A Review on Large Computation on Small Scale Platform: Raspberry Pi vs Arduino, Way of Picking the Right Smart Device for the Smart World.

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Abstract -Internet of Things (IoT) is a network or connection of physical objects or "things" embedded with electronics, software, sensors, making these objects capable of collection of data. IoT devices are very useful to monitor and control the mechanical, electrical and electronic systems used in various buildings (e.g. public and private, industrial, institutions, or residential). Home automation systems, like other building automation systems, can be typically used to control lighting, heating, ventilation, air conditioning, appliances, communication systems, entertainment and home security devices. So selecting the right devices for the automation application is one of the challenging task, hence this paper presents some of the aspects to take the decision over the choice of Arduino or Raspberry Pi of which board is easy to learn or why should use Arduino over Rpi and vice versa for the IOT application.

Key Words: IOT, IDE, GPIO, HAT, PWM.

I. INTRODUCTION

The Internet of Things (IoT) is a popular buzzword right now. The explosive growth of the "Internet of Things" is changing our world and the rapid drop in price for typical IoT components is allowing people to innovate new designs and products at home.

IoT has applications across all industries and markets. It spans user groups from those who want to reduce energy use in their home to large organizations who want to streamline their operations. It proves not just useful, but nearly critical in many industries as technology advances and move towards the advanced automation imagined in the distant future.

First thing need for many IOT application is the source to collect data to initiate the entire process and this can be done using different sensors based on the different applications and the data from the sensor need to hit to the internet and the data or instructions from the internet need to hit the actuators or sensors. But for

Housing sensors and more importantly onboardthose into IOT chains and to plug the sensors and make them to connect to the internet required a circuit board that is where Arduino and raspberry pi devices comes into the picture.

Both Raspberry pi and Arduino are single board computers with varying processing power and capabilities. This paper review on how these can be used for the different applications.

II. DETAILS ABOUT ARDUINO BOARD

Arduino is a microcontroller motherboard. A microcontroller is a simple computer that can run one program at a time, over and over again. Which is not as much powerful as Raspberry Pi, and can be considered as a one component on computer system.

But it is a great hardware for electronics projects. It doesn't need any OS and software applications to run, just need to write few lines of code to make it use. There are many Arduino boards like Arduino UNO, Arduino PRO, Arduino MEGA, Arduino DUE etc.

It's a microcontroller, not a full-fledged computer. It doesn't have an operating system, or a file system. The processor on these devices is quite simple and cannot multitask between several applications. The Arduino is entirely focused on executing a specific task even if that task involves reading multiple sensors or controlling multiple components via output pins.

The typical Arduino device has a very small amount of RAM, about 2KB, and 32KB of flash memory for your application storage. For data values that might change during the execution of application, but need to be preserved, there is also 1KB of EEPROM storage.

- *DEVELOPMENT ENVIRONMENT / TOOLS:*

With the Arduino's limited program storage and very small SRAM the efficiency of the application is important. For that reason, applications are generally written in C/C++ using the Arduino IDE. The applications written for the Arduino are rather appropriately called Sketches because they are generally of a very short nature. Their focus is on interacting with the hardware devices connected to the Arduino and perhaps transmitting data or receiving commands from another computer.

- *SENSOR CONNECTIVITY:*

The Arduino provides a complete set of 14 digital and 6 analog inputs and outputs. That allows to turn items on and

off (digital) and detect digital changes in state of connected components. Unlike the Raspberry Pi the Arduino also has a complete set of analog inputs. These can be used to measure applied voltages to respond to analog changes in things like temperature, light levels, etc. For cases where need to apply analog output the Arduino also supports pulse-width-modulation (PWM) which is a means of setting an analog level on a component (like the brightness of an LED). In addition to the array of inputs and outputs the Arduino also has a hardware design that allows add-on boards, called shields, to be coupled to it. These extend the basic, built-in I/O capabilities to controls things like motors, or add network capabilities.

- *NETWORK CONNECTIVITY:*

The Arduino provides no built-in network connectivity except in higher priced Arduino boards like the Arduino Yun. For Arduino projects that require network connectivity various shields are available to support either Ethernet or Wi-Fi connectivity. These shields however, can add significant costs to your project; often costing as much as the Arduino itself. In addition, the power requirements of the shield may result in the need to add a larger power supply to your project.

- *POWER REQUIREMENTS:*

Arduino is a relatively low power device that can run on a 9V battery or a battery pack with six AA cells. The board itself can supply power to a simple circuit that might be created for a project. The addition of shields and a larger set of sensors, display panels, etc. may increase power requirements which might require a separate power supply. The Arduino itself can also be powered off its USB port or from an AC power adapter.

- *COST:*

Base price for an "official" Arduino Uno is $25. There are several sources of Arduino Uno boards besides the official version from the Arduino foundation. Some of these boards are available for less than $10 although their quality can vary. The Arduino needs a power source which typically costs less than $5.

III. DETAILS ABOUT RASPBERRY Pi

Raspberry pi big brother of Arduino, a generation of small handy credit card sized computer which is not only famous for its size and price but also works really well. The name Raspberry is from the fruit name and Pi from python language together makes raspberry pi. The Raspberry Pi is a substantially more powerful device, but that power comes with some responsibilities that aren't requirements for Arduino devices. The Raspberry Pi is a full computer.

Typically the Raspberry Pi will run some version of the Linux operating system. Recently, Microsoft has made a version of Windows 10 available for the Raspberry Pi 2 as well. In addition to running the operating system the Raspberry Pi can readily be connected to a network via Ethernet, provides ports to connect USB input devices like keyboards and mice, and has an HDMI connector for video output.

The Raspberry Pi works pretty much like any PC or Mac that you would load Linux onto albeit with lower performance than PC hardware from even 5 years ago. Most Raspberry Pi models have 512MB or more of RAM making them quite capable of running several programs concurrently. Permanent storage is usually an SD card which is generally from 4 to 32GB in size.

It has several models and revisions like Raspberry Pi, Raspberry Pi 2, and Raspberry Pi Model B+ etc.

Raspberry Pi has an excellent programming IDE with GUI. It can be connected to a laptop or PC and can be programmed. Raspberry Pi is used for requirements that need high level of direct connectivity with the internet, like standalone single sensor that needs to update certain readings over the internet to your data collection application.

- *DEVELOPMENT ENVIRONMENT/TOOLS:*

The commonly promoted language for the Raspberry Pi is Python, the flexibility of this platform lets users to use a variety of languages including Ruby, PHP, and Java. Even Node JS can be used on the Raspberry Pi and develop IoT apps in Javascript with the Johnny-Five framework and even do visual Node development using NodeRed entirely on the Raspberry Pi.

- *SENSOR CONNECTIVITY:*

The Raspberry Pi also provides 8 I/O pins, but they are all digital in nature. In order to interact with an analog devices its need to wire up an additional chip to the digital pins. A common means of doing this is through a chip called the MCP3008 which costs under $4. There are also a selection of boards for the Raspberry Pi sometimes referred to as HAT (Hardware Attached on Top) which are similar in overall concept the Arduino shields.

- *NETWORK CONNECTIVITY:*

This is an area where the Raspberry Pi has a big lead. The majority of Raspberry Pi boards come with an Ethernet connector right on the board. The USB ports found on the Raspberry Pi also makes it easy to hook a Wi-Fi dongle up to the Raspberry Pi and obtain network connectivity that way.

- *POWER REQUIREMENTS:*

The power requirements of Raspberry Pi are more significant. Most Raspberry Pi projects rely on powering

the device from a 5V micro USB power source that outputs at least 1 to 2 amps depending upon what version of the Raspberry Pi. The Pi also has a much narrower range of voltage tolerance and really needs a constant 5 volts. The Arduino is much more tolerant accepting recommended input voltages from 7V to 12V. The current draw and consistent voltage requirement makes the Raspberry Pi unsuitable for being powered by most typical dry-cell batteries as their voltage output generally drops off as they discharge.

- *COST:*

The Raspberry Pi foundation released the Raspberry Pi Zero with an attractive price point of $5, this very low priced version is in short supply at the moment, but in coming months these should be more commonly available. The Zero does not come with a Ethernet port so networking is commonly added by connecting a Wi-Fi adapter to the USB port. The Pi Zero also has lower power requirements which may make it somewhat more suitable to battery powered applications, however the requirement for orderly shutdown of the system still exists.

IV. NEED OF ARDUNINO OR Pi

This section explain the need of Arduino or Pi device, through a simple example. Like if the person want answer any phone call automatically with a prerecorded message, then Arduino is the way. But at the same time if a person want to block the robo callers or spam callers then? Then Raspberry Pi comes into picture, which can either filter the spam calls using spam callers database over the internet or it can also put a captcha type of verification for human callers.

So Arduino is suited for repeated type of work like open the door while anyone at the gate but Raspberry Pi can do more complex things like only open the door for authorized people. Raspberry Pi has huge potential in the world of Internet of Things, where machines will directly interact and control another machines, without human intervention.

V. ADVANTAGES OF ARDUINO OVER RASPBERRY PI

- *SIMPLICITY:*

It's very easy to interface analog sensors, motors and other electronic components with Arduino, with just few lines of code. While in Raspberry pi, there is much overhead for simply reading those sensors, need to install some libraries and software's for interfacing these sensors and components. And the coding in Arduino is simpler, while one needs to have knowledge of Linux and its commands for using the Raspberry pi.

- *ROBUSTNESS:*

Raspberry Pi runs on an OS so it must be properly shut down before turning OFF the power, otherwise OS & applications may get corrupt and Pi can be damaged. While Arduino is just a plug and play device which can be turned ON and OFF at any point of time, without any risk of damage. It can start running the code again on resuming the power.

- *POWER CONSUMPTION:*

Pi is a powerful hardware, it needs continuous 5v power supply and it is difficult to run it on Batteries, while Arduino needs less power can easily be powered using a battery pack.

- *COST:*

Obviously Arduino is cheaper than Raspberry Pi, Arduino costs around $10-20 depending on the version, while price of Raspberry is around $35-40.

VI. ADVANTAGES OF RASPBERRY PI OVER ARDUINO

One can think that Arduino is the best, after reading its merits over Raspberry Pi, but, it's completely depends on the project that which platform should be used. Raspberry Pi's power and its easiness is the main attraction of it, over Arduino.

- *POWERFULNESS:*

This is the main advantage of Raspberry Pi. Pi is capable of doing multiple tasks at a time like a computer. If anyone wants to build a complex project like an advanced robot or the project where things need to be controlled from a web page over internet then Pi is the best choice. Pi can be converted into a webserver, VPN server, print server, database server etc. Arduino is good if just want to blink a LED but if need to have hundreds of LEDs needs to be controlled over web page, then Pi is the best suited.

Raspberry Pi is 40 times faster than Arduino, with PI, user can send mails, listen music, play videos, run internet etc.,and it doesn't require external hardwares for most of the functions. It can be accessed via SSH and file can be easily transferred over FTP.

- NETWORKING:

Raspberry Pi has the built in Ethernet port, through which user can directly connect to the networks. Even Internet can easily be run on Pi using some USB Wi-Fi dongles. While in Arduino, it's very difficult to connect to network. External hardwares need to be connected and properly addressed using code, to run network using Arduino. External Boards called "Shields" needs to be plugged in, to make Arduino, as functional as Pi, with a proper coding to handle them.

- *DON'T NEED DEEP ELECTRONICS KNOWLEDGE:*

For Arduino you definitively need an electronic background, and need to know about embedded programming languages. But to start with Pi you don't need to dive into the coding languages and a small knowledge of electronics and its components is enough.

Besides these advantages, one advantage is that OS can be easily switched on the single Raspberry Pi board. Pi uses SD card as flash memory to install the OS, so just by swapping the memory card you can switch the operating system easily.

VI. CHOOSING RIGHT DEVICE BETWEEN RPI AND ARDUNINO, FOR THE PROJECTS

Simple rule to select a device between Pi and Arduinois, think about what is the aim and outcome of the Project. If an application can describe it with less than

Two 'and's, get an Arduino. If you need more than two 'and's, get a Raspberry Pi.

Example: Home automation

If the user want to monitor plants and have to Tweet user when they need water." That can best be done by an Arduino.If want to monitor plants and have to Tweet user when they need water and check the National Weather Service, and if the forecast is for fair weather, turn on the irrigation system and if the forecast is for rain, do nothing." That would best be handled by a Raspberry Pi.

6.1 CHOOSE ARDUINO IF:

- Have knowledge on usage of electronic components.
- If beginner and really want to learn about electronics and its components.
- The project is simple, especially networking is not involved.
- The project is more like an electronics project where software applications are not involved, like Burglar alarm, voice controlled light.
- Not a computer geek who is not much interested in softwares and Linux.

6.2 CHOOSE RASPBERRY PI IF:

- The application is complex and networking is involved.
- The project is more like a software application, like a VPN server or Webserver
- Don't have good knowledge of electronics.
- Have good knowledge about Linux and softwares.
- Although they both have their own pros and cons, but they can also be used together to make the best out of them. Like Pi can collect the data over the network and take decisions, and command the Arduino to take the proper action like rotate a motor.

6.3 COMPARISION CHART OF ARDUINO AND RASPBERRY PI

CATEGORY	ARDUINO	RASPBERRY PI
Development Language	C/C++ With Arduino IDE	C,PHP,JAVA Python, NodeJS, .NET
Sensor Connectivity	Digital and Analog	Digital only, Analog with additional circuitry
Network Connectivity	None without shields	Ethernet, Low cost Wi-Fi dongle
Power Requirement	7V-12V, flexible low amperage	5V very specific, higher current draw
Cost	Low	Medium
Flash	32KB	SD Card (2 to 16G)
Operating System	None	Linux Distribution
USB	One, input only	Two, with peripherals
IDE	Arduino	Scratch, IDLE, anything with Linux support
Memory	0.002MB	512MB or more
Clock Speed	16 MHz(Uno model)	700 MHz(B model)

Table 1. Comparison of Arduino and Raspberry Pi

VII. CONCLUSION

This Paper gives an overall review about Arduino and Raspberry Pi and users who want to use can select the appropriate device and best one based on the requirement of their project.

Based on the comparisons in the paper the users can select the right device for the automation application.

The review is given on considering factors like Cost, Power requirement, Sensor connectivity, Network connectivity etc.

REFERENCES

[1] Vishwajeet H.Bhide "A Survey on the Smart Homes using Internet of Things (IoT)".

[2] Harshada Chaudhari, "Raspberry Pi Technology: A Review", International Journal of Innovative And Emerging Research in Engineering, Volume 2, Issue 3, 2015.

[3] Sah. P, "Saving Environment Using Internet Of Things: Challenges and Possibilities", Advancesin Internet of Things, 6, Scientific ResearchPublishing- 2016.

[4] Design of a Home Automation System Using Arduino,Nathan David, IJSER, Volume 6, Issue 6, June-2015.

[5] https://www.raspberrypi.org/products/models.

[6] https://learn.sparkfun.com.

[7] www.arduino.org.

[8] Internet of Things- From research and innovation tomarket Deployment by Dr.Ovidiu Vermesan SINTEF Norway and Dr. Peter Friess EU Belgium.

[9] Article on Arduino and Raspberry Pi by Krishna Rao Veeramachaneni, [published on April 14 2016].

[10] PritishSachdeva, Shrutikkatchii, "A Review Paper on Raspberry Pi", International Journal of CurrentEngineering and Technology, Volume 4, No. 6,December 2014.

[11] Raspberry Pi education manual, Volume 1.0, December 2012.