Comparative Analysis of Raspberry Pi with other IotTs Hardware Boards

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Abstract: The Internet of Things is a highly dynamic and distributed network system composed of large number of identifiable smart objects. The objects are able to communicate and interact among themselves. There are number of hardware that supports an entire development of IotTs Applications. Out of that hardware, Raspberry Pi, fully customizable and programmable small computer board is very important. This paper provides the comparative analysis of Raspberry Pi with various IOT hardware board.

Key Terms: Internet of Things, Raspberry Pi, Arduino, BeagleBone Black, Phidgets, UDOO.

I. INTRODUCTION

Raspberry Pi developed in the 1981 by United Kingdom. It is very small powerful computer machine, which is credit card size that can do lots of things. It can be connecting into the TV or computer monitor. The Raspberry Pi uses a variety of different processors. The Raspberry Pi is slower than a modem laptop or desktop, but is still a complete Linux computer and can grant all the expected abilities that implies, at a low power consumption level. Many of the projects modes with a Raspberry Pi are open and we can alter the documents and create our self.

The Raspberry Pi mostly uses Advanced RISC Machine (ARM) processor, this processor is the heart of the Raspberry Pi system. There are many software are used which are RASPBIAN, PIDORA, OPENELEC, RASPBMC, RISC operating system and ARCH LINUX.

NOOBS (New Out Of the Box Software) category it supports python as well as Basic, C, C++, Java and Perl and Ruby languages. All ages of people to explore computing and learn the programming languages like scratch and python. Python Language is used for Raspberry Pi board operating by NOOBS Operating System.

II. RASPBERRY PI MODELS AND MEMORY

Raspberry Pi has two Models, one is A Model and another one is B Model. A model contains 256 MB of RAM and one USB port. Model A is lower power than the model B. Currently the B model contains with a second USB port, an Ethernet connections to a network and 512MB of RAM. Above models is Interface outputs that enable users to plug the machines into a TV, mice, Keyboard and many other input devices could connect via a USB port. The PCB (Printed Circuit Board) houses the input and output connectors as well as the computer hardware itself. There are three Linux based operating systems supported by the Raspberry Pi.

A. Block Diagram

![Fig 1. Block Diagram Of Raspberry Pi](image-url)

The Raspberry Pi models A and B boards been upgraded to the A+ model and B+ model. These upgraded models are slightly improvements such as the expanded the number of USB ports and enhanced power consumption. These are open source models. The block diagram of Raspberry Pi(shown in Fig 1.)

B. Operating System

Raspberry Pi was designed for the Linux operating system. Raspbian and Pidora are the most popular options of operating systems. Raspbian is based on the Debian operating system and Pidora is based on the Fedora operating system.

C. Raspberry Pi Intelligence

The Raspberry Pi has the intelligence to communicate with the outside of the world and has been utilized in a cluster of digital maker projects from music machines and family members detectors to weather stations and tweeting birdhouses with infrared cameras. All over the world
Raspberry Pi is used by children to learn to program and find out how computers work.

D. Hardware And Software Specification

- Central Processing Unit (CPU).
- SD Card of 8 GB or 4 GB for booting operating system.
- HDMI/DVI monitor for display.
- Ethernet cable for Internet access or WiFi.
- WiFi Adaptor.
- USB to power source.
- 40 GIPO Pins (General Purpose Input and Output).
- Audio Fittings.
- USB first port for Keyboard connector.
- USB second for Mouse connector.
- 5 volt power supply.
- Sensors.
- Camera Serial Interface (CSI) camera port for connecting the Raspberry Pi camera.

1) CPU (Central Processing Unit)

The Raspberry Pi board (shown in Fig 2.) contains the brain of the CPU. That is important for caring out the procedures of the computer through logical and mathematical operations and its uses ARM11 series processors.

2) GPU (Graphics Processing Unit)

The Graphical Processing Unit means the particular chip in the Raspberry Pi board and that is to construct to speed up the operation of image calculations. This board constructed with a Broadcom video core IV and its supports open GL Hardware Specifications of Raspberry Pi.

3) Ethernet Port

In the Raspberry Pi the Ethernet port is the fundamental gateway for interacting with further devices. It is also used to plug our home router to access the internet.

4) GIPO Pins

GIPO means the General Purpose Input and Output pins are used in the Raspberry Pi board to accomplish with the other boards. GIPO pins are obtaining input and output commands based on programming Raspberry Pi. It is manages the digital GIPO pins. It is also accepted the other electronic components like if connect it to the temperature sensor to redirect to digital data.

5) XBee Socket

The wireless communications purpose we used the XBee socket in Raspberry Pi board. This module includes an 868 MHz antenna to be used in this frequency.

6) Power Source Connector

The power source cable is a little switch. It is occupy the side of the shied. It is used for the main purpose of the power source connector is to empower an external power source.

7) UART

The Universal Asynchronous Receiver / Transmitter is continuous input / output. It is used for converting the debugging cable and it is useful to transmit the serial data in the form of text.

8) Display

Two types of Raspberry Pi boards are I) HDMI and II) Composite. I) HDTV and LCD monitors are to be connected by an HDMI male cable with adopter. 1.4 version cable is used for HDMI. Audio and video of the Raspberry Pi outputs are through HDMI. It is not supported HDMI Inputs. II) Composite video is using with can be connected in older TVs. Audio is available from the 3.5mm jack socket when using a composite video connection at that time it can be sent to our TV. To send audio to our TV, we need a cable which adjusts from 3.5mm to double RCA connectors.

E. How to Set Up and Start Our Raspberry Pi

The SD card slot is grant to allow us to insert card in Raspberry Pi board. The personal computer hard disk memory is high, as same as the Raspberry Pi board SD card memory device. When we use the board the Linux Operating System is booted onto the card. Many operating systems are used in Raspberry Pi like Linux, Qtonpi, ARM, Mac. We select any one of the above operating system to use it to SD card for store the data. Not only one SD card storage device is used, otherwise USB external hard drive and USB drive are used. There are many SD cards are available but Raspberry Pi is accepts max64 GB SD card.

Now we are going to start our Raspberry Pi board, first we connect a monitor, keyboard and mouse. The output will be produce in three various ways like HDMI, video, DS1 Video and composite video. The main convenience to work
with Raspberry Pi is it is too small in size and less cost to works as a personal computer.

III. OTHER IOT HARDWARE BOARDS

Other than Raspberry Pi Board, there are number of boards available for IOT Hardware. They are

A. ARDUINO

Arduino board (shown in Fig 3.) is a open source microcontroller based on ATMega328 Processor. It simply connect to the computer with USB cable or power it with AC-to-DC adapter or with battery.

Arduino is an open-source electronics platform based on easy to use hardware and software. Arduino board is able to read input light on a sensor, a finger on a button and turn it into an output, activating a motor, turning on a LED. It must to be usable for nay kind of IOT device. Arduino boards are relatively inexpensive compared to other microcontroller platforms. Arduino Integrated Development Environment (IDE) is also available for writing programs for the board. Arduino supports two working models, standalone or connected to a computer via USB cable. Abundant example programs in Arduino IDE make it easy for IOT device work in all kind of environments.

![Fig 3. An Arduino Uno Board](image1)

B. BEAGLEBONE BLACK

BeagleBone Black Board (shown in Fig 4.) is a low-cost open source credit card-sized computer with cortex A8 ARM Processor from Texas Instruments. It is a system-on-a-chip device which means it perform all the duties of computing on a single chip. It is a powerful system with 1GHz processor. It can run on operating system such as Linux/Andriod4.0. It has more processing capacity than Arduino. BeagleBone Black is perfect for physical computing and smaller embedded application.

![Fig 4. A Beaglebone Board](image2)

C. PHIDGETS Board

Phidgets Board (Shown in Fig 5.) are a set of “plug and play” building blocks for low cost USB sensing and control from computer, tablet or phone. Users create applications that use phidgets to interact with physical world. There are various phidget available, each having a counterpart class in the phidget API. Phidgets are easy to use set of USB based building blocks for low cost sensing from your PC. A wide array of sensors, I/O devices and controllers are available.

Phidgets can be programmed using a variety of software and programming languages ranging from Java to Microsoft Excel. The Phidget API is what allows system to access phidget devices in high level manner.

![Fig 5. A Phidgets Board](image3)

D. UDOO Board

UDOO is a single-board (shown in Fig 6.) computer with an integrated Arduino2 compatible microcontroller, designed for computer science education, the world of makers and the Internet of Things. They are powerful prototyping board for software development and design and are easy to use, allowing projects to be developed with minimal knowledge hardware design. UDOO boards are open hardware, low-cost platform equipped with an ARM iMX6 free scale processor and an Arduino duo compatible section based on ATMELE SAM3XSE ARM Processor. This board is ideal to robots, drones and rovers as well as any Mobile IOT project you can imagine. UDOO Dual, UDOO Quad and UDOO Basis are other boards of UDOO.

![Fig 6. AN UDOO BOARD](image4)
IV. COMPARISON OF RASPBERRY PI WITH THEIR IOT HARDWARE BOARDS

Table 1. Comparative Analysis of Raspberry Pi with Other IoT Boards

<table>
<thead>
<tr>
<th></th>
<th>Raspberry Pi</th>
<th>Arduino</th>
<th>BeagleBone Black</th>
<th>Phidgets</th>
<th>UDOO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size (mm)</td>
<td>85.6 X 53.98 X 17</td>
<td>75 X 53 X 15</td>
<td>86.3 X 53.3</td>
<td>81.3 X 53.3</td>
<td>110 X 85</td>
</tr>
<tr>
<td>Weight (g)</td>
<td>45</td>
<td>30</td>
<td>39.68</td>
<td>60</td>
<td>120-170</td>
</tr>
<tr>
<td>Cost per node US $</td>
<td>25 – 35</td>
<td>30</td>
<td>45</td>
<td>50 - 200</td>
<td>99 – 135</td>
</tr>
<tr>
<td>Processor</td>
<td>ARM BCM2835</td>
<td>ATMega8,ATmega1 68, 328, 1280</td>
<td>AM335x, 1 GHz ARM @CORTEX A8</td>
<td>Phidget SBC</td>
<td>Free i.MxQuad, 4XARM ® Cortex, A9CorAtmeT, SAM3X8E,, ARM Cortex, M3CPU</td>
</tr>
<tr>
<td>RAM</td>
<td>256-512MB</td>
<td>16-32MB</td>
<td>512MB</td>
<td>64MB</td>
<td>1GB</td>
</tr>
<tr>
<td>Power</td>
<td>5V/USB</td>
<td>7-12V/USB</td>
<td>5V</td>
<td>6-15V</td>
<td>6-15V</td>
</tr>
<tr>
<td>Analog Inputs</td>
<td>0</td>
<td>6</td>
<td>6</td>
<td>8</td>
<td>14</td>
</tr>
<tr>
<td>Digital I/O pin</td>
<td>14</td>
<td>14</td>
<td>14</td>
<td>8 1+8 O</td>
<td>62+14</td>
</tr>
<tr>
<td>USB Ports</td>
<td>1-2</td>
<td>1</td>
<td>1</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>LAN (Mbit)</td>
<td>10/100</td>
<td>-</td>
<td>10/100</td>
<td>-</td>
<td>10/100/1000</td>
</tr>
<tr>
<td>Board Operating System</td>
<td>Raspbian, Ubuntu,Andriod,Arch Linux, FreeBSB, Fedora, RiscOS</td>
<td>-</td>
<td>Linux Angstrom</td>
<td>Linux</td>
<td>Linux Andriod, Ubuntu, ArchLinux, Linux</td>
</tr>
</tbody>
</table>

The different development boards have different characteristics such processor, processing speed, RAM, Power, Operating Systems etc. The Table 1 shows the comparative Analysis of Raspberry Pi with other boards. In our observation, Raspberry Pi Development board has Ethernet, SD card, HDMI, WIFI and GSM, it is best suitable of Internet of Things.

V. CONCLUSION

Raspberry Pi performances are compared with some popular boards. Raspberry Pi has higher performance in comparison with other board in terms of storage and computing speeds but the cost of higher price. Raspberry Pi equipped with inbuilt WIFI and Bluetooth serves an easy means to connect to internet. Raspberry Pi makes suitable for applications in IOT concept. All of the boards can be very successfully applied to IOT hardware components. Choosing between one and other will depend on projects requirements.

REFERENCES