

A comparative analysis of Raspberry pi Hardware with Adruino, Phidgets, Beaglebone black and Udo

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Abstract- *Internet of things (IoT) is a highly dynamic ideology. It is composed of large number of interconnected computing devices, mechanical and digital machines, objects that are provided with unique identifiers. IoT is the integrated part of the future internet. IoT is the technology through which these interconnected objects can communicate with each other with the sensors. In IoT there are various cheap and flexible computer hardwares that allows the end user programming present. In this paper one of them is considered which is the Raspberry pi which is cheap, credit card sized completely customizable and programmable little PC board, and the comparative analysis of Raspberry pi's key elements and performances with other current existing IoT prototype platforms which are as follows a)Phidgets, b)Adruino, c)Beaglebone black and D) Udo. This analysis shown that despite of few disadvantages with the Raspberry pi it remains the most inexpensive hardware.*

Keywords- Raspberry pi, Adruino, prototype platfroms

1.Introduction

The IoT is the interconnectivity of uniquely identifiable embedded computing devices within the existing internet infrastructure. Interconnected objects in the IoT can communicate and interact either with themselves or with the end user or with other entities in the network [1]. There are hundreds of products today which allows the end user programming. gives the opportunity to non-professional end-users of making additions to products, according to their specific needs. There are various hardwares which are not expensive and open source softwares available using which it

is possible to programmatically control many devices in a way that own solutions meet user needs. Also, providing various techniques to end user and the possibility to shape products according to their need makes it beneficial for both the user and the developer who develops the product.

This paper considers one of the prototype platforms which enables the end user programming which is Raspberry pi. primary emphasis of this paper is on the raspberry pi and its comparative study of its performance Based on various categories with other prototype platforms those are a)Adruino, b)Phidgets, c)Beaglebone black, and d)Udo.

This paper is going to be as follows first is the Overview of the Raspberry pi and after that raspberry pi and its core component and detail comparison with the other platforms which are available with conclusion.

2.Overview Of Raspberry pi

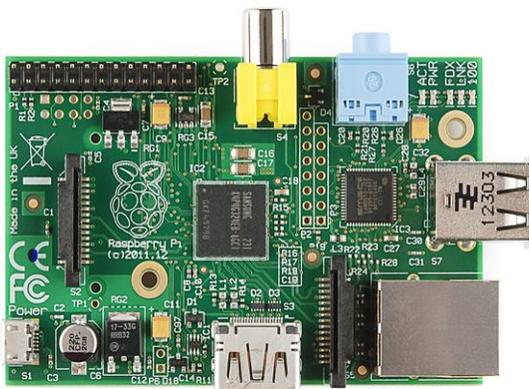
Smart objects are the objects which enhances the interaction with not only the people but other smart objects. They can understand and react to their environment. These objects are the building blocks of the IoT. These objects can store their information, they are connected together, they are able to access the internet services [3].

Raspberry pi is the credit card sized chip which is very powerful introduced in 2012 (figure 1). Developed in uk by raspberry Pi foundation [2]. It is very affordable that you can use to learn programming through fun practical objects. It plugs into the tv or the computer monitor very easily. It requires power supply, keyboard for command and display for visual. It provides high performance with the affordable

price which is around 25\$-35\$. Raspberry pi chip model A and model B is shown below. [4]



(a)



(b)

Figure 1. Raspberry pi model A(fig(a)) and the B(fig(b))

Raspberry pi chip contains central processing unit(cpu), graphic processing unit(gpu), audio and communication hardware and ram. Ram differs in model A and B, model A has 256mb memory chip and model B has 512 memory chip. These all things are built onto the single component.[2]

Figure 2 shows the raspberry pi’s core components, which includes ram. Cpu, gpu, and processor and other various connectors for peripheral devices. Its supports 3 types of video output HDMI video, composite video and DSI video. Raspberry pi doesn’t come with the onboard storage you’ll need an empty sd card in that you can flash Operating System. Mouse and keyboard can be connected through usb port to navigate through the operating system. It provides

3.5mm audio jack to connect our external speakers to the chip. [5]

Raspberry pi contains 32 bit processor, 700 MHz system on chip which is built on ARM11 architecture [2]. To gain more power one can overclock it. Internet connectivity can be provided via Ethernet cable or dongle via usb(WIFI). Raspberry pi is like any other computer which contains os. There are wide variety of os that raspberry pi supports. But linux operating system is a great match for the raspberry pi because it is open source and keeps the price of the platform low. Linux os

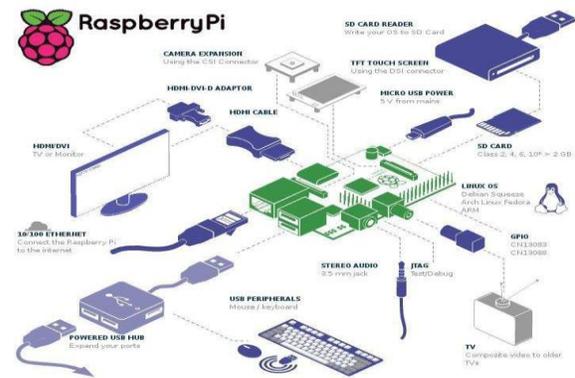


Figure 2. components of Raspberry pi

option is called Raspbian. One of the great thing of the raspberry pi is it has wide range of usage.

3.Raspberry pi vs other hardware platforms

Comparing the performance of Raspberry pi with the following IOT platforms.

A)Phidgets-Phidgets are an easy to use set of building blocks for less cost sensing and control from your pc.

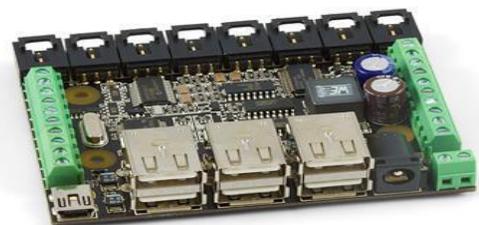


Figure 3: Phidgets

Phidgets are the usb sensors and controllers that connects computers and technology to real world. It uses Universal serial bus(USB)-based hardwares as the basis for input for eg, switches, RFID tags, light intensity, temperature movement etc and output actuators like LCD displays, LED indicators etc. Each phidgets will be requiring visual component so that it provides visual on screen interface through which end-user control becomes interactive. The name Phidgets is a portmanteau of physical and widgets, meaning is a physical component that enables a user to perform a function or access a service, in this case, reading a environmental conditions or controlling physical devices such as motors. We can communicate to the phidgets in the same language as the source code of application being developed. [6][7]

B)Arduino-Arduino is an open source prototyping platform based on easy to use hardware and software. It is a simple microcontroller

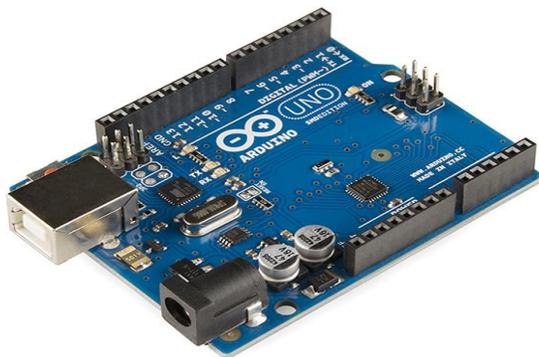


Figure 4: Adruinouno

board. it consists of both a physical programmable circuit board (often referred to as a microcontroller) and a piece of software or a IDE (Integrated Development Environment) that runs on your computer, used to write and upload computer code to the physical board.

Arduino can read inputs through various sensors for example light on the sensor, finger on the button and can turn it into outputs- activating the motor, turning on the led. You can tell your board what to do by sending a set of commands/instruction to the microcontroller on the board.

Adruino supports 2 working nodes connected to computer via usb or standalone.[8]

C)Beaglebone black- It is a small credit card sized board. It supports both android 4.0 and linux operating system.

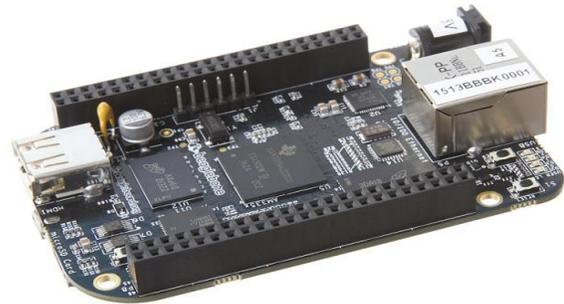


Figure 5. Beaglebone black

Talking about the processor it uses ARM cortex A8 processor. It uses various connectivities (usb client for power and communications, usb host, Ethernet, HDMI) as shown in the figure.

It is designed to work on much higher level and also it has more processing power as compared to adruino. [10]

D) Udoo- Udoo is a single-board mini personal computer. This product was launched on kickstarter in april 2013. It can be used on both android and linux os, with an embedded adruino-compatible board. It is a very powerful board for software development and design. It is easy to use and allows developing project with minimum knowledge of the hardware. It embeds micro-computer with most common communication ports which are digital and analog input/output, SATA, HDMI, WIFI, ETHERNET and USB.



Figure 6. An Udoo board

Talking about the processor it has the ARM i.MX freescale processor and an adruino compatible section contains AMTEL SAM3X ARM Processor. [11] We can say that the udoo brings the good elements of raspberry pi and the Adruino together into a single mini personal computer. Udoo is available in three models i)UDOO dual basic,ii) UDOO dual, iii)UDOO quad.

Let’s compare these on various aspects.

I] Power and Memory: In order to meet multilayer application requirements, the main goal is low power consumption. We can perform Ultra-low-power operation by using the low power hardware components. Cpu of the raspberry pi hardware is mainly responsible for the carrying out the information of computer program. Raspberry pi has Arm based BCM2835 which is cheap and powerful and consumes very less power hence raspberry pi can operate on 5v 1A power provided by onboard micro-usb port.Raspberry

Name	Processor	RAM*	Power
Raspberry -Pi	ARM BCM2835	256-512 MB	5V/ USB
Arduino	ATMEGA8, ATMEGA168 ATMEGA328ATMEGA1280	16-32 KB	7-12V /USB
BeagleBone Black	AM335x 1GHz ARM@ Cortex- A8	512 MB	5V
Phidgets	PhidgetSBC	64 MB	6-15V
Udoo (Quad)	Freescale i.MX6Quad, 4 x ARM@ Cortex™-A9 core Atmel SAM3X8E ARM Cortex-M3 CPU	1 GB	6-15V

pi has 4 different power modes.[12]

A) standby: in this mode mainly cpu components that processes the information are mainly shut down and but power circuits are still active. We Can activate cpu components that processes the information but issuing interrupt(special call) to the cpu. This mode is also known as the wait for interrupt that meanscurrent processing is stopped until cpu receives an interrupt.

B) Run: all the cpu components that processes the information are powered up and running.

C) shutdown: there isn’t any power

D) Dormant: only the caches are powered on and core is powered off. Raspberry pi for operating require upto 700mA. Various sources can be used to power up the raspberry pi provided they should be able to provide current nearly equal to 700mA. Thses various sources are, [6]

- Alkaline batteries
- Computer usb port
- Solar charger

Lets talk about the storage, devices should have efficient storage available to store the real time data collected. There is no inbuilt storage available on the raspberry pi circuit although we can use the secure digital (SD) card as per our need. Everything is stored on the SD Card. Minimum 2gb SD card is required there are also 32gb and 64 gb cards are available but they are expensive. Storage can be expanded anytime by using devices that provides extra space by usb ports. [6]

Advantages:

- User can expand storage as per his need using SD card.
- Storage can be expanded anytime using devices which provides extra space with by USB ports.

Disadvantages:

- Biggest Limitation Regarding power is external devices cannot draw more than 100mA from any of its usb port. So if any external device want more than that it can get more power.
- RAM of Raspberry pi is limited i.e 512mb or 256mb. One cannot expand its memory.

Comparison of various hardwares are provided below regarding CPU, MEMORY and POWER.

II) Cost and Size: Cost and the size is one of the important constraint. If the components which are smaller in sizes are used as sensor nodes then they can be placed in more locations and and can be used in many scenarios. And talking about the cost if the components are cheaper one can purchase more in low budget, to collect more data. So if one can get more components in cheaper price he can collect more and more data from different sources.

Raspberry pi comes for a price around 25-35 \$, Adruino for 30\$, beaglebone black for 45\$, Phidgets around 50-200 \$, and Udoo for 99-135\$. So the cheapest is Raspberry pi.

Advantages:

- It comes for very cheap cost so anyone can afford it.

- It is credit card sized which is very compact.

Disadvantages:

- Although it comes for cheap price it requires addition cost to buy SD card Keyboard etc.

Name	Board operating system	Programming language
Raspberry Pi	Raspbian, Ubuntu, Android, ArchLinux, FreeBSD, Fedora, RISC OS	C, C++, Java, Python
Arduino	/	Arduino
BeagleBone Black	Linux Angstrom	Arduino
Phidgets	Linux	Visual basic, vb .net, c#, c++, java, matlab
Udoo	Ubuntu, Android, Linux, ArchLinux	Arduino, C, C++, Java

Table 2: comparison of size weight and cost

III) Programming languages use and Operating system

Various platforms uses various operating system and various programming languages as a command. There are various ways in which we can program smart devices, we can either program it using in some form of operating system or to choose a higher level of abstraction. Different operating systems have different nature, they differs in the approach to thread model, real time features, data protection etc.

Table 3 represents the comparison of operating system and programming languages used in different prototype platforms. As shown in the table raspberry pi supports various operating system. Linux version is most suited for raspberry pi. Linux version is called as Raspbian [9].

Name	Size (mm)*	Weight (g)*	Cost per node US\$*
Raspberry Pi	85.6 x 53.98 x 17	45	25-35
Arduino (Uno)	75 x 53 x 15	~30	30
BeagleBone Black	86.3 x 53.3	39.68	45
Phidgets	81.3 x 53,3	60	50-200
Udoo	110 x 85	120-170	99-135

Table 3. various operating systems and programming languages

Mostly the linux version is used because it is open source which makes platform very cheap. They run on raspberry pi's ARM processor very well. There for several reason to choose the linux operating system which is called as raspbian,

- Due to Open source there is wide spread community which supports the operating system.
- It is optimized for the raspberry pi's hardware.
- Raspbian provides more than a pure OS: it comes with over 35,000 packages, the pre-compiled software bundled in a nice format for easy installation on your Raspberry Pi. [9]

Advantages:

- Its performance increases rapidly due to its raspbian Os beacuse it is optimized for raspberry pi
- Product does not require extensive programming experience since it is aimed for the younger generation to learn about programming. It uses python which is less complex than other programming languages.

Disadvantages:

- Its processor cannot run x86 operating systems.
 - Hence it cannot run windows Operating system.

IV) Communication:

Ethernet port is the main gateway to communicate with the other devices. Using Ethernet port it can be directly connected to router or the other computer. Raspberry pi A model does not have standard Rj45 ethernet port but model B does have it. Even though model A does not have standard RJ45 ethernet port it can be connected to wired network using USB Ethernet Adapter. USB Ethernet Adapter comes with the 2 speed modes which are- 10mb/s and 100Mb/s [13].

When a cable is connected raspberry pi will automatically receive the details it needs to access when it loads its OS through DHCP protocol [13].

As shown in the table Raspberry pi Supports 2 speed mode which is 10mb/s and 100Mb/s.

Beaglebone black supports the same speed modes as the Raspberry pi. Aduino and phidgets does not support the lan. Here the fastest communication takes place in the udoo as shown in the table.

NAME	LAN(Mbit)	WiFi Module
Raspberry pi	10/100	-
Aduino	-	-
Beagleboneblack	10/100	-
Phidgets	-	-
Udoo(quad)	10/100/100*	-

Table 4: Comparison of Communication Interfaces Advantages:

- Raspberry pi does have Rj45 port hence it can directly connected to the Router or the other Computer.

Disadvantages:

- Lack of integrated wifi module but this support can be added using the wifi dongles.

4. Conclusion

Raspberry pi’s performance is compared to the various hardware platforms on a basis of size and cost, communication, OS and languages used, Power and Memory. On the basis of above it can be stated that udoo is the highest in its performance but it is very much expensive compared to other hardware platforms. Raspberry pi on the other hand is very cheap credit card size chip. Most of the people can easily afford Raspberry pi due to its cheap price. When used linux os with Raspberry pi it can provide great performance. End user can easily program Raspberry pi according to his need. It provides platform to connect large number of peripherals. Raspberry pi has wide variety of usage. It supports Ethernet port with 2 speed modes. Excepts its few disadvantages it serves its job very perfectly.

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