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HIGH VERSATILITY - LOW COST μCONTROLLER'S COMPARISON GUIDE

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***Abstract*—In this work, are studied and compared the Arduino and Raspberry Pi processors. Initially, they are explained in detail, the microcontroller and microprocessor concept, their functions, as well as their uses and differences. Processors are analyzed to understand how they are used and as far as possible their abilities. The models that have been released on the market up to the most up-to-date. Finally, the applications that each processor can be used with and the comparison of their advantages and disadvantages.**

Keywords— **Watermarking, Haar Wavelet, DWT, PSNR**

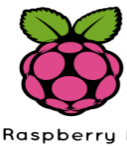
I. INTRODUCTION

It is studied what a microprocessor and a microcontroller is. The history of those, as well as the evolution of microprocessors over time. It is of great importance in the operation of the microcontroller as it depends on Arduino and Raspberry; the same is done in their features and manufacturers.

Afterwards it is focused on Arduino. It is explained what processor it is, its' history, country of manufacture, languages, and models. Furthermore, both its' environment of development and the commands used to program codes for Arduino are explained, as extended as possible. There are some well-known examples of Arduino as well as various uses it may has.

In the third chapter, the Raspberry board is being studied.

When it first appeared, during its' evolution, the tests and the problems that existed with it. The models that came out on the market from the earliest trend and the most up-to-date are presented. Finally, there are some applications that have been made with it as well as its' uses.



At the end of this paper, the differences between the two processors, Arduino-Raspberry, are studied. It analyzes its' differences, advantages, and disadvantages. Ultimately, it ends up to the conclusion which processor is better and why.

II. MICROCONTROLLER – MICROPROCESSOR

A. General

Microprocessors are responsible for the inspiration and creation of some of the greatest innovations in computer systems [1]These innovations include embedded microcontrollers, personal controllers, modern workstations, handheld and mobile devices (eg mobile phone processors), application and file servers, web server for the internet, low cost supercomputers and large-scale computer networks. Microprocessors are instruction set processors (ISPs). An ISP executes commands of a predetermined set of commands. Its' function depends on the set of commands that the microprocessor is capable of performing. The term microcontroller refers to a type of processor that can operate with minimal external components due to its' many built-in subsystems. For that reason, it is considered as a variant of a microprocessor. A microcontroller is a built-in chip (integrated circuit) that is often part of a system. Like a simple standard computer, the microcontroller also includes CPU, RAM, ROM for data and software storage respectively, flash memory for permanent storage, input / output ports, analog to digital converter, reverse and timers. As it is designed to perform only one specific task to control a simple system, it is much smaller and simpler designed to include all the functions required in a single integrated circuit. Processors consist of dozens of gates and complex circuits that, with their prolonged use, emit heat and require a lot of space. As size diminished, the new processors were called microprocessors. Their smallest size also reduced switching time due to physical factors. As a result, modern microprocessors have a clock

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frequency ranging from hundreds of megahertz to several gigahertz. Although their complexity, size, construction, and overall shape have changed completely over the past sixty years, it is important that their original design and operation have not changed much. The first microprocessor appeared in 1972, three years after computers. The evolution of microprocessors greatly resembles the corresponding evolution of mid-range computers. Below, they appear chronically with their characteristics:

Table -1 Dates

1971	First microcontroller INTEL 4004 a4 bit controller with 2.300 transistor with a clock frequency of 108KHz
1974	INTEL 8080 an 8bit controller was the development of the 8008 controller with 6.000 transistors with frequency of 2MKHz
1975	Zilog makes the Z80 an 8-bit microprocessor based on 8080 whose engine language is a superset of that of the Intel 8080. Its' timing signal was 3.5MHz with 16bit address width while it could see 64Kbytes of memory.
1978	The first 16bit microprocessors are displayed. Intel presents 8086/8088 whose operating frequency has risen to 10MHz and requires 29,000 transistors. Similarly, Motorola displays 68000 with 8MHz and 68,000 transistors.
1982	The 80286 is generated with operating frequency initially at 6 and then at 12.5MHz and 134.000 transistors.
1985	Intel 80386 contains 275,000 transistors and a 33MHz operating frequency, and the Motorola MC86020 has 200,000 transistors and 16MHz operating frequency.
1989	The 32bit Intel 80486 microprocessor with 1,200,000 transistors and 50 MHz frequency is displayed.
1993	Intel Pentium of P5 family, which contains 3,100,000 transistors, running at 60 and 66 MHz. At the same time, Digital introduced the first 64-bit Alpha microprocessor.
1997	The Intel Pentium II Microprocessor with MMX Technology for Multimedia Support is introduced. It had 7,500,000 transistors and its' operating frequency was 300MHz.
1999	Pentium III is created with 9,500,000 transistors and operating frequency at 450MHz (today it has reached 1.13GHz).
2000	Pentium IV was designed according to the NetBrust microarchitecture. Its operating frequency is 2.0 GHz and its integrated circuit consists of 55,000,000 transistors but without this it provides a significant increase in processing speed over Pentium III.

The microcontroller has features that make it preferable for use in applications over the use of individual components that make it up (processors, memories, and input-output devices). In particular [2]:

Low Costs, it's one of the most basic features one takes into account. Continuous release of microcontrollers from different companies improved their quality and reduced prices due to competition. Autonomy, achieves the integration of complex regional subsystems such as memories and communication ports. That many microcontrollers do not need any other integrated circuits to operate. Small size, the completion of the basic elements, of which it is composed, reduced the dimensions in relation to the use of the individual elements as a total computer system. Low Power Consumption, microcontrollers operate at comparatively low frequencies reaching 32 KHz, resulting in low power consumption of mW as well as μW. In addition, they are able to enter standby sleep mode, temporarily suppress the operation of the central processing unit (CPU) and the peripheral, so ear can be done by greatly reducing the power consumption of the microcontroller. This can be used in applications with strict requirements for this parameter. Achieve real-time control or measurement, while computers must run real-time operating systems (RT-Linux, QNX, etc.) to achieve this, microcontrollers do not require additional software. Reduced emissions of electromagnetic interference and reduced sensitivity to corresponding interference from other electrical and electronic devices. This advantage results from the smaller number and length of external interfaces as well as lower operating speeds. More available terminals for digital inputs / outputs. For a given integer circuit size, due to their non-binding for external peripheral connection. The basic microcontroller architecture does not differ from that of the common microprocessors. Although, the first is often found in the Harvard architectural memory, which is used in various arrays of programming memory and data memory connection (eg, Microchip rows). In the common microprocessors, the unified memory device of the Neumann type is common. Integration of peripherals means easier implementation of applications due to simpler interconnections. We also have more credibility due to fewer interfaces and a small overall computing system.

However, the microcontroller has many disadvantages. Some of them are: - Failure to change the program because it is written in ROM - The programming difficulty - It has a long development time. To complete a product it may take a week to a year.

B. The microcontroller function

The microcontroller [3] [4]is a fast device, not as fast as the computer of course, so that every command that runs on it is done at very high speed. When the power is turned on, the Logic Controller activates the quartz oscillator in turn. In the first few milliseconds, while the first preparations are in progress, the capacitors are charged. When the voltage level

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reaches the maximum value and the frequency of the quartz oscillator is stabilized, the process of writing bits in special operating registers (SFrs) begins. Everything happens according to the oscillator clock and above all the electronics begin to work. All these are done in a very short time (nano seconds). The PC or programming counter is resetting the program memory address. Then, the address sends the instructions to the decoder that decodes the commands and thus executes them. After executing a command, the program counter address is incremented by one, and therefore sends the next command address to the command decoder and executes the following instructions.

C. Manufacturers of microcontrollers.

Most companies produce a wide range of microcontrollers. Variegating from very small and inexpensive for simple applications to very advanced ones for very demanding applications. Some of the most well-known microcontroller manufacturers are: ARM (does not build but grants kernel rights), Atmel, Epson -Freescale Semiconductor (formerly Motorola), Hitachi -Maxim (after Dallas acquisition), Microchip, NEC, Toshiba, Texas Instruments, Intel and Analog Devices.

D. Widespread microprocessor classes

Microcontrollers (sometimes 4bit but usually 8bit) of very low cost, general purpose, with very small number of terminals (even fewer than 8). In order not to be easily copied, their internal software is designed with emphasis on low power consumption and self-sufficiency. The ability to expand their memory is absent.

Microprocessors (typically 8 but 16 or 32bit) low cost, general purpose, with a modest to relatively large number of terminals. They have a large number of common peripherals, such as URTS, I2C, and SPI or CAN ports, analog to digital and digital to analog.

Microprocessors (mostly 32 bit) medium cost, general purpose, with a large number of terminals. They are characterized by the emphasis on command execution speed, high self-sufficiency of peripherals and large internal or external program memory (FLASH) and RAM capabilities.

Microcontrollers of specialized applications, which usually incorporate a specialized communication protocol that is always implemented in hardware. Those types of microcontrollers are used in telecommunication devices such as modems. The large portion of sales of microcontrollers still concerns those of 8bit, whose class with the lowest cost and the smallest software size for the same result, especially because the modern 8bit microcontroller families have improved their performance over the past few years.

E. Programming languages.

C, C ++ and its' variants are among the most widely used programming languages for microcontrollers. Assembly can be used in software components where speed or small size of memory is necessary. However, the greatest requirements in functionality and ease of C programming versus Assembly, combined with the memory adequacy of modern microcontrollers, they have distinguished the Assembly from most applications.

III. ARDUINO

Arduino is a single-board microcontroller [5]. It appeared in 2003 by Professor Massimo Banzi at the Interactive Design Institute in the city of Ivrea, Italy. He wanted to ease the comprehension of electronics for students. It is a simple open source board [6]with built-in microcontroller input-output. It can be used to develop various projects, interactive objects as well as to connect to the computer via Processing, Max / MSP, Pure Data, Supercollider. Essentially this is an electronic circuit based on ATmega microcontroller from Atmel and all the designs and software needed for its' operation can be found easily and free of charge so that it can be manufactured by the common user. Once assembled, has the potential to be a tiny computer, since the user can connect multiple inputs / outputs modules on it and program the microcontroller to receive data from the input and process them to result in the correct output commands.

Fig. 1. Arduino Uno

A. Arduino publications

Arduino has released many unofficial and official [5] publications. The official editions are: Serial Arduino, Arduino Extreme, Arduino Mini, Arduino Nano, LilyPad Arduino, Arduino NG, Arduino NG plus, Arduino Bluetooth, Arduino Diecimila, Arduino Duemilanove ("2009" The Arduino Uno, The Arduino Mega2560, The Arduino Leonardo, The Arduino Esplora, The Arduino Due. From the unofficial (some: Freeduino, Boarduino, Sanguino, Seeduino, BBB, RBBB, etc.), only Freeduino v1.16 and Seeduino are recommended. Of course there are Shields. Arduino and Arduino's compatible boards use the technology of shields, printed board expansion circuits linked to the normally supplied Arduino pin-headers. Shields can provide control of motors, GPS, Ethernet, LCD or breadboarding. A number of shields can also be made piece by piece by assembling it by the user. Some of those are: Arduino Wifi Shield (Wireless internet connection), Arduino Ethernet Shield (It connects to the internet with RJ45 cable), Arduino SD Shield (Wireless

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communication with wireless unit with Arduino board. The unit can communicate up to 100 feet indoors or up to 300 feet outdoors. The unit includes an SD slot), Arduino Proto Shield (It allows Arduino to communicate wirelessly with a wireless unit. The unit can communicate up to 100 feet indoors or outdoors up to 300 feet. The unit does not have an SD slot), Arduino Motor Shield (It allows driving two DC motors from the same device by controlling the speed and direction of each one separately)

B. Programming language

The programming language used by Arduino to encode it is Wiring [7], which is quite easy to compile and is available on platforms such as: Linux, MAC and Windows licensed with GPL. The most important thing about Arduino is that the whole circuit board is licensed using Creative Commons, which means that anyone can build their own board as they wish. Arduino is used extensively in robotics and of course it is not the best way to create an interactive electronic device.

C. HARDWARE

An Arduino board consists of an Atmel AVR 8bit microcontroller, with complementary elements to help the user to program and integrate into other circuits. An important aspect of Arduino is the way the connectors are exposed, allowing the CPU board to connect with varieties of interchangeable add-on-modules, known as shields. Some Shield communication with the Arduino board over just a few pins. Many Shields are individually arranged via an I2C Serial Bus, allowing many shields to be stacked and used in parallel. The original Arduino has used the mega AVR chip series, namely ATmega8, ATmega328, ATmega1280 and ATmega2560. Many processors have been used by Arduino compatible. Most boards include a 5 volt linear regulator and a 16 MHz crystal oscillator (or a ceramic resonator in some variations); of course some designs such as the LilyPad run at 8MHz and give the built-in voltage regulator because of the special form-limiting factor. The Arduino microcontroller is also programmed with a boot loader that simplifies the transfer of programs for n-chip flash memory, compared to other devices typically needed by an external developer. When using the Arduino software stack, all board cards are programmed over an RS-232 serial connection, but the way this is deployed depends on the equipment version. A series of Arduino boards contain a simple selector circuit for converting between RS-232 level and TTL signal level. Existing Arduino boards have been programmed over via USB, using USB to a serial chip adapter such as the FTDI FT232. Some variants, such as the Arduino Mini and the unofficial Boarduino, use a detachable USB to a serial transformer or cable, Bluetooth or other ways.

The board has several microcontroller I / O pins in order to be used by other circuits. Diecimila, Duemilanove and the well-known Uno offer 14 digital I / O pins, 6 of which can produce pulse width modulation signals, and 6 analogue outputs. These Pin are at the top of the board, via female 0.1-inch headers. Several application plug-in shields are commercially available. The Arduino Nano and the Arduino-compatible Bare Bones board and the Boarduino board can provide male pin header at it's' bottom and attached to solderless breadboards [8]

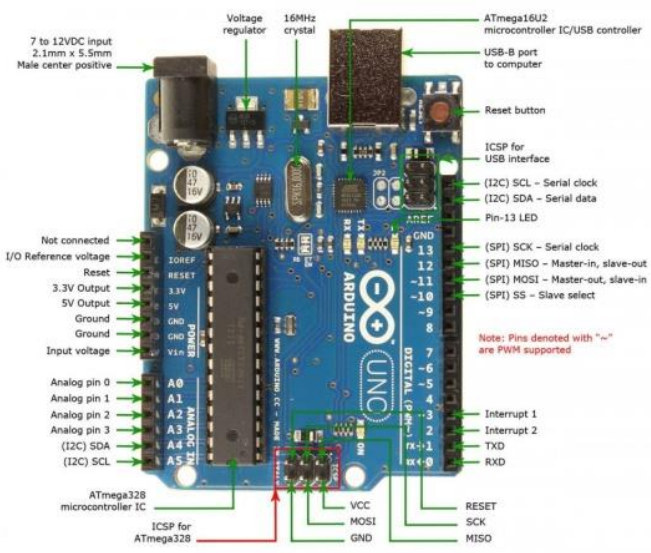

Fig. 2. Arduino

Table -2 Characteristics in belief

Microcontroller	ATmega328
Operating Voltage	5 V
Input voltage	7-12 V
Voltage limits	6-20 V
V Digital I / O terminals	14 (out of 6 provide PWM output)
Digital Input Terminals	6
DC current per I / O terminal	40 mA
DC current for 3.3V	50mA
Flash Memory	32KB
SRAM	2KB
EEPROM	1KB
Clock speed	16MHz

D. SOFTWARE

The Arduino Integrated Development Environment is a Java-based, multi-platform application that comes from the IDE for the Programming Language and the Wiring Design. It is

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designed to introduce programming to users who are not familiar with software development. It includes a code editor with features such as syntax markup, brackets and auto recess, as well as being able to compile and load programs on the board with just one click. By "sketch" we refer to a program or code written for Arduino. Arduino programs are written in C or C ++. The Arduino IDE comes with a software library called Wiring, which makes many common I / O functions much easier. Users only have to set two functions to make a run-time program. Setup (): a function runs once at the start of a program that can initialize the settings. At this point, we declare the variables we want for our project. Loop (): a function which when called is executed until the board is deactivated.

Something that a user must pay attention at is that Arduino must be connected to the system so that the program is stored in a folder. Then, there is a specific program structure presented at the beginning of the program. There are four types of variables: byte (8 bit storage), int (integer), long (large integer size), float (real numbers). There are fixed variables, arrays, numerical operators, comparison operators, logic operators (AND, OR, NO), index operators, flow control structures, digital output, data types, mathematical and trigonometric functions, pseudo random number generator functions, number. And of course there are some basic commands.

E. Advantages of Arduino

The main advantage of Arduino is the huge community that supports it, which has created, expanded and maintained a similar sized online knowledge base. So while an experienced electronics may prefer a different platform component depending on the application he wants to perform, Arduino with extensive documentation manages to gain all those whose knowledge of electronics is limited concerning what they learned during their school education, in a programming environment. Because it is primarily intended for beginners and despite detailed instructions, not everyone have the knowledge and the means to build an electronic board. The boards come ready, prefabricated on the internet at affordable prices. So, most suppliers with a bit of extra money can use the Arduino Smarter Kit which, in addition to the Arduino board, also contains other components and tools that may be needed for applications. Additionally, it runs on many operating systems. They have developed the Arduino software environment for Windows, Machinstoh OSX as well as Linux operating systems. Most microcontroller development systems are limited to Windows

Fig. 3.Smarter Kit

F. Apps Arduino

Arduino and music [9] Laser Harp The most well-known project using Arduino is the Harp Laser (Laser Harp). It was first introduced by Bernard Szajner in 1981, but became popular by Michel Jarre where he used it on concerts. The laser harp is a musical instrument that interacts with light. It is actually a device that produces a series of vertical light lines starting from the floor. The musician interrupting the light beams produces a variety of musical sounds. Cutting the beam does not only participate in the production of sound but also the height of the obstacles from the floor. The harp does not take on its own sounds; it requires to be connected to a new technology synthesizer to receive from Arduino sequentially the MIDI (Musical Instructions Digital Interface) data it produces.

Arduino and modeling Another application with Arduino, also known as modeling, is the remote-controlled vehicle. A microcontroller that is responsible for vehicle control (Arduino) is required to build such a project, and a system for Arduino wireless communication with the device that will divert it is also necessary. The microcontrollers' purpose is to control the necessary motors and servomotors that are powered by a current source for the vehicles' direction. The redirection can be adapted to any form of vehicle. Besides, standard equipment, modelers have the option of adding a GPS shield that informs Arduino about its' location coordinates. This way, the vehicle knowing its' destination of the coordinate given, will be able to move it without having to direct it.

Arduino and decoration An interesting and relatively simple application is the construction of a LED cube. The LED cube is formed by leds which are arranged at equal spacing positions. Usually the cube is 4x4x4, consisting by four layers, each one consisting of four lines and four columns. LEDs flashes according to Arduino either randomly or in such a way as to form a shape.

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Fig. 4. Decorations cubes

Arduino at home Arduino can be used to facilitate the way people live in their homes. Of course, this is achieved by various applications, from room temperature to parking aid (car-to-wall distance).

Arduino security alarm The controller has the ability to combine with a variety of sensors in order to function as a home alarm. By detecting for example movement, controlling specific doors and windows even the temperature in the event of a fire can be a reliable alarm system, and with an appropriate program on the computer it is even possible to remotely inform the buildings' officers.

Arduino and arts-painting It is a construction that draws random curves on the walls. This device is a motorized vehicle which moves parallel to a wall. A double pendulum is mounted on the vehicle and a paint spray on its' end. When the vehicle moves, the pendulum begins to oscillate to the right and to the left while being controlled by a sensor to see if it exceeds a minimum or a maximum. For example, if the pendulum oscillation is less than desired, then the vehicle starts moving rhythmically to the left and right to increase the pendulum oscillation. On the contrary, when the oscillation is greater than the permissible then the vehicle stops. When the pendulum has the correct oscillation, then with an automation system the spray begins to draw colored curves along the entire length of the wall. Replacing the spray with various colors can create an original work of art. This construction simulates the creation of graffiti on a wall, releasing the dynamism of the graffiti design, while removing the human factor.

Fig. 5. Senseless drawing bot

IV. RASPBERRY

Raspberry Pi [10] is a single-stranded small computer series developed in the United Kingdom by the Raspberry Pi Foundation. It was originally created to promote and teach basic computer science in schools, colleges and developing countries. They originally started Model A and Model B devices, these computers ranged in spec (Standard Performance Evaluation Corporation) and capabilities. The original model became much more popular than expected, by even selling outside the targeted market for uses like robotics. With the models, it does not include peripherals (such as keyboards, mice, and cases). The philosophy of the Raspberry Pi Foundation is to provide low-cost, high-performance calculators that people use to educate themselves, solve problems and have fun. Everything else provides all kinds of information and education to help more people access information and digital production. They are developing free resources to help people learn about computers and their use and how to act with them as well as train specialists so they can teach people. As a result, they will be able to understand and shape their unique and digital world that will be able to solve the problems people engage with.

In 2006, the early concepts of Raspberry Pi were based on Atmel ATmega644 microcontroller. The trustee of the Eben Upton Foundation gathered a team of teachers, academics and enthusiasts to create a computer with the purpose to inspire children. The computer is inspired by the 1981 Acorn BBC Micro. The A, B and B + model names are references to the original models of the British BBC Microcomputer, developed by Acorn Computers. The first ARM version of the PC was placed in a package the same size as a USB stick. It had one USB port on one end and one HDMI port on the other. The goal of the foundation was to offer two versions worth $ 25 and $ 35. Most popular and widespread was model B with higher prices on February 29, 2012, lower Model A cost on February 4, 2013, and even lower cost (US $ 20) on Model A + on November 10, 2014. On November 26, 2015, the cheaper Raspberry Pi and Raspberry Pi Zero started at $ 5.

Several generations of Raspberry Pis have been released. All models feature Broadcom (a fabless semiconductor company that made products for wireless and broadband communications) on a chip (SoC) with a built-in ARM-compliant central processing unit (CPU) and an on-chip GPU.

The first generation (Raspberry Pi 1 Model B) was released in February 2012, followed by the simpler and cheaper Model A. In 2014, the Foundation released a board with an improved design, Raspberry Pi 1 Model B+. These boards are approximately credit-card sized and represent the standard mainline form-factor. Improved A+ and B+ models were released a year later. A "Compute Module"1 was released in April 2014 for embedded applications.

[1] The Compute Module is primarily designed for those who are going to create their own Printed Circuit Board (more in paragraph **f**)

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The Raspberry Pi 2, which added more RAM, was released in February 2015.
A Raspberry Pi Zero with smaller size and reduced input/output (I/O) and general-purpose input/output (GPIO) capabilities was released in November 2015 for US$5. By 2017, it became the newest mainline Raspberry Pi. On 28 February 2017, the Raspberry Pi Zero W was launched, a version of the Zero with Wi-Fi and Bluetooth capabilities, for US$10. On 12 January 2018, the Raspberry Pi Zero WH was launched, a version of the Zero W with pre-soldered GPIO headers.
Raspberry Pi 3 Model B was released in February 2016 with a 1.2 GHz 64-bit quad core processor, on-board 802.11n Wi-Fi, Bluetooth and USB boot capabilities. On Pi Day 2018 the Raspberry Pi 3 Model B+ was launched with a faster 1.4 GHz processor and a three-times faster gigabit Ethernet (throughput limited to ca. 300 Mbit/s by the internal USB 2.0 connection) or 2.4 / 5 GHz dual-band 802.11ac Wi-Fi (100 Mbit/s). Other features are Power over Ethernet (PoE), USB boot and network boot (an SD card is no longer required).
Raspberry Pi 3 Model A+ launched at 15 November 2018. Features: A 1.4GHz 64-bit quad-core ARM Cortex-A53 CPU. 512MB, LPDDR2 and SD RAM. Dual-band 802.11ac wireless LAN and Bluetooth 4.2/BLE. Improved USB mass-storage booting and last improved thermal management

Fig. 6. Raspberry Pi 3 A+

Raspberry Pi 4 Model B was released in June 2019 with a 1.5 GHz 64-bit quad core ARM Cortex-A72 processor, on-board 802.11ac Wi-Fi, Bluetooth 5, full gigabit Ethernet(throughput not limited), two USB 2.0 ports, two USB 3.0 ports and dual monitor support (4K resolution).

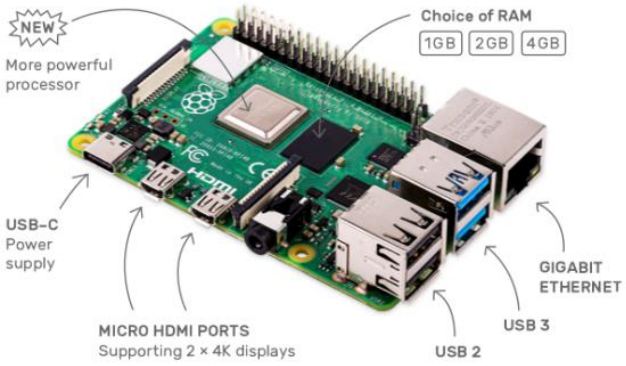

Fig. 7. Raspberry Pi 4 Model B

A. Models

Raspberry Pi [10]Model B is the third of Raspberry Pi series. It was a high-end model for that time. It has 512 MB RAM, 26 GPIO Pins, two USB ports, one HDMI port, one video output, one audio output, one touch screen connector, one camera connector, one Micro SD Card slot and one Ethernet port 100 Mb.
Raspberry Pi model A + in November 2014, it replaced Model A. It has the same features, with some variations, such as increasing the GPIO Pins from 26 in Model A to 40 and incorporating video and audio into one output port. This is a low cost variation of Raspberry Pi. Recommended for applications requiring very low power that does not need Ethernet or multiple USB ports.
Raspberry Pi Model A It is a low-end model. It has 256 MB RAM, 26 GPIO Pins, one USB port, one HDMI port, one video output, one audio output, one screen connection, one camera connector, one Micro SD Card slot, and no port Ethernet. Compared to other models, Model A is lighter and consumes less power. It is used in robotics and in applications where weight and power are of utmost importance.
Raspberry Pi Model B + Replaced in July 2014 Model B. It has the same features as it has, with some variations, such as increasing GPIO Pins from 26 Model A to 40, embedding video and audio on one output port and increasing of USB ports from 2 to 4.
Raspberry Pi Zero It is the smallest size model with double meaning. Features 1GHz mono processor, 512MB RAM, 40 female GPIO Pins, 2 female Pins with Raspberry Reset, 2 female Pins used as a TV antenna, one Micro USB port, one Micro HDMI port, one camera connection as well and one Micro SD Card slot. (For female Pins, Pins (Pins Header) is needed as an additional accessory.
Raspberry Pi ZERO W extends the Pi Zero family. The Pi Zero W, launched at the end of February 2017, has all the features of the original Pi Zero but has additional connectivity consisting of: 802.11 b / g / n wireless LAN, Bluetooth 4.1 and low power Bluetooth (BLE).

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Raspberry Pi 3 model B Replaced Raspberry Pi 2 Model B in February 2016. It features a 64-bit ARMv8 processor, 40 GPIO Pins, 1GB RAM, four USB ports, one HDMI port, one Ethernet port, with a screen, a camera connection, a single video and audio port, and a Micro SD Card slot.

Raspberry Pi 3 Model B is a computer in credit card size. The Raspberry Pi 3 offers a faster 1.2GHz 64-bit processor and 1GB of memory. It features Quad Core Processor 1.2GHz 64-bit, 1GB RAM, 4 USB 2.0 ports for keyboard, mouse and other peripherals, Ethernet port, WiFi, Bluetooth 4.1, HDMI output, mini jack output and microUSB slot to power it . For Pi 3 to work, it needs a 5V 2.5A power supply and a microSD card whenever the operating system [13] [14].

Raspberry Pi Zero WH Is the same as the Zero W simply with headers-pins. (Zero W with Hearders).

Raspberry Pi 3 model B+ (14 March 2018) has the following features. Broadcom BCM2837B0, Cortex-A53 (ARMv8) SoC @ 1.4GHz 64bit, 1GB LPDDR2 SDRAM, 2.4GHz and 5GHz IEEE 802.11b / g / n / ac wireless LAN, Bluetooth 4.2, BLE, 300 Mbps), Extended 40-pin GPIO header. Full size HDMI, 4 USB 2.0 ports. CSI camera port for Raspberry Pi camera connection. DSI display port for Raspberry Pi touch screen connection 4-pole stereo output and composite video port. Small SD port to load the operating system and store data. Power 5V / 2.5A DC as well as Power-over-Ethernet (PoE) support (requires separate PoE HAT)

Raspberry Pi 4 Model B. The Pi 4 is also powered via a USB-C port, enabling additional power to be provided to downstream peripherals, when used with an appropriate PSU. Three sizes of onboard RAM are available: 1 GB (US$35), 2 GB (US$45), and 4 GB (US$55). The Raspberry Pi 4 has a design flaw where third-party e-marked USB cables, such as those used on Apple Macbooks, incorrectly identify it and refuse to provide power. This is expected to be corrected in a future board revision. The Hardware tested 14 different cables and found that 11 of them turned on and powered the Pi without issue.

B. HARDWARE

Raspberrys' hardware [11]has evolved into various versions characterized by variations in memory capacity and supporting peripheral devices. Model A, A +, and Pi Zero lack the Ethernet and USB Hub components. The Ethernet adapter is internally connected to an additional USB port. In models A, A + and Pi Zero, the USB port is directly connected to the system on a chip (SoC). In the Pi 1 Model B + model and in newer models, the USB / Ethernet chip contains a five-point USB hub, of which four ports are available, while Pi 1 Model B provides only two. In Pi Zero, the USB port is also directly connected to the SoC but uses a micro USB (OTG) port. Concerning the processor, the Broadcom BCM2835 SoC used in the first-generation Raspberry Pi is somewhat equivalent to the chip used in the first generation of smartphones (the CPU is an older ARMv6 architecture), which includes the ARM1176JZF-S 700 MHz processor, graphics VideoCore IV processing unit (GPU), and RAM. It has a 16 KB level 1 (L1) and a 128 KB cache 2 (L2) cache. Level 2 cache is mainly used by the GPU. The SoC is stacked under the RAM chip, so only the edge is visible. Raspberry Pi 2's previous V1.1 model used a Broadcom BCM2836 SoC with 900MHz quad-core ARM Cortex-A7 with 256K shared L2 memory. Raspberry Pi 2 V1.2 was upgraded to Broadcom BCM2837 SoC with ARM Cortex-A53 processor 64-bit 1.2 GHz quad-core, the same SoC that is used in Raspberry Pi 3 but is submultiples) at the same CPU clock speed of 900 MHz at V1.1. The BCM2836 SoC is no longer in production (by the end of 2016). Raspberry Pi 3+ uses a Broadcom BCM2837B0 SoC with a 64-bit quad-core ARM Cortex-A53 processor with 512 KB shared memory L2. The Raspberry Pi 4 uses a Broadcom BCM2711 SoC with a 1.5 GHz 64-bit quad-core ARM Cortex-A72 processor.

C. SOFTWARE

The operating systems recommended by the Raspberry Pi Foundation are the use of Raspbian, a Debian-based Linux operating system. Other third-party operating systems available through the official website include Ubuntu MATE, Windows 10 IoT Core, RISC OS, and specialized distributions for the Kodi multimedia center and classroom management. Some non-Linux-based operating systems are RISC OS Pi, FreeBSD, NetBSD, Plan 9, Inferno Windows 10 IoT Core, xv6, Haiku, HelenOS. Some other Linux-based operating systems are Android Things, Arch Linux ARM, openSUSE, SUSE Linux Enterprise Server 12 SP2, Raspberry Pi Fedora Remix, Gentoo Linux, CentOS (Enterprise Enterprise Operating System), Devuan, Red Sleeve, Slackware ARM. Still, OpenWrt, Kali Linux, SolydXK, Archos OS, Sailfish OS, Tiny Core Linux Alpine Linux, Void Linux, Fedora 25, and Daylight Linux.

D. Programming languages

Raspberry Pi [11]was designed to encourage young people to learn how to encode. The Raspberry Pi Foundation proposes Python language for new users who are now starting to browse on it. Pi, in Raspberry Pi, comes from the Python programming language, so the programming idea is written in the name of the computer itself. In the short time that Raspberry Pi appeared, a large number of programming languages adapted to Raspberry Pi, either by the developer of the language, who wanted to support Pi by transferring their creation or by enthusiastic users who wanted to see their language of choice. Whether this way or the other, this multitude of languages indicates the full potential that can be reached and grow around Pi, and it seems that this great support will continue for a long time. Any language that will compile for ARMv6 can be used with Raspberry Pi, although it is not limited to using Python. The Python, C, C ++, Java, Scratch, and Ruby languages are all installed by default on Raspberry Pi. People from Raspberry Pi recommend Scratch for younger children. Other programming languages used are:

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HTML, JQUERY, JavaScript, C, and C ++, PERL and ERLANG.

E. Accessories [12]

The official keyboard includes three host USB ports for connecting external devices, such as USB mice, USB drives, and other USB-controlled devices. The product's micro USB port is for connection to the Raspberry Pi. From the USB hub built into the keyboard, the Raspberry Pi controls, and provides power to the three USB Type A ports. The Raspberry Pi keyboard has three lock keys: Num Lock, Scroll Lock, and Caps Lock. There are three LEDs in the top right-hand corner that indicate which locks are enabled.
Num Lock – Allows use of the red number keys on the letter keys, effectively creating a numeric keypad. This mode is enabled and disabled by pressing the Num Lock key.
Caps Lock – Allows typing capital letters; press the Shift key to type lower-case letters in this mode. This mode is enabled and disabled by pressing the Caps Lock key.
Scroll Lock (ScrLk) – Allows use of the cursor keys for browsing web pages and spreadsheets without the mouse. This mode is enabled and disabled by pressing the ScrLk key while holding the FN key.

E.a. Mouse

The mouse has three buttons, which activate high-quality micro-switches. The wheel is for quick scrolling when browsing documents and web pages.

E.b. TV HAT

The Raspberry Pi TV HAT has a DVB-T2 and DVB-T tuner on board, which allows receiving and decoding digital television streams on the Raspberry Pi board.

E.c. Camera Module V2

The Raspberry Pi Camera Module v2 replaced the original Camera Module in April 2016. The v2 Camera Module has a Sony IMX219 8-megapixel sensor (compared to the 5-megapixel OmniVision OV5647 sensor of the original camera). The Camera Module can be used to take high-definition video, as well as stills photographs. It's easy for beginners, but has plenty to offer advanced users if you're looking to expand your knowledge

E.d. Pi NoIR Camera V2

The Pi NoIR gives you everything the regular Camera Module offers, with one difference: it does not employ an infrared filter. (NoIR = **No I**nfra**r**ed.) This means that pictures you take by daylight will look decidedly curious, but it gives you the ability to see in the dark with infrared lighting.

E.e. Pi PoE HAT

The Raspberry Pi Power over Ethernet HAT is a small accessory for the Raspberry Pi computer. It can only be used with the Raspberry Pi 4 Model B (launched June 2019) and the Raspberry Pi 3 Model B+ (launched March 2018). The PoE HAT allows powering the Raspberry Pi using Power over Ethernet–enabled networks; for this product to be used, the network it is connected to needs to have power-sourcing equipment installed.

E.f. Sense HAT

The Sense HAT is an add-on board for Raspberry Pi, made especially for the Astro Pi mission. The Sense HAT has an 8×8 RGB LED matrix, a five-button joystick and includes the following sensors: Gyroscope, Accelerometer, Magnetometer, Temperature, Barometric pressure, Humidity. Also created a Python library providing easy access to everything on the board.

E.g. Pi Touch Display

This 7″ touch screen monitor for Raspberry Pi gives users the ability to create all-in-one, integrated projects such as tablets, infotainment systems and embedded projects. The 800 x 480 display connects via an adapter board which handles power and signal conversion. Only two connections to the Pi are required; power from the Pi's GPIO port and a ribbon cable that connects to the DSI port present on all Raspberry Pis (except Raspberry Pi Zero and Zero W). Touch screen drivers with support for 10-finger touch and an on-screen keyboard will be integrated into the latest Raspbian OS for full functionality without a physical keyboard or mouse.

E.h. Pi Universal Power Supply

The official and recommended universal micro USB power supply for Raspberry Pi. It recharges the Pi steady 2.5A it needs for proper performance.
Pi Zero Case
The Raspberry Pi Zero Case has been designed to fit both the Pi Zero and the Pi Zero W. The case consists of two parts. It has a standard base featuring a cut-out to allow access to the GPIO, and a choice of three lids: a plain lid, a GPIO lid (allowing access to the GPIO from above), and a camera lid (which, when used with the short camera cable supplied, allows the Raspberry Pi Camera or Camera Noir to be fitted neatly inside it).

E.i. Pi A+ Case

The Raspberry Pi A+ Case has been designed to fit both the Pi 3 Model A+ and the Pi 1 Model A+.
The high-quality ABS construction consists of two parts. The base features cut-outs to allow access to the micro SD Card and the HDMI, audio/video and USB ports, as well as the power connector.

E.j. Pi 3 Case and Pi 4 Case

The Raspberry Pi case for the Raspberry Pi 3 Model B and the new Raspberry Pi 3 Model B+.
The case for Raspberry Pi 4 with high-quality, two-part ABS construction and cut-outs for the dual micro HDMI, Audio/Video, USB and Ethernet ports, as well as the USB-C power connector and access to the microSD card.

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E.k. Pi USB WiFi Dongle

The universal USB WiFi dongle for Raspberry Pi. It has BCM43143 chipset, 802.11b/g/n, 150Mbps maximum throughput. The dimension of it is 30x16x8mm, including a USB plug. Built-in support in NOOBS and Raspbian

E.l. Micro HDMI to Standard HDMI (A/M) 1m Cable

The official Raspberry Pi micro HDMI to HDMI (A/M) cable designed for the Raspberry Pi 4 computer. Has 19-pin HDMI Type D (M) to 19-pin HDMI Type A (M), 1m white cable, Nickel-plated plugs, and 4Kp60 compliant, RoHS compliant, 3Mohm 300VDC insulation, withstands 300VDC for 0.1s.

E.m. USB Micro-B to USB-C Adapter

This small adapter allows you to convert an existing micro USB power supply (like the Raspberry Pi universal power supply for Raspberry Pi 1, 2 and 3) into a USB-C power

F. **Compute Module**

The compute module contains the peripheral features of a Raspberry Pi (the BCM2835 processor and 512Mbyte of RAM) as well as a 4Gbyte eMMC Flash device (which is the equivalent of the SD card in the Pi) [13]. This is all integrated on to a small 67.6x30mm board which fits into a standard DDR2 SODIMM connector (the same type of connector as used for laptop memory). The Flash memory is connected directly to the processor on the board, but the remaining processor interfaces are available to the user via the connector pins. Getting the full flexibility of the BCM2835 SoC (which means that many more GPIOs and interfaces are available as compared to the Raspberry Pi), and designing the module into a custom system should be relatively straightforward as they have put all the tricky bits onto the module itself. It's a Raspberry Pi shrunk down to fit on a SODIMM with onboard memory, whose connectors you can customise for your own needs. The Compute Module is primarily designed for those who are going to create their own PCB. However, we are also launching something called the Compute Module IO Board to help designers get started.

F.a. Compute Module 1

The Compute Module is a Raspberry Pi in a more flexible form factor, intended for industrial application. The Compute Module contains the guts of a Raspberry Pi (the BCM2835 processor and 512MB RAM) as well as a 4GB eMMC Flash device (which is the equivalent of the SD card in the Pi). This is all integrated on to a small 67.6x30mm board which fits into a standard DDR2 SODIMM connector (the same type of connector as used for laptop memory). The Flash memory is connected directly to the processor on the board, but the remaining processor interfaces are available to the user via the connector pins. You get the full flexibility of the BCM2835 SoC (which means that many more GPIOs and interfaces are available as compared to the Raspberry Pi), and designing the Module into a custom system should be relatively straightforward as they have put all the tricky bits onto the Module itself. The Compute Module is available for purchase in single units, or in batches of hundreds or thousands. To get started designing a PCB to use the module, we provide an **open-source** breakout board with a single module in an affordable development kit.

F.b. Compute Module IO Board

The Compute Module IO Board is a simple, open-source breakout board that you can plug a Compute Module into. It provides the necessary power to the module, and gives you the ability to program the module's Flash memory, access the processor interfaces in a slightly more friendly fashion (pin headers and flexible connectors, much like the Pi) and provides the necessary HDMI and USB connectors so that you have an entire system that can boot Raspbian (or the OS of your choice). This board provides both a starting template for those who want to design with the Compute Module, and a quick way to start experimenting with the hardware and building and testing a system before going to the expense of fabricating a custom board.

The Compute Module IO Board Version 3 is a development kit for those who wish to make use of the Raspberry Pi in a more flexible form factor, intended for industrial applications. The IO Board V3 is made for developing with CM3 and CM1. The Compute Module contains the peripheral features of a Raspberry Pi 3 (the BCM2837 processor and 1GB RAM). The accompanying IO Board is a simple, **open-source** breakout board that you can plug a Compute Module into. The board hosts 120 GPIO pins, an HDMI port, a USB port, two camera ports, and two display ports. Designing the Module into a custom system should be relatively straightforward as we've put all the tricky bits onto the Module itself, and you have the freedom to add extra components and place parts exactly where your product needs them. The CM1 and CM3 are available for purchase in single units, or in batches of hundreds or thousands.

F.c. Compute Module Development Kit

The Compute Module Development Kit is for developing industrial applications. The Compute Module Development Kit is made for developing industrial applications with CM3+, CM3+/Lite, CM3, CM3 Lite, and CM1. The Development Kit contains the critical hardware that allows you to design the Compute Module into a custom system, and gives you the freedom to add extra components and place parts exactly where your product needs them. The kit includes the Compute Module IO (CMIO) board, which is a simple, open-source breakout board into which you can plug a Compute Module. The board hosts 120 GPIO pins, an HDMI port, a USB port, two camera ports, and two display ports.

F.d. Compute Module 3

The Compute Module 3 is a Raspberry Pi 3 in a more flexible form factor, intended for industrial application. The Compute Modules 3 Lite brings the SD card interface to the Module

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pins so a user can wire this up to an eMMC or SD card of their choice.

F.e. Compute Module 3+

The Compute Module 3+ (CM3+) is a Raspberry Pi 3 Model B+ in a flexible form factor, intended for industrial applications. The CM3+ Compute Module contains the guts of a Raspberry Pi 3 Model B+ (the BCM2837 processor and 1GB RAM) as well as an optional eMMC Flash device of 8GB, 16GB or 32GB (which is the equivalent of the SD card in the Pi). Broadcom BCM2837B0, Cortex-A53 (ARMv8) 64-bit SoC @ 1.2GHz. It has 1GB LPDDR2 SDRAM. And also is come out in 8GB/16GB/32 GB eMMC Flash memories, or a Lite variant without eMMC Flash memory.

Uses and Applications of Raspberry Pi.

Raspberry Pi was immediately accepted by its' users, and especially by children. Many technology authors report that the computer, Raspberry Pi, will be keeping children swamped with the programming excitement. As a result, they suggested incorporating some other languages such as Kids Rudy, Scratch and BASIC as a "good start" to equip children with new skills that will be needed in the future. The Center for Computational History strongly supports Raspberry Pi, feels it could "start a new era." Prior to release, the board was presented by CEO of ARM Warren East at a Cambridge event that outlines Google's ideas for improving science and technology education in the UK. However, some suggest that more emphasis should be placed on improving the educational software available on existing hardware, using tools like Google App Inventor to return to school programming instead of adding new hardware choices. Generally, logically there were some problems on the board, specifically the Pi 2 Model B version, it was vulnerable to light flashes, especially light from the xenon camera blinking both green and red laser pointer. This issue was not caught before Raspberry Pi 2 was released because, while commercial electronic devices undergo sensitivity tests on radio interference, it is not common practice to test their sensitivity to optical interference.

F.f. Using Raspberry Pi

The Raspberry Pi board has also been used in several applications, whether for education or smart home. However, it is something quite new in relation to Arduino seeing in several projects and will continue to do so.

Use in education

In January 2012, surveys on the UK board have been taken by schools in both the state and the private sector. They wanted to hope that businesses would finance markets for less forward schools. Two years afterward, the Raspberry Pi Foundation hired several community members, including former software educators and developers, to launch a range of free learning resources for its website. The Foundation also launched a teacher training course called Picademy to help teachers prepare for teaching the new computer curriculum using Raspberry Pi in the classroom.

Use in home automation

There are several developers and applications that use Raspberry Pi for home automation. These developers are making an effort to modify Raspberry Pi to an affordable solution for monitoring power and energy consumption and, in general, the house. Due to the relatively low cost of Raspberry Pi, this has become a popular and economical solution for the most expensive commercial alternatives.

Use in commercial products.

OTTO [13]is a digital camera created by Next Thing Co. Includes a Raspberry Pi electronic measuring unit. It was successfully funded by the crowd in a Kickstarter campaign in May 2014. It is a real camera that does everything like the camera of the phone. The OTTO allows the user to decide how to take pictures. In addition to the unique camera that produces animated GIFs, OTTO can be converted into hundreds of different fast-flow cameras. OTTO allows the user to take pictures and share them with his own people. Photos taken with OTTO are displayed and shared on the smartphone.

Fig. 8. OTTO camera

Slice [14]is a digital media player that also uses the Compute Module tab. It was funded by many in a Kickstarter campaign in August 2014. The software running on Slice is based on Kodi. Connects to the TV via HDMI, saves and play all the videos, music and photos in full HD resolution. It has a carefully designed user interface and customized remote control that makes it effortless and fun to use. It features an emerging solid aluminum case. It features a unique, adjustable LED light ring for optical feedback and factor. It has built-in storage; the user simply transmits and places the media on the Slice hard drive using a single USB connection from any Mac or Windows computer. It can access media over a network and has 2 USB ports to connect additional devices, such as external hard drives. Built in open technologies and can be reprogrammed to run the alternative open source software.

Use in industrial automation The TECHBASE, a Polish industrial automation manufacturer, has created the world's first industrial computer based on Raspberry Pi Compute, called ModBerry. The device has several interfaces, mainly RS-485/232 serial ports, digital and analog inputs/outputs,

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CAN and 1-Wire, widely used in the automation industry. The design allows the use of the Computing Unit in hard industrial environments, leading to the conclusion that Raspberry Pi is no longer limited to home and science projects but can be widely used as a Industrial Interface solution and to meet the objectives of Industry 4.0.

Fig. 9.ModBerry

Applications of Raspberry Pi

[15]Raspberry as mentioned above is a computer on a board. Raspberry has been used in many different projects as a gaming machine and not only. Below it is demonstrated some Raspberry applications.

A photo gallery. It's an application where it takes pictures which the user can share it with their friends. Either by pressing a button or by setting some specific time. Single-board cheap computers make it easy to build our own stand alone photographic stand that can be connected to the internet without the help of our computer. It is based on the Raspberry Pi minicomputer and the Pi Camera Module. It is a touch screen controlled by partygoers, and automatically sends photos and uploads them to Google Photos, where anyone with a password can see and share. All software is open source.

Portable digital eBook library. This application concerns mainly book lovers and those who just want to carry some of their books with them. It is a mobile digital library that is ideal for holding, sharing and negotiating books with friends. Powered by a Raspberry Pi. It's portable and turns Pi into a Wi-Fi hotspot that can connect with others, find something to read it and take it with them.

Home surveillance system. The Scavix system uses a Raspberry Pi, the Raspberry Pi camera, some cases for this camera and some other smaller pieces. After some adjustment, the end result is a home security system that can detect movement, transmit a live stream and more. It can be remotely controlled by the user. Similar use could is made by Arduino.

DIY Arcade Stick. It's one of the best projects with Raspberry Pi. It is easy to move, small in size and can also be connected to any TV. In short, a joystick for games is easily connected to the TV.

V. COMPARE ARDUINO - RASPBERRY PI

Raspberry Pi [16] [17]is a fully functional computer and Arduino is a microcontroller. Both are important and useful. They are the most popular boards among students, amateurs and professionals. Experts and practitioners are aware of the utility and the differences. New users though are confused. The basic knowledge a new user needs to acquire is the project they want to make, what they want and what they need. From then on, the choice of each board you choose is easy. Both are so different but have some similarities. Both are European. The Raspberry Pi was built in England and presented in 2012, and Arduino in Italy and was introduced in 2005. Raspberry is the newer of the two. Raspberry Pi is a fully functional computer, Arduino is a microcontroller that is not as powerful as Raspberry Pi and can be considered as a component of the electronic system.

Arduino is cheaper than Raspberry Pi. The market price differs from 9 euros to 20 euros in contrast to Raspberry which is between 30 and 40 euros. As far as the simplicity of Arduino is concerned, it is easy to connect cables, sensors and electronic components as easily as possible and to program it in few or not (depending on the project) lines of code. Unlike Raspberry, libraries and software must be installed to identify the components to be used. Coding in Arduino is simpler than Raspberry that the user must know about Linux as well as commands for it. As far as power is concerned, Arduino is a plug and play device that can be switched on and off at any time, without any problems without any damage. If it is in the feed, it's running the code again. In contrast, Raspberry runs on an operating system whenever the power supply shutdown is shut down properly, because the operating system and applications can have some damage as well as damage to them and Raspberry. The biggest advantage of Raspberry Pi is the capabilities; it is capable of doing multiple tasks at any time, like a computer. Pi can be turned into a web server, VPN server, print server, database server, and more. Depending on each project, whether large or small, like a robot that needs to check Pi quite quickly, it is a good choice. Unlike the Arduino, it is handy to flash a lamp. In the case of many LEDs good choice would be Pi. This is 40 times faster than Arduino. Raspberry can send emails, listen to music, watch videos, browse the web, etc. It has many more features like memory, processor, USB ports, does not require external hardware for more functions. It can also access via SSH and the file can be transferred via FTP.

A. **Power**

Both devices are different in their power supply and startup. Specifically, the Pi 3 Model B uses 1.5 watts in inertia and 6.7 watts when a screen, keyboards and a mouse are connected. The Zero W consumes 0.5 watts in inertia and 1.75 watts when a screen, keyboards, and mouse are connected. Both of these models require 5 volts to remain on, so an adapter or rechargeable battery with a higher voltage is needed. On the other hand, Arduino boards begin to execute the code they

have when they are turned on and stop when the plug is pulled. Arduino needs a battery that keeps the voltage above a certain level, along with the shield it can have on it and thus manages power. Even if Arduino falls, the Arduino will not hurt anything or spoil its' functionality, opposed to Pi as mentioned above.

B. Networking - Networking.

The Raspberry Pi 3 has an integrated Ethernet port and Wireless N connectivity, allowing it to connect to networks very easily. The internet can run easily using just some USB Wi-Fi dongles. After the connection the user can use the operating system to connect to web servers, to process HTML. Arduino, on the other hand, is difficult to connect to the network. External hardware must be mounted and connected and used correctly in the code. The Shields must be properly connected to become Pi's, with the correct encoding of course.

C. Sensors

Both devices have several interfaces. Sensor connection with Arduino is easier than Raspberry Pi. The microcontroller can effortless interpret and respond to a wide range of sensor data using the written code. This is quite easy and interesting if the user intends to repeat a series of commands or to respond to the sensor data as a mean of making adjustments to servomotors and devices. Raspberry Pi plates, on the other hand, require software for efficient interfacing with these types of devices, which is not always feasible. The use of both boards in a project is not unprecedented. The Arduino device will act as a control panel depending on what commands Raspberry Pi's software has before the information of each sensor is fed for recording or recognition.

D. Which one is more user friendly - easy to use?

It is reported that Arduino is more useful than Raspberry. Even though both are useful, it is reported that Arduino is easier for new users than Raspberry. The choice between processors depends on the project. For electronics users or even beginners, Arduino is a better choice because they learn about links and related ones. If you do not need the project to connect to the internet then Arduino is a good choice. Finally, the projects with this processor are easier and smaller as there is not enough knowledge about software and Linux compared to Raspberry. For the use of Raspberry Pi it is necessary to know Linux and software rather than electronic-electrical knowledge. Although, they share the same amount of similarities and differences, they are easy to be used together. Raspberry will collect the required project data and instruct how the Arduino should act.

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