BB-View Cape

Portable LCD Solution for the BeagleBone Family

BY

element14

User Manual

Version 3.0

Dated: 26th June 2014

DISCLAIMER

This product is intended to be used for **ENGINEERING DEVELOPMENT, DEMONSTRATION OR EVALUATION PURPOSES ONLY** and is not considered by element14 to be a finished end product fit for general consumer use. Persons handling the product(s) must have electronics training and observe good engineering practice standards.

The goods being provided are not intended to be complete in terms of required design and/or manufacturing related protective considerations, including product safety and environmental measures typically found in end products that incorporate such semiconductor components or circuit boards.

Revision History:

Version	Date	Description
1.0	26/11/2013	Original Version
2.0	22/05/2014	Minor Updates
3.0	26/06/2014	Added support for Debian

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Table of Contents

1 Product Overview

1.1 Brief Introduction

The BB-View is a portable LCD expansion cape with touchscreen capability for BeagleBone boards, a credit-card-sized expandable Linux computer to evaluate the TI's Sitara™ AM335x ARM® Cortex™-A8 processors.

The BB-View is 24-bit LCD expansion cape supplied with an 18-bit TFT LCD module, available in two size options: 4.3" & 7", which can display up to a resolution of 480x272 (4.3" LCD) and 800x480 (7" LCD). Both have a 4-wire resistive touchscreen interface.

BB-View has been designed with convenience in mind and extends the I/O interfaces of the BeagleBone & BeagleBone Black allowing users to utilise a touchscreen LCD module without sacrificing I/O interface access. BB-View fits on top of the BeagleBone OR BeagleBone Black and still has full access to all the GPIOs via two 46-pin connectors. It's equipped with five switches (four for GPIOs & one for Boot) and two user defined LEDs.

The BB-View draws power directly from the board (BeagleBone or BeagleBone Black) eliminating the need for any kind of external power supply. The BB-View is also supplied with a pre-compiled image with Linux QT demos to help set up your BeagleBone & BeagleBone Black board quickly and easily.

Figure 1: *LCD Connected to BeagleBone Black via BB View*

1.2 Kit Contents

- BB VIEW Expansion Board
- 4.3” LCD (optional)
- 7” LCD (optional)

1.3 Board Interfaces

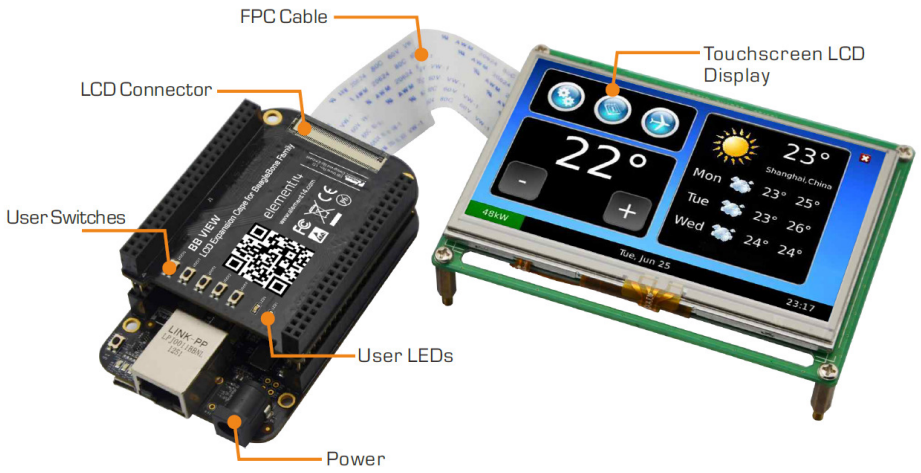


Figure 2: *BB View Interfaces*

1.4 System Block Diagram

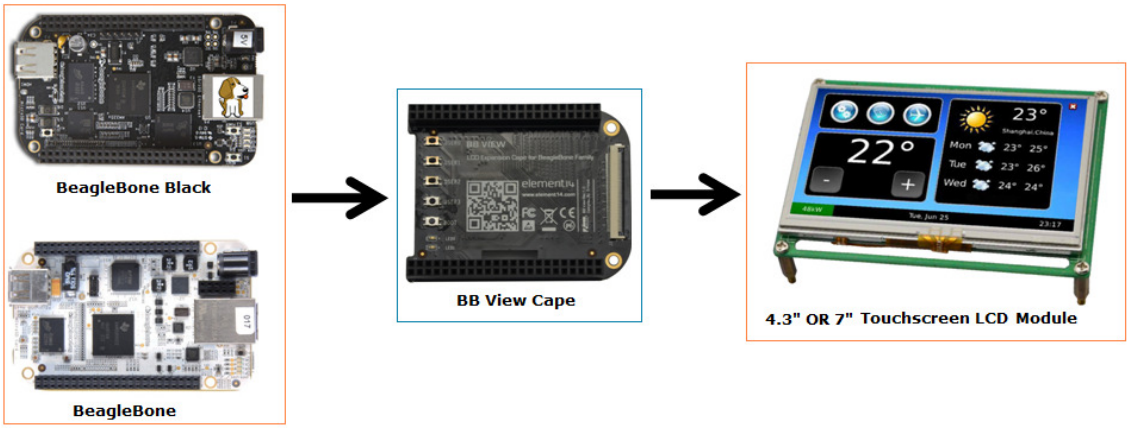


Figure 3: *BB View System Block Diagram*

1.5 Product Dimensions (mm)

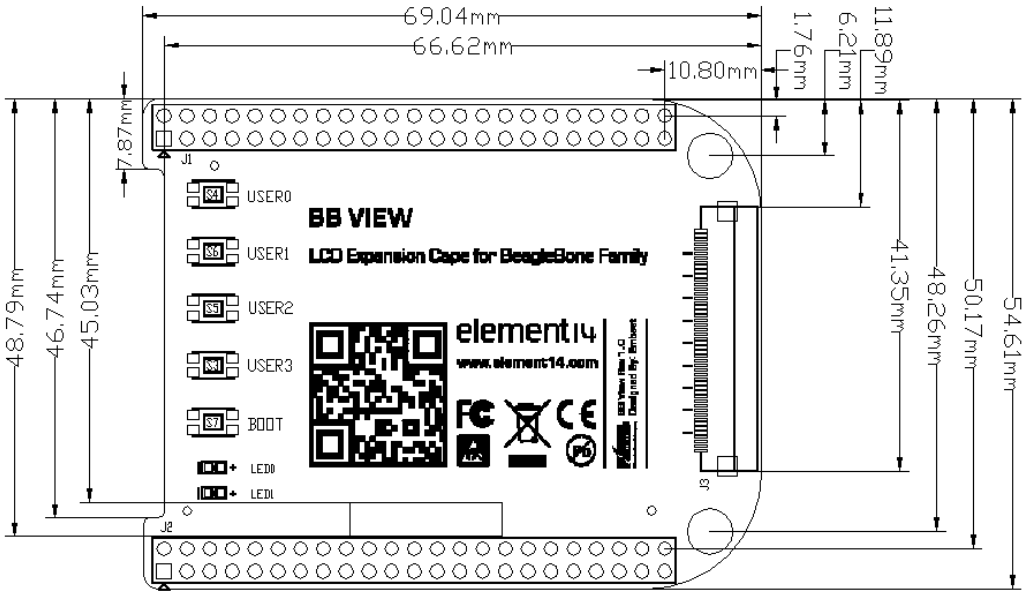


Figure 4: *BB View Dimensions*

2 BB View Features

2.1 Hardware and Software Features:

- A 24-bit compatible LCD expansion cape for the BeagleBone family
- 4-wire, 18-bit resistive touchscreen LCD modules:
  - 4.3" LCD: 480x272 resolution
  - 7" LCD: 800x480 resolution
- Five switches (four for GPIOs & one for BOOT)
- Two user defined LEDs
- Full access to all the GPIOs via two 46-pin connectors (besides those already used by the BB-View)
- Powered directly from BeagleBone boards, no external power supply required.
- Provided with pre-compiled BSP image with QT Demo to help setup the BeagleBone board quickly and easily.
- Works with BeagleBone & BeagleBone Black
- Supporting TISDK and Angstrom image
- Drivers and driver source code are provided along with BB-View

2.2 Operational Parameters:

- Dimensions: 69.04mm x 54.61mm
- Operating Humidity: 20% ~ 90%
- Power Supply: +5V (provided by BeagleBone board)
  - PCB Layers: 4

3 Introduction to Interfaces

The BB-VIEW expansion cape has an LCD connector (LCD) and two 46-position dual-row connectors (J1 and J2) that are used as the extended I/O interfaces of the connected BeagleBone Black or BeagleBone. This chapter contains pin definitions for these connectors.

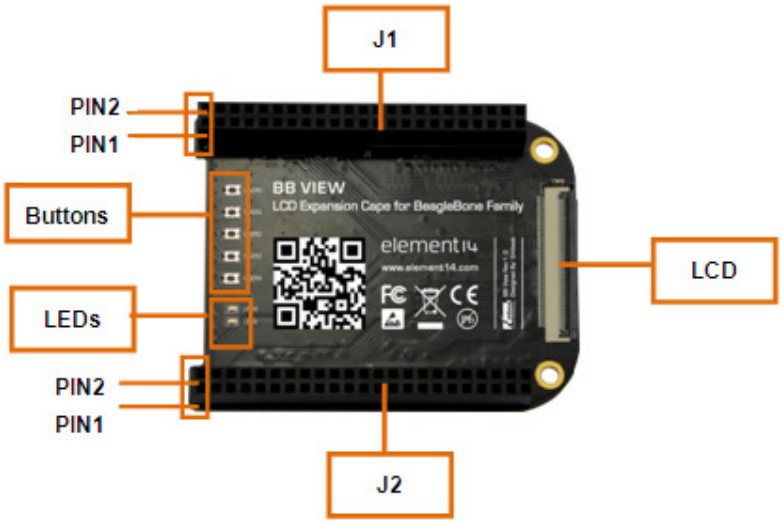


Figure 1-1 Components on BB VIEW

3.1 LCD Interface (LCD)

Pins	Definitions	Descriptions
1	B0	LCD Pixel data bit 23
2	B1	LCD Pixel data bit 20
3	B2	LCD Pixel data bit 17
4	B3	LCD Pixel data bit 11
5	B4	LCD Pixel data bit 12
6	B5	LCD Pixel data bit 13
7	B6	LCD Pixel data bit 14

Pins	Definitions	Descriptions
8	B7	LCD Pixel data bit 15
9	GND	GND
10	G0	LCD Pixel data bit 22
11	G1	LCD Pixel data bit 19
12	G2	LCD Pixel data bit 5
13	G3	LCD Pixel data bit 6
14	G4	LCD Pixel data bit 7
15	G5	LCD Pixel data bit 8
16	G6	LCD Pixel data bit 9
17	G7	LCD Pixel data bit 10
18	GND	GND
19	R0	LCD Pixel data bit 21
20	R1	LCD Pixel data bit 18
21	R2	LCD Pixel data bit 16
22	R3	LCD Pixel data bit 0
23	R4	LCD Pixel data bit 1
24	R5	LCD Pixel data bit 2
25	R6	LCD Pixel data bit 3
26	R7	LCD Pixel data bit 4
27	GND	GND

Pins	Definitions	Descriptions
28	DEN	AC bias control (STN) or pixel data enable (TFT)
29	HSYNC	LCD Horizontal Synchronization
30	VSYNC	LCD Vertical Synchronization
31	GND	GND
32	CLK	LCD Pixel Clock
33	GND	GND
34	X+	X+ Position Input
35	X-	X- Position Input
36	Y+	Y+ Position Input
37	Y-	Y- Position Input
38	SPI_CLK	SPI clock
39	SPI_MOSI	Slave data in, master data out
40	SPI_MISO	Slave data out, master data in
41	SPI_CS	SPI enable
42	IIC_CLK	IIC master serial clock
43	IIC_DAT	IIC serial bidirectional data
44	GND	GND
45	VDD1	3.3V
46	VDD2	3.3V
47	VDD3	5V

Pins	Definitions	Descriptions
48	VDD4	5V
49	RESET	No connection
50	PWREN	GPIO

3.2 Extended I/O Interface (J1)

Pins	Definitions	Descriptions
1	GND	GND
2	GND	GND
3	NC	NC
4	NC	NC
5	NC	NC
6	NC	NC
7	NC	NC
8	NC	NC
9	NC	NC
10	NC	NC
11	LCD_DATA18	LCD Pixel data bit 18
12	LCD_DATA19	LCD Pixel data bit 19
13	LCD_DATA22	LCD Pixel data bit 22
14	LCD_DATA21	LCD Pixel data bit 21

Pins	Definitions	Descriptions
15	LCD_DATA16	LCD Pixel data bit 16
16	LCD_DATA17	LCD Pixel data bit 17
17	LCD_DATA20	LCD Pixel data bit 20
18	NC	NC
19	LCD_DATA23	LCD Pixel data bit 23
20	NC	NC
21	NC	NC
22	NC	NC
23	NC	NC
24	NC	NC
25	NC	NC
26	NC	NC
27	LCD_VSYNC	LCD Vertical Synchronization
28	LCD_PCLK	LCD Pixel Clock
29	LCD_HSYNC	LCD Horizontal Synchronization
30	LCD_DE	AC bias control (STN) or pixel data enable (TFT)
31	LCD_DATA14	LCD Pixel data bit 14
32	LCD_DATA15	LCD Pixel data bit 15
33	LCD_DATA13	LCD Pixel data bit13
34	LCD_DATA11	LCD Pixel data bit 11

Pins	Definitions	Descriptions
35	LCD_DATA12	LCD Pixel data bit 12
36	LCD_DATA10	LCD Pixel data bit 10
37	LCD_DATA8	LCD Pixel data bit 8
38	LCD_DATA9	LCD Pixel data bit 9
39	LCD_DATA6	LCD Pixel data bit 6
40	LCD_DATA7	LCD Pixel data bit 7
41	LCD_DATA4	LCD Pixel data bit 4
42	LCD_DATA5	LCD Pixel data bit 5
43	LCD_DATA2	LCD Pixel data bit 2
44	LCD_DATA3	LCD Pixel data bit 3
45	LCD_DATA0	LCD Pixel data bit 0
46	LCD_DATA1	LCD Pixel data bit 1

3.3 Extended I/O Interface (J2)

Pins	Definitions	Descriptions
1	GND	GND
2	GND	GND
3	VDD_3V3B	3.3V
4	VDD_3V3B	3.3V
5	VDD5V	5V

Pins	Definitions	Descriptions
6	SYS5V	5V
7	SYS5V	5V
8	SYS5V	5V
9	NC	NC
10	SYS_RESETn	Reset
11	USER3	GPIO
12	LED0	GPIO
13	NC	NC
14	PWM	Power on enable
15	NC	NC
16	USER0	GPIO
17	I2C1_SCL	IIC master serial clock
18	I2C1_SDA	IIC serial bidirectional data
19	NC	NC
20	LED1	GPIO
21	NC	NC
22	NC	NC
23	USER2	GPIO
24	USER1	GPIO
25	NC	NC

Pins	Definitions	Descriptions
26	NC	NC
27	NC	NC
28	SPI1_CS0	SPI enable 0
29	SPI1_DO	SPI data 0
30	SPI1_D1	SPI data 1
31	SPI1_SCLK	SPI Clock
32	VDD_ADC	ADC power
33	NC	NC
34	NC	NC
35	NC	NC
36	NC	NC
37	Y+	Y+ Position Input
38	Y-	Y- Position Input
39	X+	X+ Position Input
40	X-	X- Position Input
41	NC	NC
42	NC	NC
43	GND	GND
44	GND	GND
45	GND	GND

Pins	Definitions	Descriptions
46	GND	GND

3.4 Buttons

Buttons	Definitions	Descriptions
1	USER0	Custom Button
2	USER1	Custom Button
3	USER2	Custom Button
4	USER3	Custom Button
5	BOOT	Select Boot Mode

3.5 LED Indicators

LEDs	Definitions	Descriptions
1	USER0	Custom LED indicator
2	USER1	Custom LED indicator

4 Preparations

The pre-compiled image provided with the BB VIEW can be used for demonstration of the board. However, some demonstrations need to be controlled via a PC. There are two methods for controlling a BeagleBone board from a PC:

1. A USB to serial module such as UART8000-U
2. The built in Ethernet over USB functionality

For the Ethernet over USB option there are some preparations such as installing USB over Ethernet drivers and software configuration which need to be done prior to the demonstration.

NOTE:

📖 When using a BeagleBone you can skip this step and use the USB debug interface.

4.1 Installing Drivers for the USB Interface

1. An Angstrom/Debian system is already preprogrammed into the on-board eMMC with of the BeagleBone Black. Connect the BeagleBone Black to the USB interface of your PC using an OTG cable and power on the board, after the Angstrom/Debian system startup is complete, there you can find will be a drive named "BEAGLEBONE" shown in the "My Computer" window

2. Windows will shortly detect the board and begin the driver installation procedure. When a pop-up window is displayed as below, select **Install from a list or specific location (Advanced)** and click **Next**

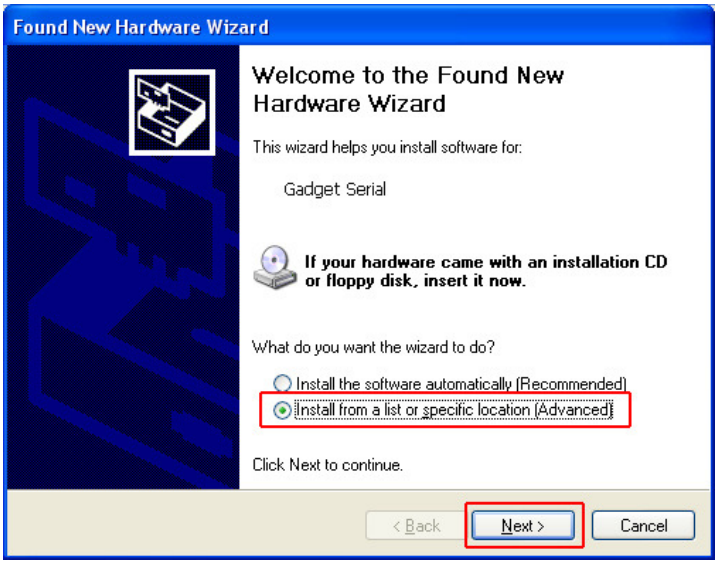


Figure 5: *Gadget Serial Driver Installation*

3. Click **Browse** in the following window and specify the location of the CDCAM folder in the drive BEAGLEBONE and then click **Next** to install the driver

NOTE

🕮 The drive letter shown below may change depending on your system configuration

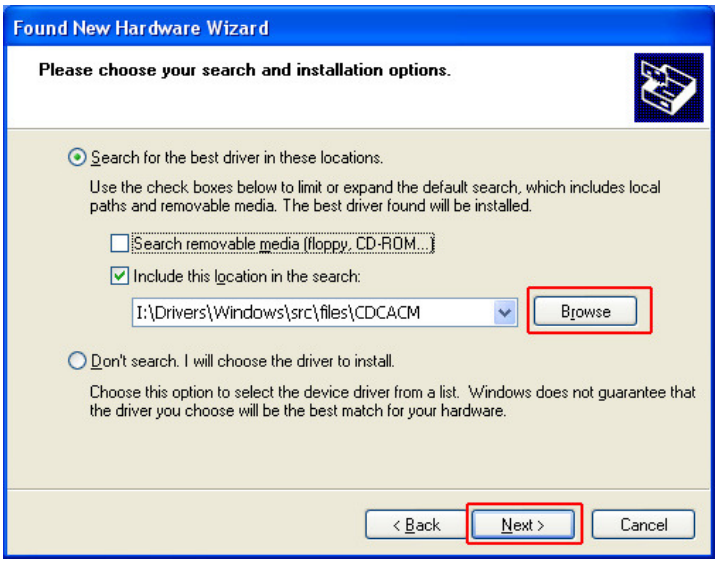


Figure 6: *Driver Location*

4. Windows will shortly detect and begin the installation of the Ethernet over USB functionality. Select **Install from a list or specific location (Advanced)** and click **Next** again when on the following window shows up to install the Ethernet over USB driver

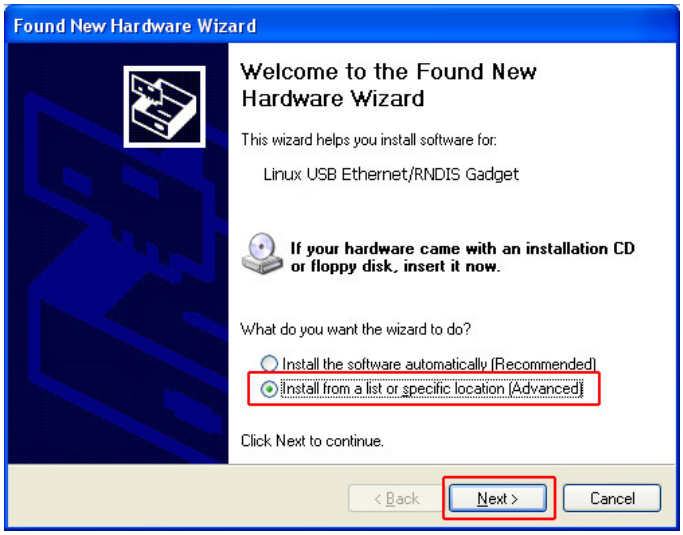


Figure 7: *Ethernet over USB Driver Installation*

5. Click Browse in the following window to specify the location of RNDIS folder in the drive BEAGLEBONE and then click Next

NOTE

🕮 The drive letter shown below may vary depending on your system configuration

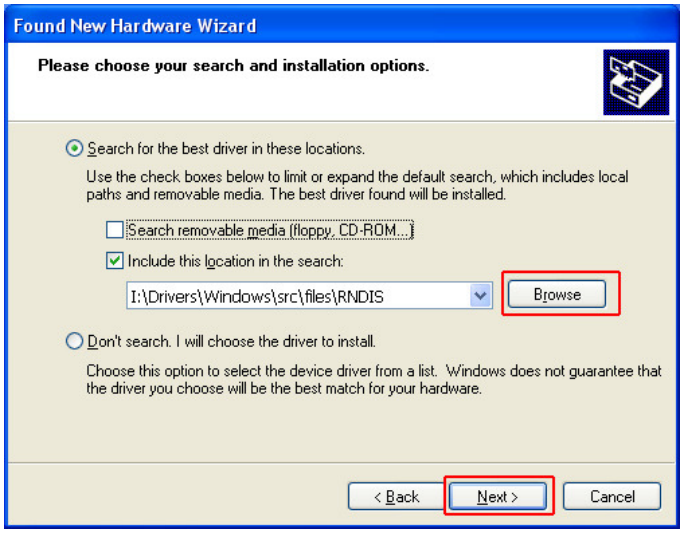


Figure 8: *Driver Location*

4.2 Setting Up a Terminal Application

There are several terminal applications available however, we recommend using PuTTY. PuTTY is a virtual terminal which can receive and display the working information of the BB VIEW after entering the system. It needs to be configured on your PC before it can communicate with the BB VIEW. The following steps detail the configuration procedure.

1. Download the utility tools pack from:

www.element14.com/BeagleBone

2. Unzip the archive you downloaded (tools.zip) and subsequently unzip the putty.zip archive contained within.

3. Run putty.exe found within the uncompressed folder to open the **PuTTY Configuration** window and configure it as shown below

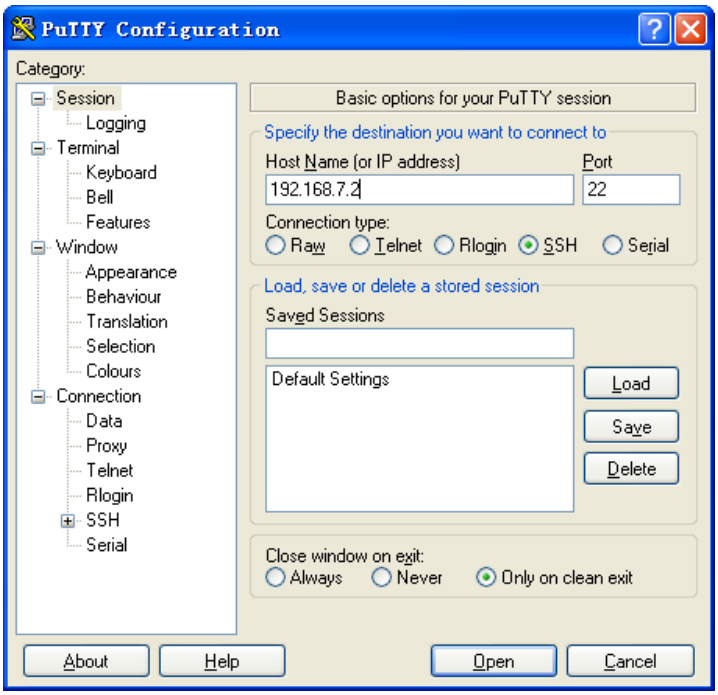


Figure 9: *PuTTY Configuration*

Click **Open** once configuration is complete

4. Enter the login credentials in the following window and press **Enter** on your keyboard:

Note:

📖 The default password for "root" on the TI SDK image is "temppwd". On the preinstalled Debian Image, "root" has no password

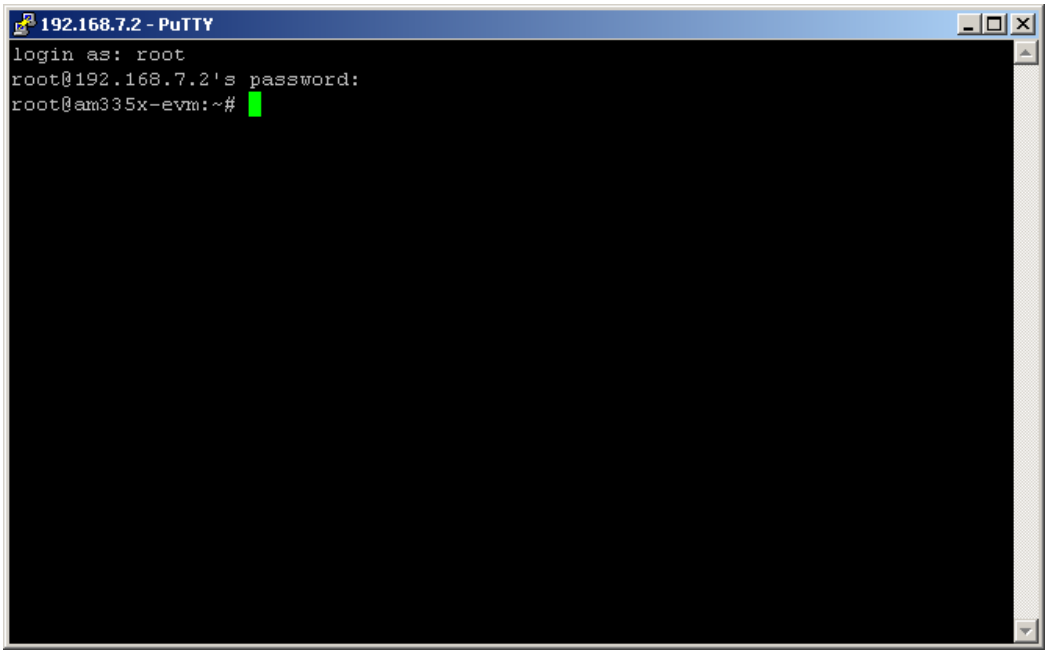


Figure 10: *Login*

After logging in successfully, a bash shell environment is activated. All the shell instructions hereafter are typed and executed under this environment.

5 Demonstration and Compilation of Debian

BB VIEW support has been added to the Debian operating system ready to be run on the BeagleBone Black. This chapter will introduce how to carry out demonstrations of the display function of the BeagleBone Black and BB VIEW under Debian, as well as how to create a Linux development environment and compile the system.

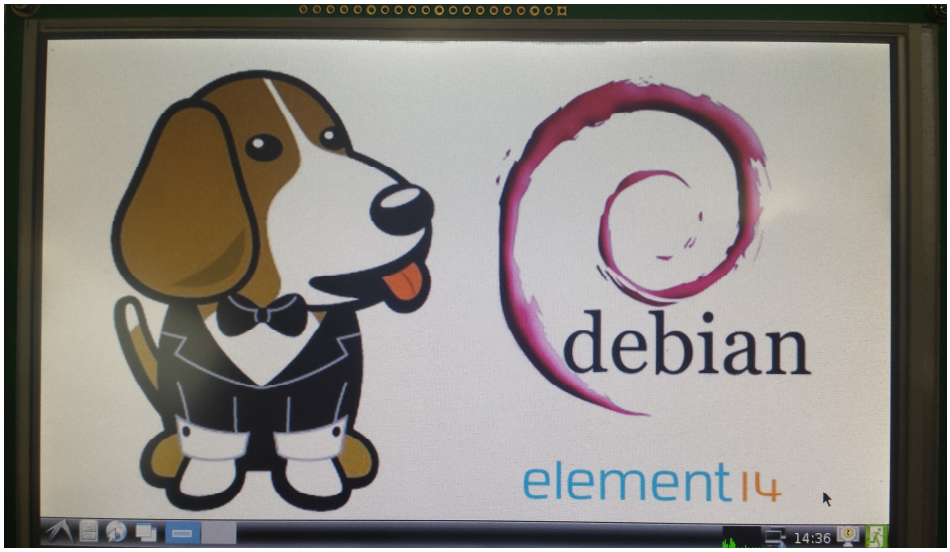


Figure 11: Debian on 4.3" LCD with BB-View

Note:

- To avoid any confusion attributed to multi-line instructions, each instruction has been preceded with a bullet point "•".
- Please note that there are SPACES in the following instructions. Missing any SPACE will lead to failure when running an application.

5.1 Demonstration of Display Function

5.1.1 Image programming

The preinstalled Debian image on the BeagleBone Black does not have support for the BB VIEW.This can be easily remedied by simply patching the

old Debian system in the eMMC. The following steps show the update process using a USB flash drive.

1. Download the Debian patch files and the utility tools pack from:

 http://www.element14.com/BeagleBone

2. Uncompress both of the archives

3. Use the HP USB formatting tool (HPUSBFW.exe) from the utility tools pack to format a USB flash drive

4. Copy all the patch files to the USB flash drive

5. Ensure that a Debian system currently exists in the BeagleBone Black eMMC

6. Connect the USB flash drive to the BeagleBone Black and power it on

7. Execute the following instructions in a terminal program (such as PuTTY) to mount the flash drive

   - **$ mkdir /media/udisk**
   - **$ mount /dev/sda1 /media/udisk**

8. Execute the following instructions to patch the image

   - $ **cp -f /media/udisk/zImage /boot/uboot**
   - $ **cp -f /media/udisk/*.dtb /boot/uboot/dtbs**
   - $ **tar -xvf /media/udisk/kernel_modules.tar.gzvcd -C /**
   - $ **cp -f /media/udisk/xorg.conf /etc/X11/**
   - $ **sync**

9. Power off the board and connect BeagleBone Black, BB VIEW and an LCD display, and then power it on again

5.1.2 Setting up Display Modes

1. The following instructions are executed in PuTTY for the use of 4.3" LCD displays

   - root@beaglebone:~# **cd /boot/uboot/dtbs**
   - root@beaglebone:~# **cp am335x-boneblack-lcd4.dtb am335x-boneblack.dtb**
   - root@beaglebone:~# **sync**

   Now restart the board to complete the configuration for the 4.3" LCD display.

2. The following instructions are executed in putty for use of 7" LCD displays

   - root@beaglebone:~# **cd /boot/uboot/dtbs**
   - root@beaglebone:~# **cp am335x-boneblack-lcd7.dtb am335x-boneblack.dtb**
   - root@beaglebone:~# **sync**

   Now restart the board to finish the demonstration with a 7" LCD display.

Note:

- If you have calibrated the touch screen, after you change the display mode, you must execute the following instructions to recalibrate in putty:

  ```
  root@beaglebone:~# rm /etc/pointercal*
  root@beaglebone:~# sync
  ```

  and then reboot the board

- The 4.3" and 7" LCD screens provided with the BB-View have different styles of FPC. These are not cross compatible and using the wrong FPC will result in apparent failure of the module

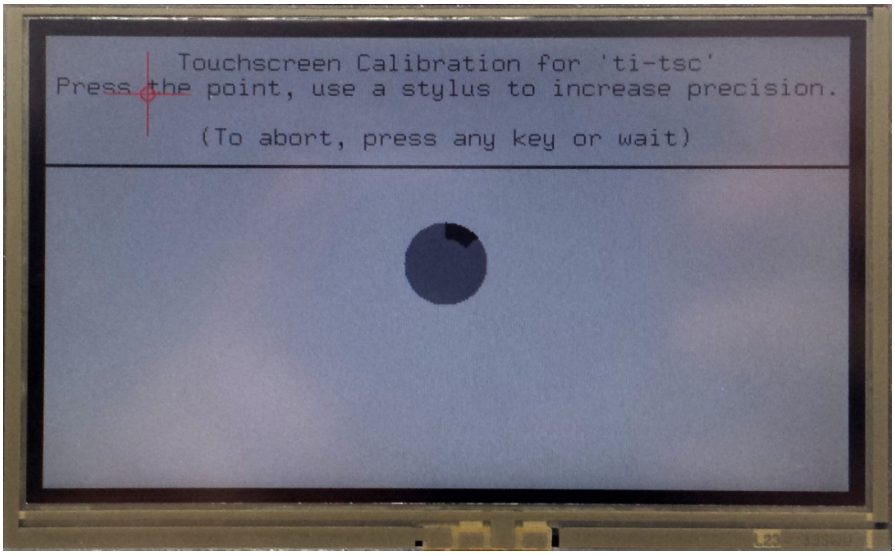


Figure 12: *Calibration Screen*

5.1.3 Button Test

Execute the following instruction and then press the custom buttons (USER0-USER3). You can see corresponding changes in the output of the program.

- root@beaglebone:~# **hexdump -C -v /dev/input/event2**

5.1.4 LED Test

1. Turn off LED0
   - root@beaglebone:~# **echo 0 >/sys/class/leds/bb-view\:led0/brightness**
2. Turn on LED0
   - root@beaglebone:~# **echo 1 > /sys/class/leds/bb-view\:led0/brightness**
3. Turn off LED1
   - 33**/sys/class/leds/bb-view\:led1/brightness**
4. Turn on LED1

- root@beaglebone:~# **echo 1>**

  /sys/class/leds/bb-view\:led1/brightness

5.2 Compilation of the Kernel

The kernel source code is named bb-black-kernel-3.8.13-bb-view.tar.bz2 and has been modified to support the BB VIEW. It can be downloaded from:

 http://www.element14.com/BeagleBone

Please refer to the BeagleBone Black User Manual for the details regarding kernel compilation and updating.

6 Demonstration and Compilation of the TI SDK

BB VIEW support has been built in to the TI SDK systems running on both the BeagleBone and the BeagleBone Black. This chapter will introduce how to carry out demonstrations of the display function of the BeagleBone Black and BB VIEW using the TI SDK, as well as how to create a Linux development environment and compile the system.

Note:

- To avoid any confusion attributed to multi-line instructions, each instruction has been preceded with a bullet point "•".
- Please note that there are SPACES in the following instructions. Missing any SPACE will lead to failure when running an application.

6.1 Demonstration of the Display Function

For the demonstration we will use a TI-SDK system image provided on the element14 website. This requires programming the image into the BeagleBone or BeagleBone Black first.

6.1.1 Image Programming on BeagleBone Black

1. Download the BB View TI-SDK Image File (ti-sdk-image.zip) and the utility tools pack (tools.zip) from:

 http://www.element14.com/BeagleBone

2. Uncompress both of the archives

3. Within the TI SDK zip (ti-sdk-image.zip) uncompress the image file for either the BeagleBone or BaegleBone Black depending on your board

4. Program the uncompressed image into a Micro SD card by using Win32DiskImager.exe from the utility tools pack

5. Insert the card into the BeagleBone Black, press and hold the Boot button on the BB VIEW while powering on the board. Keep the button held down until the bank of 4 LEDs light up for a few seconds

6. When all 4 user LEDs stay constantly on, the image has been programmed into BeagleBone Black. Please power off the board and remove the Micro SD card, and then connect BeagleBone Black, BB VIEW and a LCD display and power it on again

7. Follow the instructions shown on the LCD to complete screen calibration.

6.1.2 Image Programming on BeagleBone

1. Download the TI-SDK image (ti-sdk-image.zip) and the utility tools pack (tools.zip) from:

 http://www.element14.com/BeagleBone

2. Uncompress both of the archives

3. Within the TI SDK zip (ti-sdk-image.zip) uncompress the image file for either the BeagleBone or BaegleBone Black depending on your board

4. Program the uncompressed image into a Micro SD card by using Win32DiskImager.exe from the utility tools pack

5. Insert the card into the BeagleBone and connect the BeagleBone Black, BB VIEW and an LCD display, and then power on the board to start the system

6.1.3 Setting Up Display Modes – 4.3”

The procedure to set up display modes is the same on both the BeagleBone and BeagleBone Black.

1. Connect to the BeagleBone board as shown in section 4

2. The following instructions are executed in the terminal window to configure the BB View to use 4.3" LCD displays:

   - root@am335x-evm:~# **echo "optargs=dispmode=4.3inch_LCD" > /media/mmcblk0p1/uEnv.txt**
   - root@am335x-evm:~# **sync**

Note:

📖 The system supports 4.3" LCD displays by default, and therefore there is no need to execute these instructions if the default settings haven't been changed.

3. Restart the board to apply the settings, the BB View is now set up for 4.3" LCD displays.

6.1.4 Setting Up Display Modes – 7"

1. Connect to the BeagleBone board as shown in section 4
2. The following instructions are executed for use of 7" LCD displays:

   - root@am335x-evm:~# **echo "optargs=dispmode=7inch_LCD" > /media/mmcblk0p1/uEnv.txt**
   - root@am335x-evm:~# **sync**

3. Now restart the board to apply the settings for 7" LCD displays.

Note:

📖 If you have calibrated the touch screen, after you change the display mode, you must execute the following instructions to recalibrate in putty:
root@am335x-evm:~#rm /media/mmcblk0p1/pointercal
root@am335x-evm:~# sync
And then reboot the board.

📖 The 4.3" and 7" LCD screens provided with the BB-View have different styles of FPC. These are not cross compatible and using the wrong FPC will result in apparent failure of the module

6.1.5 Demonstration of Temperature Control

Temperature control is one of the typical applications included in the TI SDK system. The following instructions show how to run this application.

1. Click **Qt4** icon on the desktop of TI-SDK system as shown below

Figure 13: *Run QT4*

2. Click **Thermostat Demo** in the following interface

Figure 14: *Select Thermostat Demo*

3. Click the **RUN** button in the following interface

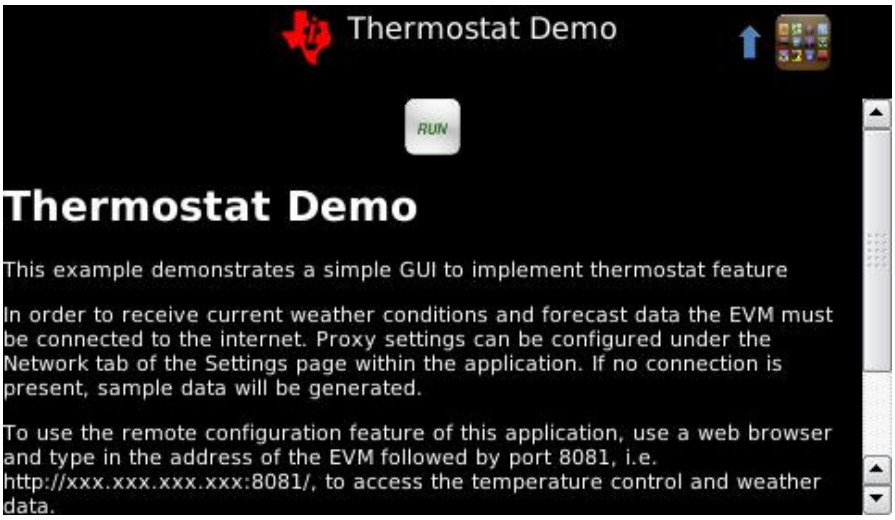


Figure 15: *Run Thermostat Demo*

4. The interface of the temperature control application is shown below

Figure 16: *Temperature Control Application*

6.1.6 Button Test

Execute the following instruction in the terminal and then press the custom buttons (USER0-USER3). You can see changes correspondingly in the output of the program.

- root@am335x-evm:~# **hexdump -C -v /dev/input/event1**

6.1.7 LED Test

Enter the following into the terminal:

1. Turn off LED0
   - root@am335x-evm:~# **echo 0 > /sys/class/leds/LED0/brightness**
2. Turn on LED0
   - root@am335x-evm:~# **echo 1 > /sys/class/leds/LED0/brightness**
3. Turn off LED1
   - root@am335x-evm:~# **echo 0 > /sys/class/leds/LED1/brightness**
4. Turn on LED1
   - root@am335x-evm:~# **echo 1 > /sys/class/leds/LED1/brightness**

6.2 Compilations of the TI SDK

BeagleBone and BeagleBone Black share the same source code package for the TI SDK system, and therefore the compilation and image updating processes are the same for both boards.

6.2.1 Building Development Environment

Before getting started with system compilation, you must first build a Linux development environment. (For installation of a Linux system, please refer to 7Appendix 1:)

1. Download BB VIEW TI-SDK source code (ti-sdk-source.zip) from:

 http://www.element14.com/BeagleBone

To the $HOME directory

2. Execute the following instructions to install the development environment:
   - $ **cd $HOME**

- $**./ti-sdk-am335x-evm-06.00.00.00-Linux-x86-Install --mode console**

3. Follow the on screen prompts to finish the installation, the file ti-sdk-am335x-evm-06.00.00.00 will now be in the $HOME directory.

4. Execute the following command to install mkimage.

- $ **sudo apt-get install uboot-mkimage**

5. Execute the following instruction to define a temporary environment variable for the compiler in the Ubuntu system

- $ **export PATH=$HOME/ti-sdk-am335x-evm-06.00.00.00/linux-devkit/sysroots/i686-arago-linux/usr/bin/:$PATH**

Note:

- The instruction used to define environment variables can be added into .bashrc in the $HOME directory so that the system can create the variable automatically when booting up.
- To view the path of the compiler, type echo $PATH into the terminal.

Now the development environment has been created successfully.

6.2.2 Compiling Uboot

The SDK provided officially by TI needs to be patched in order to support BB VIEW. A Linux kernel has been patched and is available in the BB VIEW TI-SDK source code (ti-sdk-source.zip) from:

 http://www.element14.com/BeagleBone

It can be used as an alternative and compiled directly without need to apply the patch. This section will introduce two uboot compilation processes.

Compiling uboot from TI

1. Copy u-boot-2013.01.01-psp06.00.00.00-bb-view.patch to $HOME/ti-sdk-am335x-evm-06.00.00.00/board-support/

2. Execute the following instruction within the directory: board-support/ to apply the patch
    - $ **cd ~/ti-sdk-am335x-evm-06.00.00.00/board-support/u-boot-2013.01.01-psp06.00.00.00**
    - $ **patch -p1 < ../u-boot-2013.01.01-psp06.00.00.00-bb-view.patch**
3. Execute the following instruction to compile
    - **cd $ ~/ti-sdk-am335x-evm-06.00.00.00/board-support/u-boot-2013.01.01-psp06.00.00.00**
    - $ **make CROSS_COMPILE=arm-linux-gnueabihf- ARCH=arm distclean**
    - $ **rm -rf am335x**
    - $ **make O=am335x** CROSS**_COMPILE=arm-linux-gnueabihf- ARCH=arm am335x_evm**

    After the compilation is done, the files MLO and u-boot.img can be found within am335x/ of the current directory.

Compiling uboot from element14

1. Execute the following command to uncompress the uboot source code
    - $ **cd ~/**
    - $ **tar xvf u-boot-2013.01.01-psp06.00.00.00-bb-view.tar.bz2**
2. Execute the following instructions to compile
    - $ **cd $HOME/ u-boot-2013.01.01-psp06.00.00.00**
    - $ **make CROSS_COMPILE=arm-linux-gnueabihf- ARCH=arm distclean**
    - $ **rm -rf am335x**

- $ **make O=am335x CROSS_COMPILE=arm-linux-gnueabihf- ARCH=arm am335x_evm**

After the compilation is done, the files MLO and u-boot.img can be found within am335x/ of the current directory.

6.2.3 Compiling Kernel

The SDK provided officially by TI needs to be patched in order to support BB VIEW. A Linux kernel has been patched and is available in the BB VIEW TI-SDK source code (ti-sdk-source.zip) from:

 http://www.element14.com/BeagleBone

It can be used as an alternative and compiled directly without need to apply the patch. This section will introduce two kernel compilation processes.

Compiling kernel from TI

1. Copy linux-3.2.0-psp04.06.00.11-bb-view.patch from $HOME to $HOME/ti-sdk-am335x-evm-06.00.00.00/board-support/
2. Execute the following instructions to install patch and then compile the TI-SDK kernel
   - $ **cd ~/ti-sdk-am335x-evm-06.00.00.00/board-support/linux-3.2.0-psp04.06.00.11**
   - $ **patch –p0 < ../ linux-3.2.0-psp04.06.00.11-bb-view.patch**
   - $ **make ARCH=arm CROSS_COMPILE=arm-linux-gnueabihf- distclean**
   - $ **make ARCH=arm CROSS_COMPILE=arm-linux-gnueabihf- am335x_evm_defconfig**
   - $ **make ARCH=arm CROSS_COMPILE=arm-linux-gnueabihf- uImage modules**

A kernel file with LCD support named uImage is generated under arch/arm/boot/.

Compiling Kernel from element14

Execute the following instructions to unzip the source code and compile the kernel image

- **$ cd ~/ti-sdk-am335x-evm-06.00.00.00/board-support/linux-3.2.0-psp04.06.00.11**
- **$ patch –p0 < ../ linux-3.2.0-psp04.06.00.11-bb-view.patch**
- **$ make ARCH=arm CROSS_COMPILE=arm-linux-gnueabihf- distclean**
- **$ make ARCH=arm CROSS_COMPILE=arm-linux-gnueabihf- am335x_evm_defconfig**
- **$ make ARCH=arm CROSS_COMPILE=arm-linux-gnueabihf- uImage modules**

A kernel file with LCD support named uImage is generated under arch/arm/boot/.

6.3 System Update

Format a flash drive of a TF card to FAT32 and mount it under Ubuntu Linux system, and then execute the following instructions to copy the image to the flash drive of TF card (let's assume the flash drive or TF card is mounted under /mnt)

- **# cd ~**
- **$ cp u-boot-2013.01.01-psp06.00.00.00/am335x/MLO /mnt**
- **$ cp u-boot-2013.01.01-psp06.00.00.00/am335x/u-boot.img /mnt**
- **$ cp linux-3.2.0-psp04.06.00.11/arch/arm/uImage /mnt**
- **$ mkdir /mnt/rootfs**

- $ **cd linux-3.2.0-psp04.06.00.11**
- $ **make ARCH=arm CROSS_COMPILE=arm-linux-gnueabihf- modules_install INSTALL_MOD_PATH=/mnt/rootfs**
- $ **cd /mnt/rootfs**
- $ **tar -czvf ../kernel_modules.tar.gz ./**
- $ **cd /mnt**
- $ **rm –rf rootfs**
- $ **ls**

Connect the BB VIEW to a BeagleBone or BeagleBone Black and then connect the power supply. To update the image, insert the flash drive into the board and execute the following instructions after entering the TI SDK system. (If a TF card is used instead of a flash drive, please change the path in the instructions accordingly)

- $ **cp /media/sda1/MLO /media/mmcblk0p1/**
- $ **cp /media/sda1/u-boot.img /media/mmcblk0p1/**
- $ **cp /media/sda1/uImage /media/mmcblk0p1/**
- $ **tar -xvf /media/sda1/kernel_modules.tar.gz -C /**
- **$ sync**
- **$ reboot**

7 Demonstration and Compilation of Angstrom

BB VIEW support has been added to the Angstrom operating system ready to be run on the BeagleBone Black. This chapter will introduce how to carry out demonstrations of the display function of the BeagleBone Black and BB VIEW under Angstrom, as well as how to create a Linux development environment and compile the system.

Note:

- To avoid any confusion attributed to multi-line instructions, each instruction has been preceded with a bullet point "•".
- Please note that there are SPACES in the following instructions. Missing any SPACE will lead to failure when running an application.

7.1 Demonstration of Display Function

7.1.1 Image programming

The preinstalled Angstrom image on some BeagleBone boards does not have support for the BB VIEW. This can be easily remedied by simply patching the old Angstrom system in the eMMC. The following steps show the update process using a USB flash drive.

1. Download the BB View Angstrom Patch files and the utility tools pack from:

 http://www.element14.com/BeagleBone

2. Uncompress both of the archives
3. Use the HP USB formatting tool (HPUSBFW.exe) from the utility tools pack to format a USB flash drive
4. Copy all the patch files to the USB flash drive

5. Make sure that an Angstrom system currently exists in the BeagleBone Black eMMC

6. Connect the USB flash drive to the BeagleBone Black and power it on

7. Execute the following instructions in a terminal program (such as PuTTY) to mount the USB flash drive

- **$ mkdir /media/udisk**
- **$ mount /dev/sda1 /media/udisk**

8. Execute the following instructions to patch the image and then restart the system

- $ **cp -f /media/udisk/uImage /boot/**
- $ **cp -f /media/udisk/*.dtb /boot/**
- $ **tar -xvf /media/udisk/kernel_modules.tar.gz -C /**
- $ **opkg install /media/udisk/xf86-input-tslib_0.0.6-r17.1_armv7a-vfp-neon.ipk**
- $ **cp /media/udisk/50-tslib.conf /usr/share/X11/xorg.conf.d/**
- $ **sync**

9. Modify the display width by entering the Angstrom system, and then modifying the DefaultDepth value of /etc/X11/xorg.conf

DefaultDepth 16

To

DefaultDepth 24

10. Power off the board and connect the BeagleBone Black, BB VIEW and an LCD display, and then power it on again

7.1.2 Setting up Display Modes

The following instructions are executed in PuTTY for the use of 4.3" LCD displays:

- root@beaglebone:~# **cd /boot**
- root@beaglebone:~# **cp am335x-boneblack-lcd4.dtb am335x-boneblack.dtb**
- root@beaglebone:~# **sync**

Now restart the board to complete the configuration for the 4.3" LCD display.

The following instructions are executed in PuTTY for use of 7" LCD displays

- root@beaglebone:~# **cd /boot**
- root@beaglebone:~# **cp am335x-boneblack-lcd7.dtb am335x-boneblack.dtb**
- root@beaglebone:~# **sync**

Now restart the board to complete the configuration for the 7" LCD display.

Note:

🕮 If you have calibrated the touch screen, after you change the display mode, you must execute the following instructions to recalibrate in putty:
root@beaglebone:~# rm /etc/pointercal*
root@beaglebone:~# sync
and then reboot the board

🕮 The 4.3" and 7" LCD screens provided with the BB-View have different styles of FPC. These are not cross compatible and using the wrong FPC will result in apparent failure of the module

7.1.3 Button Test

Execute the following instruction and then press the custom buttons (USER0-USER3). You can see corresponding changes in the output of the program.

- root@beaglebone:~# **hexdump -C -v /dev/input/event2**

7.1.4 LED Test

1. Turn off LED0
   - root@beaglebone:~# **echo 0 > /sys/class/leds/bb-view\:led0/brightness**
2. Turn on LED0
   - root@beaglebone:~# **echo 1 > /sys/class/leds/bb-view\:led0/brightness**
3. Turn off LED1
   - root@beaglebone:~# **echo 0 > /sys/class/leds/bb-view\:led1/brightness**
4. Turn on LED1
   - root@beaglebone:~# **echo 1 > /sys/class/leds/bb-view\:led1/brightness**

7.2 Compilation of the Kernel

The BB View Angstrom Source Code (angstrom-source.zip) has been modified to support the BB VIEW. It can be downloaded from:

http://www.element14.com/BeagleBone

Please refer to the BeagleBone Black User Manual for the details regarding kernel compilation and updating.

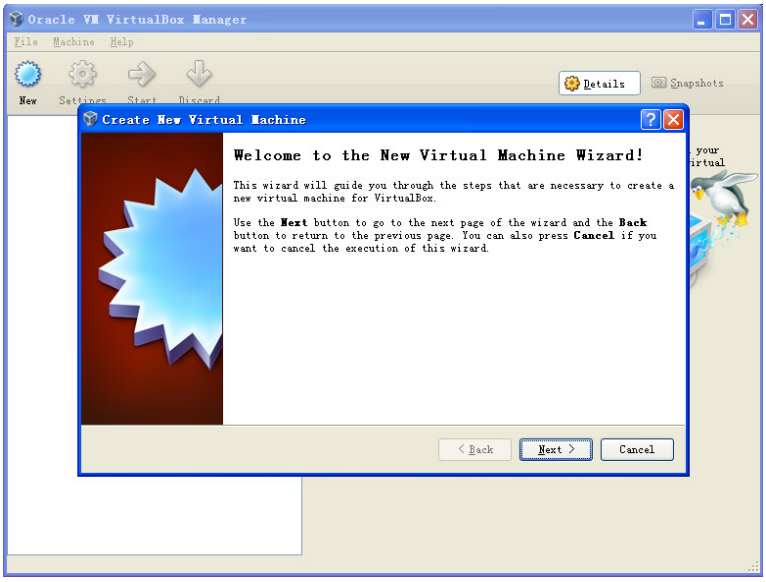
Appendix 1: Installing an Ubuntu Linux System

An appropriate development environment is required for software development. The CD included with product contains a development environment which needs to be installed under a Linux environment. If you are working on a PC running Windows, you have to create a Linux system first, and then you can install the environment. An easy method for achieving this is to use virtual machine software such as VirtualBox to install Ubuntu Linux on an emulated/virtual PC. The following sections will introduce the installation processes of VirtualBox and an Ubuntu system.

1.1 Installing VirtualBox

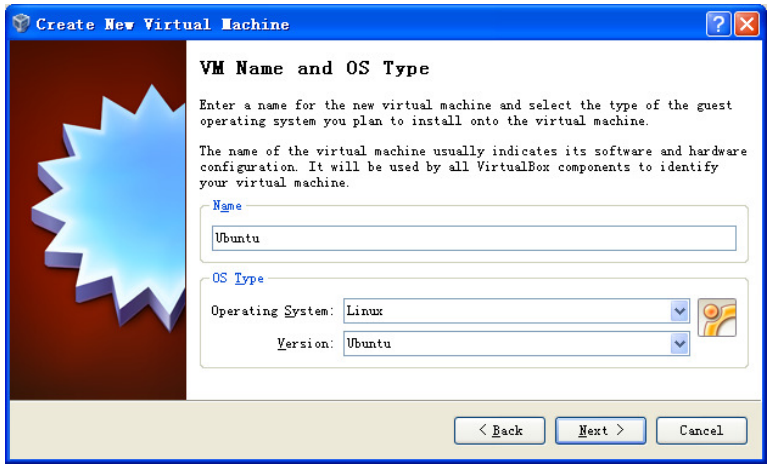
You can access http://www.virtualbox.org/wiki/Downloads to download the latest version of VirtualBox. At the time of writing VirtualBox requires a minimum of 512MB of RAM to run however 1GB is recommended.

The installation process is simple. Start VirtualBox from the **Start** menu of Windows, and then click **New** in the VirtualBox window. A pop-up window titled "Create New Virtual Machine" will be shown as below:



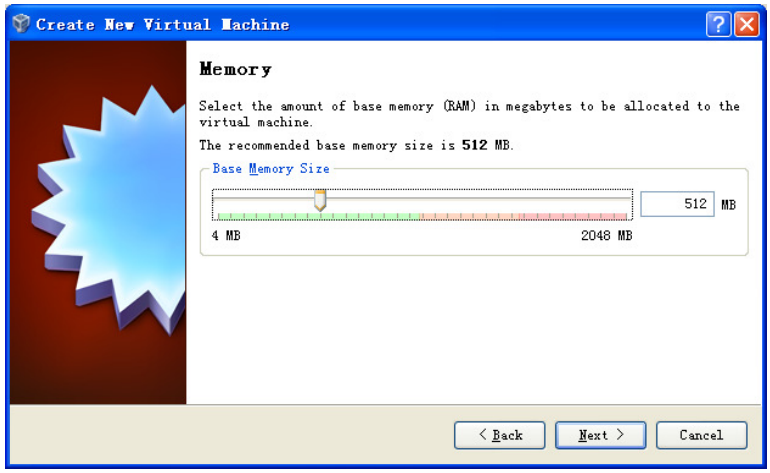
5. Click **Next** to create a new virtual machine.

6. Enter a name for the new virtual machine and select the operating system type as shown below:



7. Enter a name in the **Name** field, e.g. Ubuntu, and select **Linux** in the **Operating System** drop-down menu, and then click **next**.

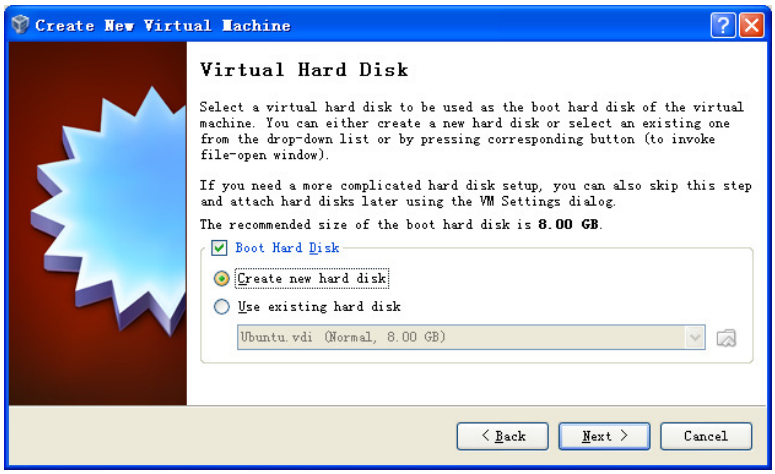
8. Allocate memory to the virtual machine and then click **Next**



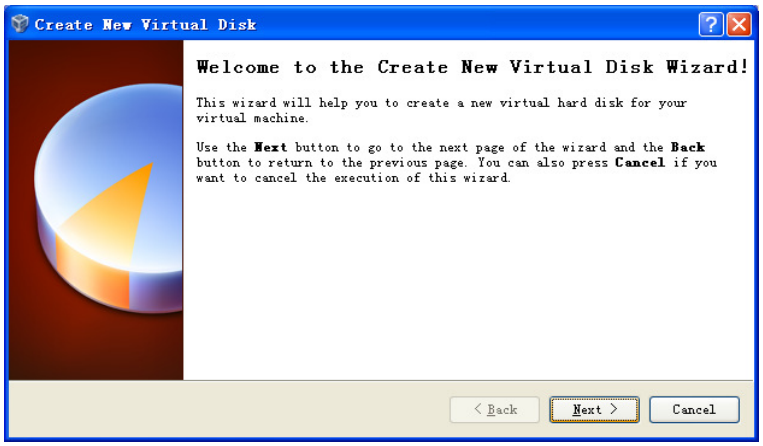
Note:

- If your PC has 1GB of RAM or lower, keep the default setting
- If your PC more than 1GB of RAM, you can allocate up to 1/4 to the virtual machine, for example, 512MB out of 2GB memory could be allocated to virtual machine.

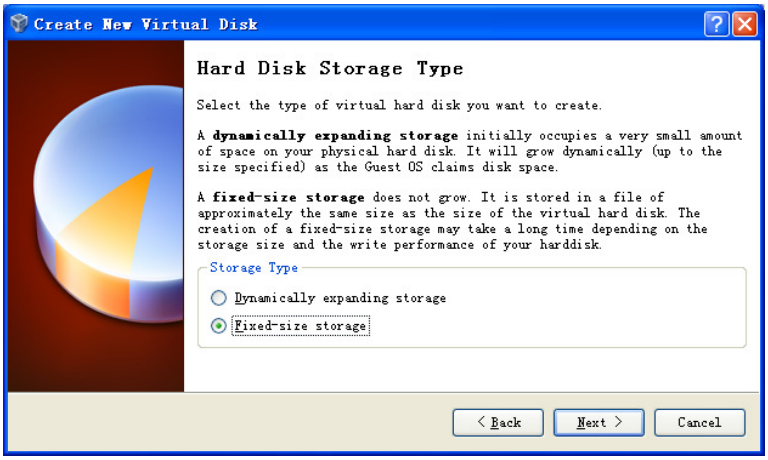
9. If this is the first time you have installed VirtualBox, you need to select **Create new hard disk** in the following window, and then click **Next**



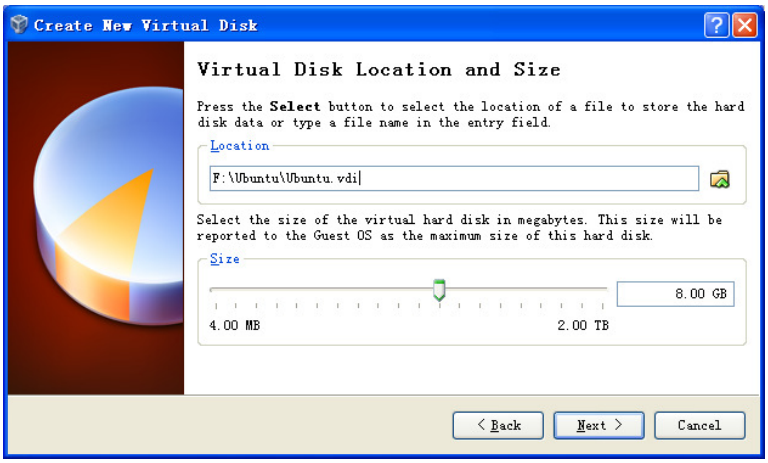
10. Click **Next** in the following window



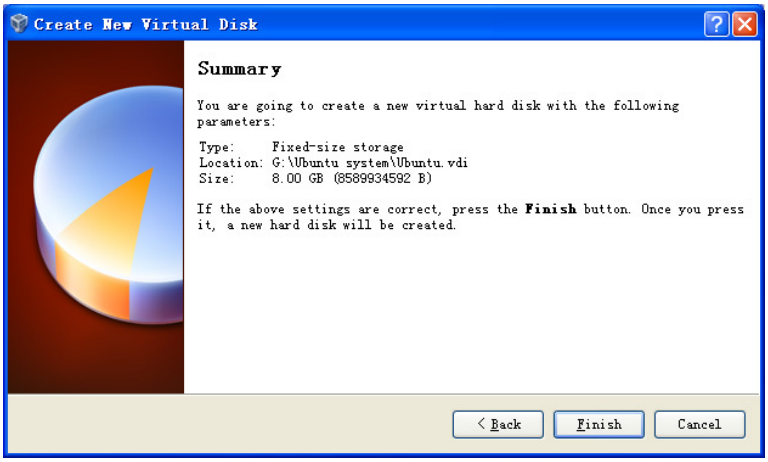
11. Select **Fixed-size storage** in the following window and click **Next**



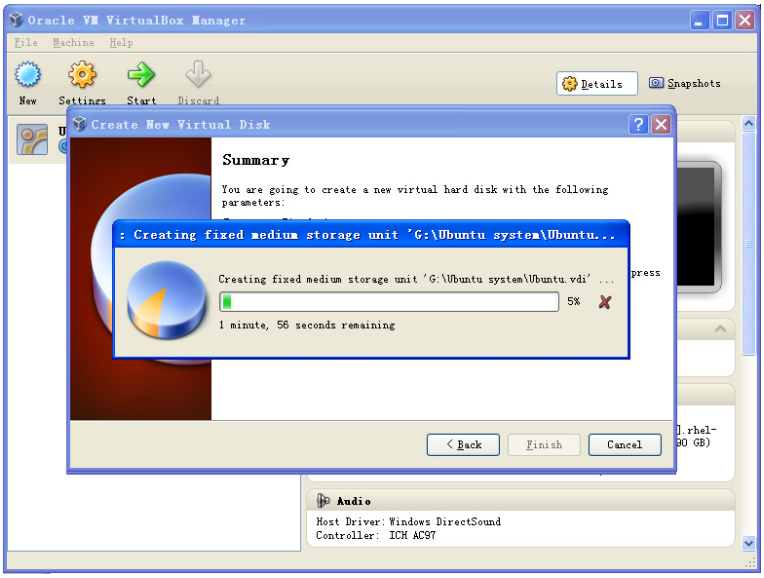
12. Define where the hard disk data is stored and the default space of the virtual disk (8GB at least), and then click **Next**



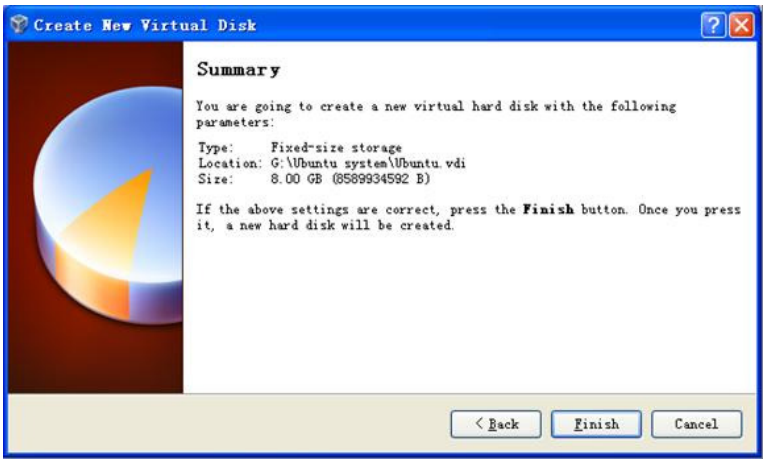
13. Click **Finish** in the following window



14. Your PC will then create a new virtual disk



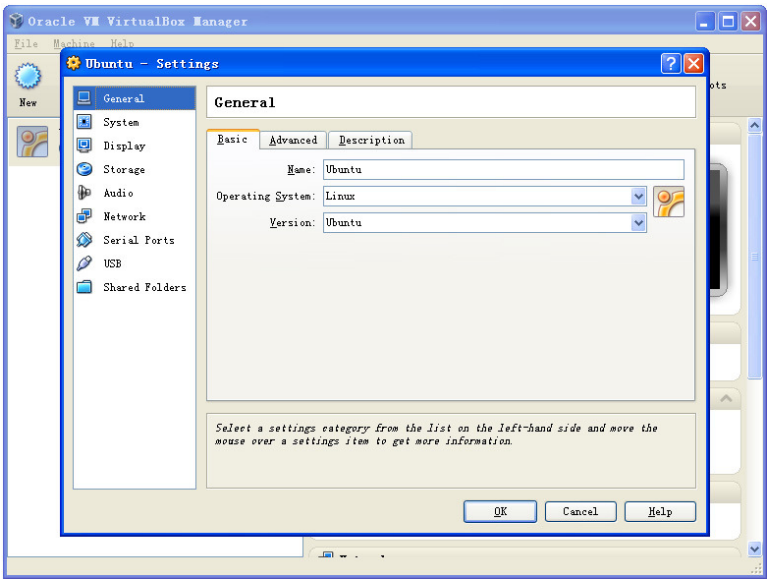
15. A window with summary of the newly created virtual machine will be shown as below when the creation process is done. Please click **Finish** to complete the whole process.



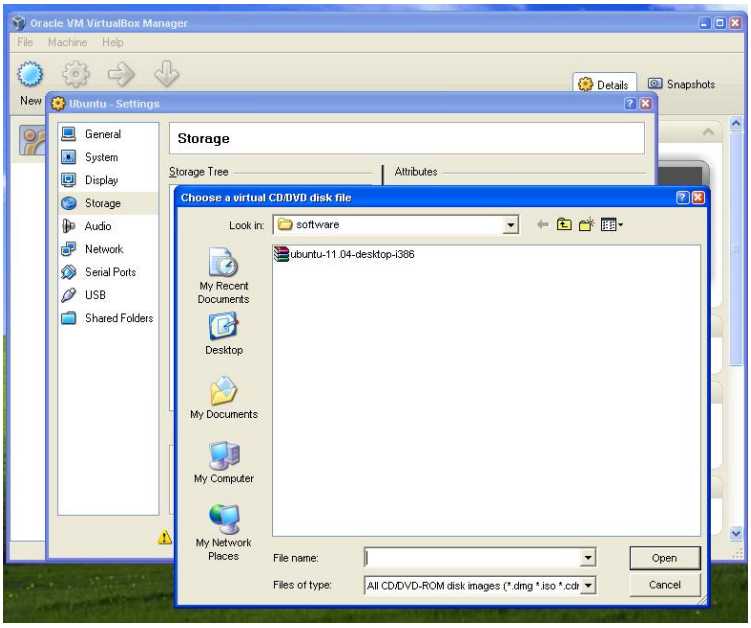
1.2 Installing an Ubuntu Linux System

After VirtualBox is installed, we can install the Ubuntu Linux system. Visit http://www.Ubuntu.com/download/Ubuntu/download to download the ISO image file of Ubuntu, and then follow the steps below:

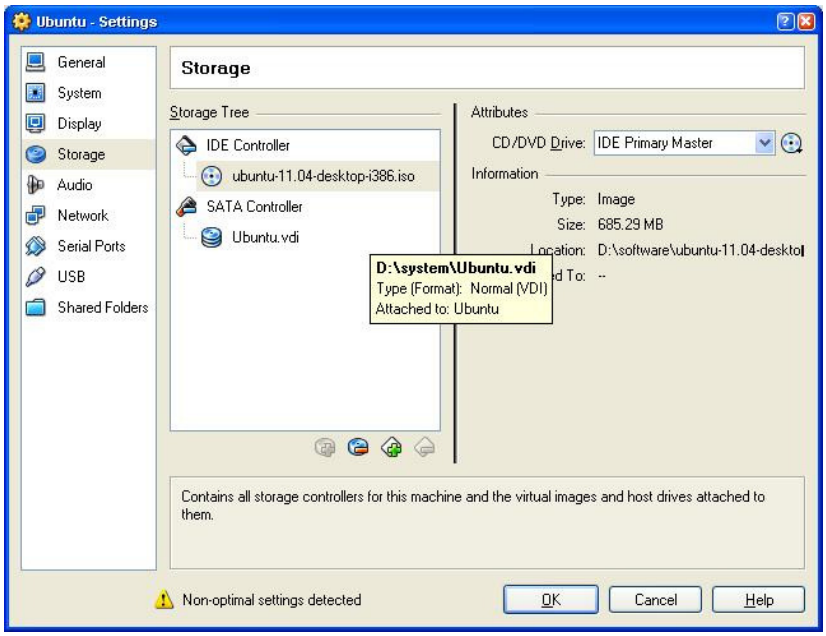
1. Start VirtualBox from the **Start** menu and click **Settings** on the VirtualBox window. A **Settings** window will be shown as below



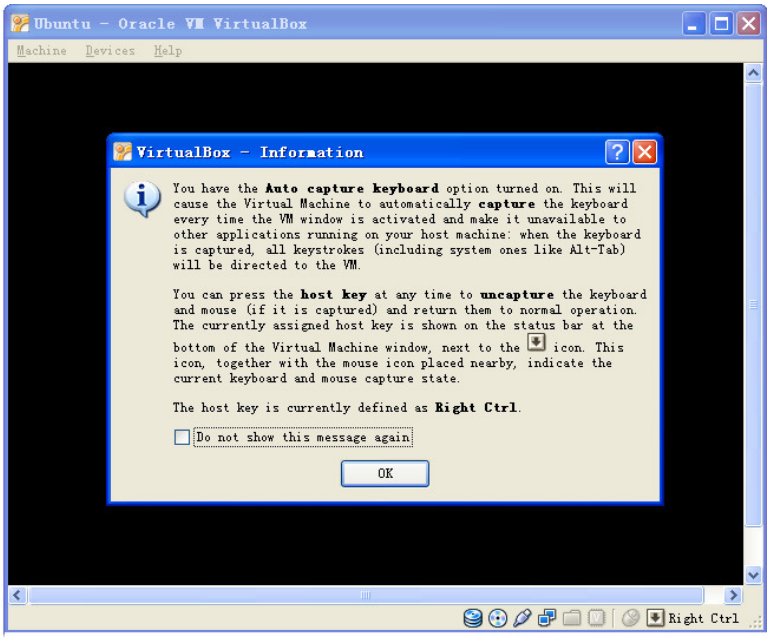
2. Select **Storage** on the left in the **Settings** window and click the CD icon next to the option **Empty** under IDC controller in the right part of the window, and then find the ISO file you downloaded



3. Select the ISO file you downloaded and click **OK** as shown below

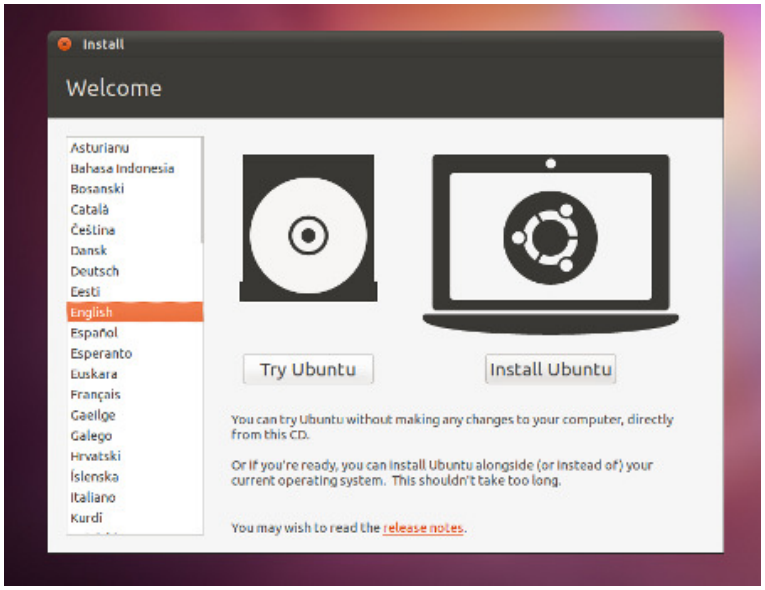


4. Click **Start** on the VirtualBox window, the Ubuntu installation program will start as shown below:

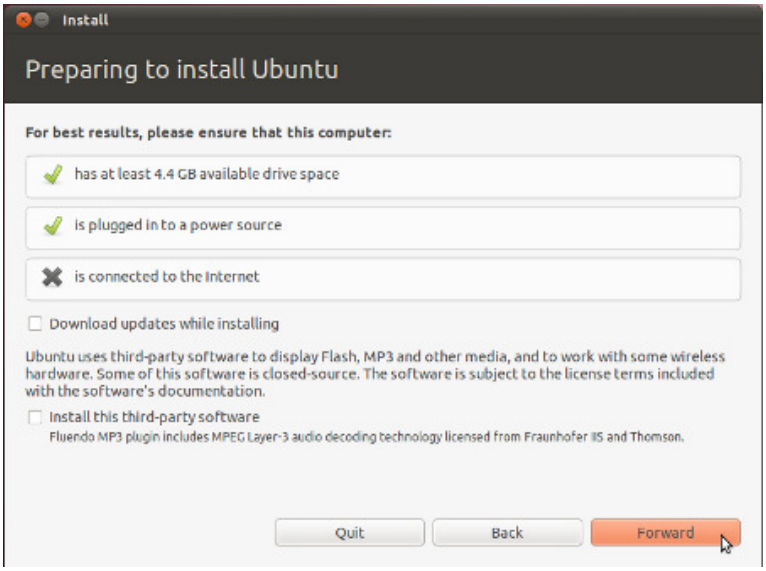


5. Some prompt windows will pop up during the initiation process. You just need only click **OK** all the way to the end of the process.

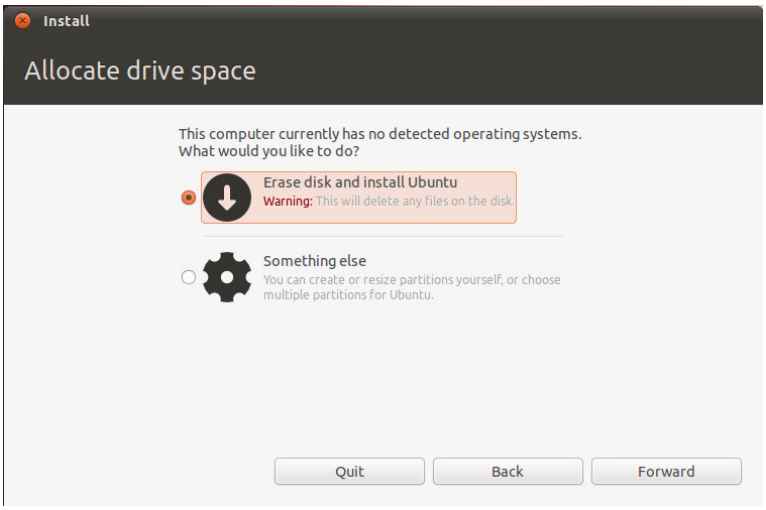
6. Click **Install Ubuntu** to start installation when the following window appears



7. Click **Forward** to continue the process



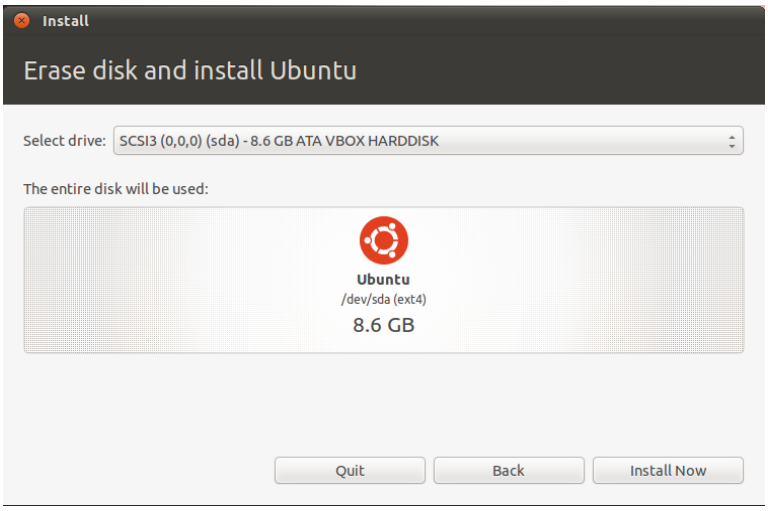
8. Select **Erase disk** and install Ubuntu and click **Forward**



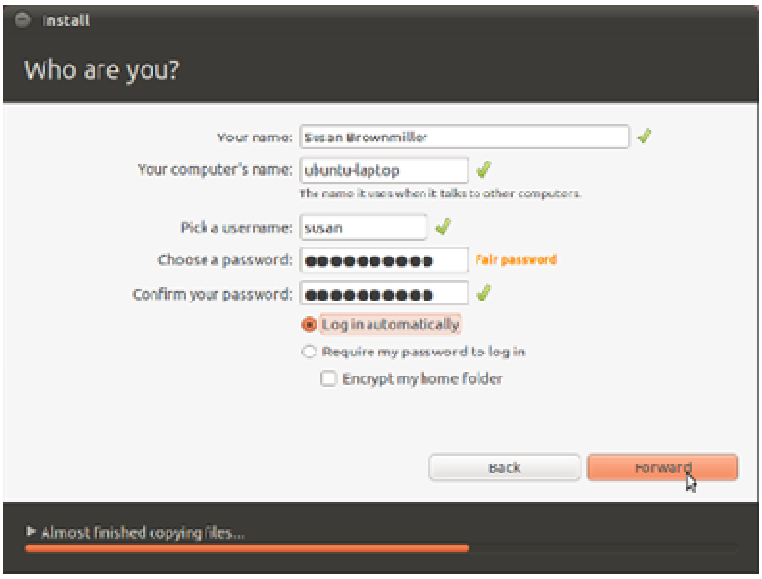
Note:

📖 Selecting this option will only affect the virtual hard drive you created earlier and will not lead to any content loss on your hard drive.

9. Click **Install Now** in the following window to start installation:

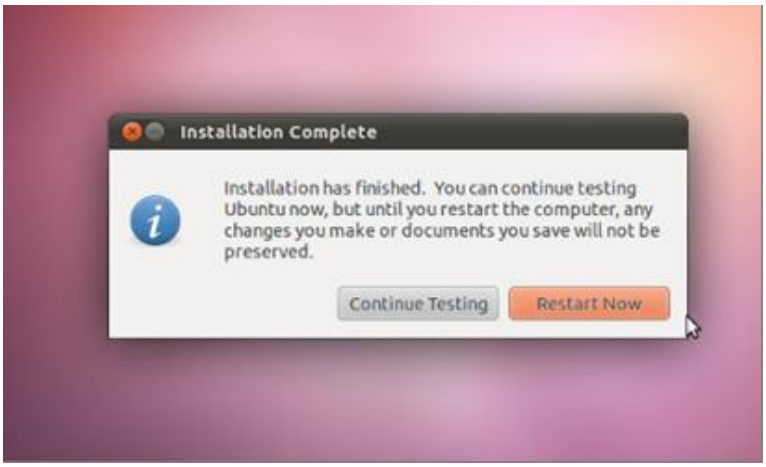


10. Some simple questions need to be answered during the installation process. Please enter appropriate information and click "**Forward"**. The following window is the last question that will appear during the process:

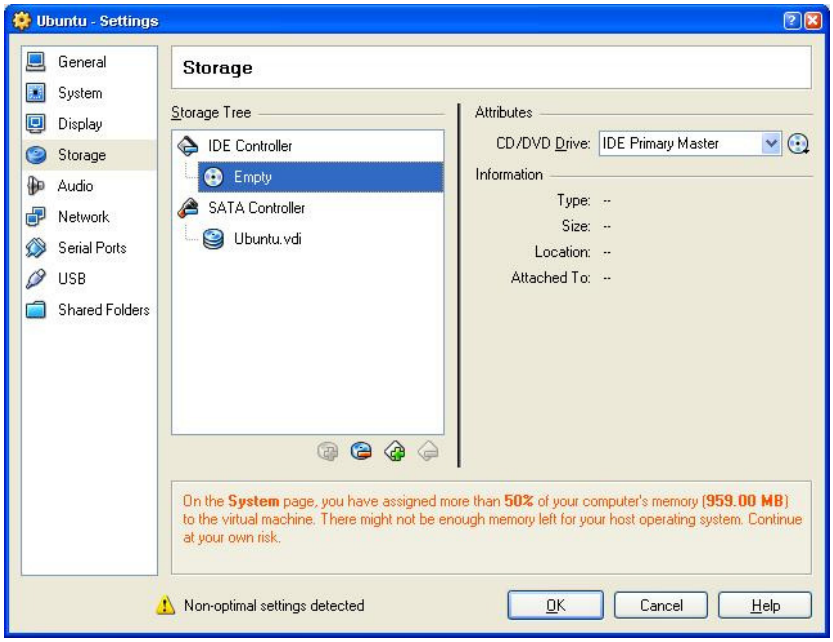


11. After all the required information is properly entered in to the fields, select **Log in automatically** and click **forward**.

12. The installation of Ubuntu may take between 15 minutes to an hour depending on your PC's specification. A prompt window will be shown as below after installation is done. Please select Restart Now to restart Ubuntu system.



13. The Ubuntu system is ready for use after restarting. Normally the ISO file shown below will be ejected automatically by VirtualBox after restarting Ubuntu. If it is not, you can eject the ISO file manually in the **Settings** window of VirtualBox. The following window shows the settings window after the ISO file is ejected.


Ubuntu - Settings
General
System
Display
Storage
Audio
Network
Serial Ports
USB
Shared Folders
Storage
Storage Tree
IDE Controller
Empty
SATA Controller
Ubuntu.vdi
Attributes
CD/DVD Drive: IDE Primary Master
Information
Type: --
Size: --
Location: --
Attached To: --
On the System page, you have assigned more than 50% of your computer's memory (959.00 MB) to the virtual machine. There might not be enough memory left for your host operating system. Continue at your own risk.
Non-optimal settings detected
OK
Cancel
Help