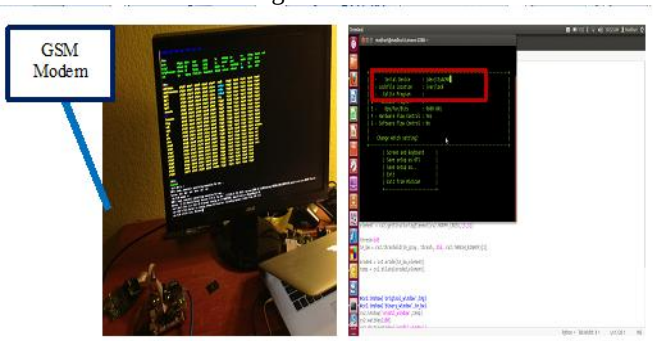

Fig 6: GSM module Testing

Configuration of Minicom is required. To configure Minicom connection can be established only upon obtaining of administration privilege for the same. As is evident from Figure 6, Serial port Settings through Minicom. In order to establish communication between GSM module and the board, Python code making used of AT commands is utilized.

III. CONCLUSION

A comprehensive experiment is carried out to explore the board wholly. The board accommodates all additional accessories coupled with the image processing applications. The board exhibits amalgamation of ARM and DSP architecture that facilitates to improve the performance of image processing applications. Such amalgamation rules out the necessity of having FPGA, microprocessor, etc. The high end processor of the board and open source platform makes this board feasible for real time applications. The whole system is based on one entire system is developed on a sole chip which lowers the expense of the board by almost 50% and better architecture results in less power consumption.

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