Raspberry Pi and Models

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What Is Raspbery Pi And History

In the 21st century technology age, it has become very important to use the innovations required by the age in lessons in order to ensure the permanence of education, and the concepts of robotics and robotics - coding are the most important of these innovations (Butuner, 2019). One of the most used boards in the field of robotic coding is the raspberry pi microcontroller card.

Raspberry Pi is a family of computers designed by the Raspberry Pi Foundation, a UK-based charity. The Raspberry Pi Foundation has released multiple Raspberry Pi models, each with slightly different features. Each Raspberry Pi model uses a System on Chip, a single microchip that contains all the basic components of a computer system; System on Chip for Raspberry Pi includes a processor and a graphics-processing unit (GPU) (Gay, 2017).

The Raspberry Pi is a small and inexpensive computer that was originally designed for educational use. Microcontroller is designed to help programmers improve their capabilities and better understand how programmable microcontrollers work. Raspberry Pi board; It looks like a computer designed on a single board, integrated with the CPU, ports and installed computer chips. It also has all the connectivity components required for the devices you want to connect to the card. The device does not come with any monitor, mouse, keyboard, internal storage. We can add components such as monitors, keyboards and mice to the device using these ports (Vijayan et al., 2015).

There are two different versions of Raspberry Pi on the market. These have been identified as Model A and Model B. The main difference between the two versions is an Ethernet and extra USB port added to the Model B. Other features and components are the same. These features also increase the price of the Model B. Both models have Arm CPU / GPU, GPIO, RCA, audio output, LEDs, USB, HDMI, power and an SD card slot. Features such as WiFi and audio input can be added to the device using the available USB ports on the board. In addition, an SD card and a power supply are required for the operating system and data storage (Sanchez, 2019).

Broadcom BCM2835 microchip containing the ARM1176JZF-S 700 MHz central

processing unit was used in the first models of the Raspberry Pi. Broadcom used the BCM2836 microchip in the Raspberry Pi 2 model that was released later. As with the first model, the VideoCore IV GPU has a graphics-processing unit. It uses SD card for booting and data storage. It has USB 2.0 ports, HDMI video output, audio output, MIPI camera input, GPIO interface and 5V MicroUSB power input.

Raspbian (Debian Wheezy based), Pidora (Fedora based), Snappy Ubuntu Core or other supported operating systems can be downloaded from the official website of Raspberry Pi. In addition, the device supports Pardus ARM, Arch Linux ARM and Windows 10 IoT Core operating systems. The device can be programmed with the Python programming language as well as with the BBC Basic, C and Perl programming languages (McManus et al., 2017).

Raspberry Pi Models

Raspberry Pi has various models. While these models are basically the same, innovation, speed, etc. they differ in terms of (Monk, 2013).

Raspberry Pi Zero

Raspberry Pi Zero is a Raspberry Pi model that attracts attention due to its low price tag. In addition, it is the smallest Raspberry Pi model among the models. Its hardware (processor and memory) is exactly the same as the Raspberry Pi Model B. Due to its size, it has a micro USB-OTG port instead of a full size USB. Raspberry Pi Zero is half the size of the model A + with twice as many utilities. Raspberry Pi Zero model was shown in Figure 1.
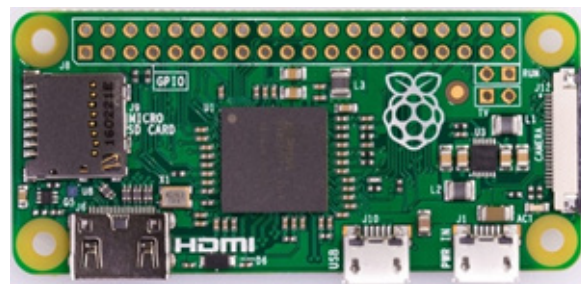

Figure 1. Raspberry Pi Zero

Technical features of Raspberry Pi Zero model;

- 1GHz single-core CPU

- 512MB RAM

- Mini HDMI port

- Micro USB OTG port

- Micro USB power

- HAT-compatible 40-pin header

- Composite video and reset headers

- CSI camera connector (v1.3 only)

Raspberry Pi Zero W

Raspberry Pi Zero W is an extension of the Pi Zero family and was additionally produced with wireless LAN and Bluetooth connectivity. Raspberry Pi Zero W model was shown in Figure 2.
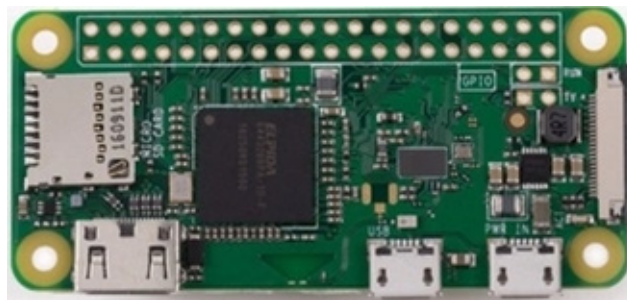

Figure 2. Raspberry Pi Zero W

Launched at the end of February 2017, Pi Zero W has all the functionality of the original Pi Zero but is built with additional connectivity features consisting of the following.

Technical features of Raspberry Pi Zero W model;

- 802.11 b / g / n wireless LAN

- Bluetooth 4.1

- Bluetooth Low Energy (BLE)

- Like the Pi Zero, it also has:

- 1GHz, single-core CPU

- 512MB RAM

- Mini HDMI and USB On-The-Go ports

- Micro USB power

- HAT-compatible 40-pin header

- Composite video and reset headers

- CSI camera connector

Raspberry Pi 1 Model A+

Model A + is a low cost model of the Raspberry Pi and replaced the original Model A in November 2014. It is the updated version of Model A. In this version, the 26-pin GPIO connector has been increased to 40 pins, the composite video output has been removed, and the micro SD card slot is used instead of the normal SD card. It was aimed to be used in projects that may have a lack of space by reducing the card sizes. Raspberry Pi 1 Model A + model was shown in Figure 3.

Figure 3. Raspberry Pi 1 Model A+

Compared to Model A:

- More GPIO pins designed. The 26-pin GPIO connector on Model A has been increased to 40 pins.

- Micro SD. The old friction SD card socket has been replaced with a much nicer push-and-push micro SD version.

- Lower power consumption. Linear regulators have been replaced by switches, reducing power consumption by 0.5W to 1W.

- Better sound. The audio circuitry includes a special low noise power supply.

- Smaller smooth form factor. The USB connector is aligned with the edge of the board, the composite video has been moved to the 3.5mm jack, and 4 square mounted mounting holes have been added. Model A + is approximately 2 cm shorter than Model A.

Raspberry Pi 1 Model B+

Model B + replaced Model B in July 2014 and handed over to Model B model Raspberry Pi 2. Raspberry Pi 1 Model B + model was shown in Figure 4.

Figure 4. Raspberry Pi 1 Model B+

Compared to Model B:

- More GPIO pins. The GPIO header has been increased to 40 pins from the 26-pin GPIO connector on Model A.

- More USB ports. It came with 4 USB 2.0 ports and better plug and play and over current behavior compared to the 2 USB ports on the Model B.

- Micro SD. The old friction SD card socket has been replaced with a much nicer push-and-push micro SD version.

- 100 Base Ethernet (same as original Model B)

- Lower power consumption. By replacing linear regulators with switches, power consumption has been reduced by 0.5 W to 1 W.

- Better sound. The audio circuitry includes a special low noise power supply.

- Smoother form factor. The USB connectors are aligned with the edge of the board, the composite video has been moved to the 3.5mm jack and added 4 square mounting holes.

Raspberry Pi 2 Model B

Raspberry Pi 2 Model B is the second generation Raspberry Pi model. It replaced the original Raspberry Pi 1 Model B + model in February 2015. Raspberry Pi 2 Model B model was shown in Figure 5.

Figure 5. Raspberry Pi 2 Model B

Compared to Raspberry Pi 1:

- 900 MHz quad core ARM Cortex-A7 CPU

- 1 GB RAM

- (Pi 1) Like Model B +, it also has:

- 100 Base Ethernet

- 4 USB ports

- 40 GPIO pins

- Full HDMI port

- Combined 3.5mm audio jack and composite video

- Camera interface (CSI)

- Display interface (DSI)

- Micro SD card slot

- VideoCore IV 3D graphics core

Raspberry Pi 3 Model B

Raspberry Pi 3 Model B is the oldest model of the third generation Raspberry Pi. It replaced the Raspberry Pi 2 Model B in February 2016 and was defined as a single board computer with wireless LAN and Bluetooth connectivity. Raspberry Pi 3 Model B model was shown in Figure 6.

Figure 6. Raspberry Pi 3 Model B

Technical specifications;

- Quad Core 1.2GHz Broadcom BCM2837 64bit CPU

- 1 GB RAM

- BCM43438 wireless LAN and Bluetooth Low Energy (BLE) on board

- 100 Base Ethernet

- 40-pin extended GPIO

- 4 USB 2 ports

- 4-Pole stereo output and composite video port

- Full size HDMI

- CSI camera port to connect Raspberry Pi camera

- DSI display port for connecting a Raspberry Pi touch screen

- Micro SD port for loading your operating system and storing data

- Switched Micro USB power supply up to 2.5A

Raspberry Pi 3 Model B+

Raspberry Pi 3 Model B + is the latest revision of Raspberry Pi 3 series. Raspberry Pi 3 Model B + model was shown in Figure 7.

Figure 7. Raspberry Pi 3 Model B+

Technical specifications;

- Broadcom BCM2837B0, Cortex-A53 (ARMv8) 64-bit SoC @ 1.4GHz

- 1 GB LPDDR2 SDRAM

- 2.4GHz and 5GHz IEEE 802.11.b / g / n / ac wireless LAN, Bluetooth 4.2, BLE

- Gigabit Ethernet over USB 2.0 (maximum throughput 300 Mbps)

- Extended 40-pin GPIO header

- Full size HDMI

- 4 USB 2.0 ports

- CSI camera port to connect Raspberry Pi camera

- DSI display port for connecting a Raspberry Pi touch screen

- 4-pole stereo output and composite video port

- Micro SD port for loading your operating system and storing data

- 5V / 2.5A DC power input

- Power over Ethernet (PoE) support (requires separate PoE HAT)

Raspberry Pi 3 Model A+

Raspberry Pi 3 Model A + extends the Raspberry Pi 3 series to A + board format. Raspberry Pi 3 Model A + model was shown in Figure 8.

Figure 8. Raspberry Pi 3 Model A+

Technical specifications;

- Broadcom BCM2837B0, Cortex-A53 (ARMv8) 64-bit SoC @ 1.4GHz

- 512 MB LPDDR2 SDRAM

- 2.4GHz and 5GHz IEEE 802.11.b / g / n / ac wireless LAN, Bluetooth 4.2 / BLE

- Extended 40-pin GPIO header

- Full size HDMI

- Single USB 2.0 ports

- CSI camera port to connect Raspberry Pi Camera Module

- DSI display port for connecting Raspberry Pi Touch Screen

- 4-pole stereo output and composite video port

- Micro SD port for loading your operating system and storing data

- 5V / 2.5A DC power input

Raspberry Pi 4 Model B

Raspberry Pi 4 Model B model is the latest version in the market for now. Raspberry Pi 4 Model B model was shown in Figure 9 (Sanchez, 2019).
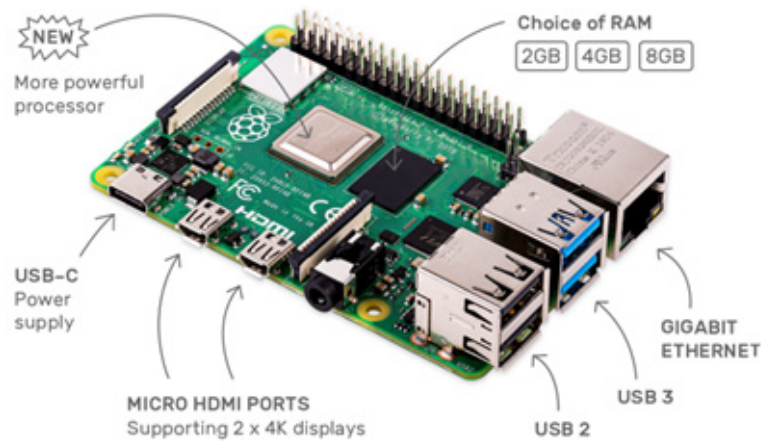

Figure 9. Raspberry Pi 4 Model B

Technical specifications;

- 1.5 GHz quad core ARM Cortex-A72 CPU 64-bit SoC Broadcom 2711

- 4Gb LPDDR4 RAM

- 4kp60 HEVC video

- VideoCore VI Graphics

- USB-C power input supporting 5V-3A operation

- True Gigabit Ethernet

- 2 micro HDMI connection ports 4K video (1 × 4K @ 60Hz or 2 × 4K @ 30Hz)

- 2 USB 3.0 and 2 × USB 2.0 ports

- Bluetooth 5.0 BLE

- Dimensions: 68.63 x 94.09 x 26.63 mm

Raspberry Pi OS

After choosing the Raspberry Pi model, you need to decide which operating system or systems will be run on the computers. Raspberry Pi models can run a wide variety

of operating systems, from the customized Raspbian operating system provided by the Raspberry Pi Foundation to media center operating systems and custom RISC operating systems. Here, we will examine the operating systems that can be used in Raspberry Pi models (Pajankar et al., 2016).

Raspberry Pi Foundation provides an installer called NOOBS (short for New Out Of Box Software) to install one or more operating systems on Raspberry Pi computers. The NOOBS installer supports all four operating systems:

- Raspbian

- LibreELEC

- OSMC

- Windows 10 IoT Core

Raspbian

Raspbian is the official operating system of the Raspberry Pi microcomputer. This operating system was based on the Linux distribution Debian and includes features that allow us to make the most of the features of the microcomputer. Raspbian was optimized to run on ARM computers and comes with a large number of packages and applications. Raspberry Pi Operating System uses LXDE based PIXEL (Pi Enhanced X-Window Environment, Lightweight) desktop which is both useful and lightweight. Interface view of Raspbian operating system was shown in Figure 10.
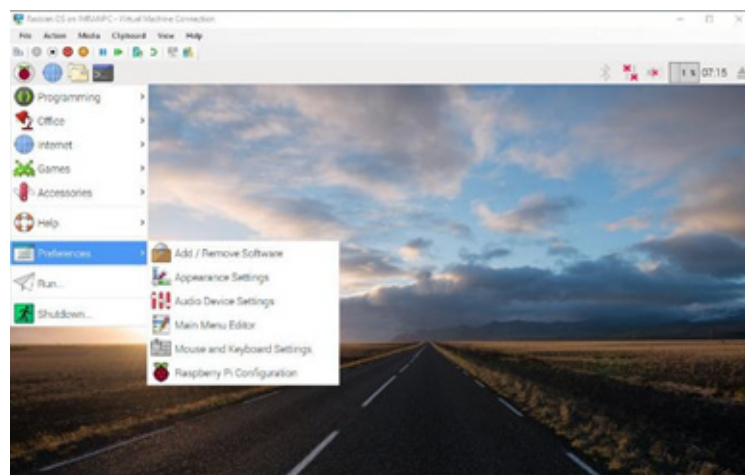

Figure 10. Raspbian Interface

Raspbian Lite

Raspbian Lite is a lightweight version of Raspbian. Raspbian Lite doesn't include a GUI, so it boots to the command line. Raspbian Lite can be used to get the best performance from an older Raspberry Pi computer. Raspbian Lite also doesn't include any apps, so the

installation takes much less space than regular Raspbian.

RISC OS Pi

RISC OS Pi was designed for users who want to open applications individually. This may seem like a limitation, especially if we are used to using many programs at the same time, but it should be noted that the RISC OS Pi occupies only 16MB of memory and has a very simple learning curve.

Lakka

Lakka offers a Linux distribution specifically designed for us to run RetroArch emulators. It is one of the best distributions for retrogaming that we can install on microcomputer.

RetroPie

RetroPie is an operating system similar to the Lakka operating system and aims to transform our microcomputer into a Retro console. It is compatible with all versions of Raspberry Pi. This operating system can run under the full version of Raspbian. Therefore, besides being able to use all RetroArch emulators, we can also run any program on the Linux operating system.

Recalbox

Recalbox is another distribution of Raspberry Pi designed for Retrogaming. This distribution is located between Lakka and RetroPie. This distribution uses the Linux operating system.

Ubuntu Retro Remix

Ubuntu Retro Remix is actually a script that allows us to turn Ubuntu into a game distribution for the Raspberry Pi.

LibreELEC

LibreELEC, short for Libre Embedded Linux Entertainment Center, is a fully featured media center application running on Raspberry Pi cards. LibreELEC runs the Kodi media center, which provides quick access by dividing the home screen into five main categories such as Pictures, Videos, Music, Programs and Settings.

OSMC

OSMC (Open Source Media Center) is a customized version of the Debian Linux distribution to use the Kodi media center as its main application. When you start OSMC on the Raspberry Pi computer, you will see Kodi as the graphical interface.

Windows 10 IoT Core

Windows 10 IoT Core is a lightweight version of Windows 10 designed for developers, hackers, and hobbyists who want to use Raspberry Pi cards as a device to prototype IoT devices. Windows 10 IoT Core is almost completely different from full versions of Windows 10 running on tablets, laptops, desktops, and servers.

Karmbian OS

Kali Linux is an ethical hacking distribution for Karmbian OS, Raspberry Pi and other microcomputers.

OpenMediaVault

NAS is a device with which we can connect to the network and enable certain services (especially storage) to all computers on the network. While commercial NAS can be quite expensive, we can transform the Raspberry Pi into a fully functional NAS. This distribution allows us to enable or disable the processes and services we need and use certain protocols within the network. You can easily manage remotely from your web panel. It also supports RAID configurations.

Alpine Linux

Alpine is a very minimalist and standalone distribution that focuses on users building secure networks and infrastructures. It is a very small and simple distribution, does not take up more than 50 MB.

Lubuntu

Lubuntu is a lightweight Linux distribution that uses the LXDE desktop environment, which is the desktop environment Raspbian uses by default. Works on Lubuntu, Raspberry Pi 2 Model B, Raspberry Pi 3 Model B and later Raspberry Pi boards. However, it does not work on Raspberry Pi boards previously produced. Lubuntu typically uses about half the RAM of Xubuntu, so it's a good choice to get good performance on a full-featured version of Linux.

Xubuntu

Xubuntu is a version of Ubuntu Linux that uses the Xfce desktop environment instead of the Unity graphics shell that regular Ubuntu uses. As Xubuntu is a relatively demanding version of Linux, it is a better choice for the Raspberry Pi 3 Model B than the Raspberry Pi 2 Model B.

Ubuntu MATE

Ubuntu MATE is an official derivative of the widely used Ubuntu version of Linux. Ubuntu MATE differs from regular Ubuntu in that it uses the MATE desktop environment instead of the Unity graphics shell. Apart from this big difference, Ubuntu MATE provides a similar range of software to Raspbian and runs at similar speed.

RaspBSD, FreeBSD, and NetBSD

FreeBSD and NetBSD are two Unix-like operating systems derived from Berkeley Software Distribution (BSD), a derivative of Research Unix. Both are open source operating systems preferred by IT professionals for reliability and security.

Raspbery Pi Programming

Programming languages in Raspberry Pi operating system were examined on the Raspbian operating system (Monk, 2013).

Programming with Scratch

The Raspbian operating system includes the Scratch programming tool to teach the basics of programming, especially for elementary school children who are just beginning to program. The Scratch application was developed by the Lifelong Kindergarten Group at the Massachusetts Institute of Technology (MIT) Media Lab. You can use the Scratch application as the first step to understanding programming basics without considering programming syntax constraints. The Scratch interface was shown in Figure 11.

Figure 11. Scratch 3 Desktop for Raspbian

Programming in Python

The Raspbian operating system includes development environment (IDE) applications of the Python programming language to develop web applications, small databases and 2D games. Includes IDLE (Integrated Development and Learning Environment) IDE

versions for Raspbian, Python 2 and Python 3. Figure 12 shows a Python language implementation in the IDLE IDE.
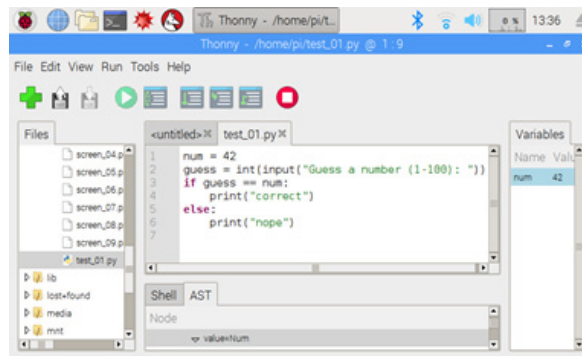

Figure 12. Raspberry Pi Python IDE

Programming in Java

The Raspbian operating system includes BlueJ and Greenfoot applications for the use of the Java programming language. BlueJ is an editor developed for creating Java coding and working on objects. Figure 13 shows an example BlueJ interface (Bluej IDE, 2021).
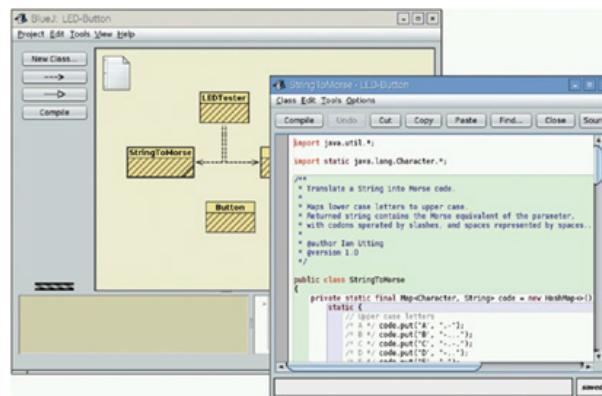

Figure 13. Bluej IDE

Greenfoot is an IDE application developed to create a number of Java scenarios. One of the Greenfoot sample applications was shown in Figure 14 (Greenfoot IDE, 2021).
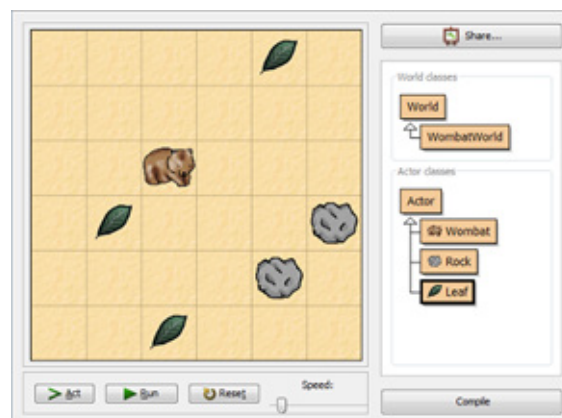

Figure 14. Greenfoot IDE

Programming in Other Languages

Includes Geany IDE for implementing programming languages such as Raspbian, C, PHP (PHP Hypertext Preprocessor), HTML, CSS (Cascading Style Sheets) and Perl. Geany has an accessible user interface. It includes features such as automatic completion of application programming terms and tags, syntax highlighting, and multiple document support. Geany IDE application was shown in Figure 15 (Geany IDE, 2021).
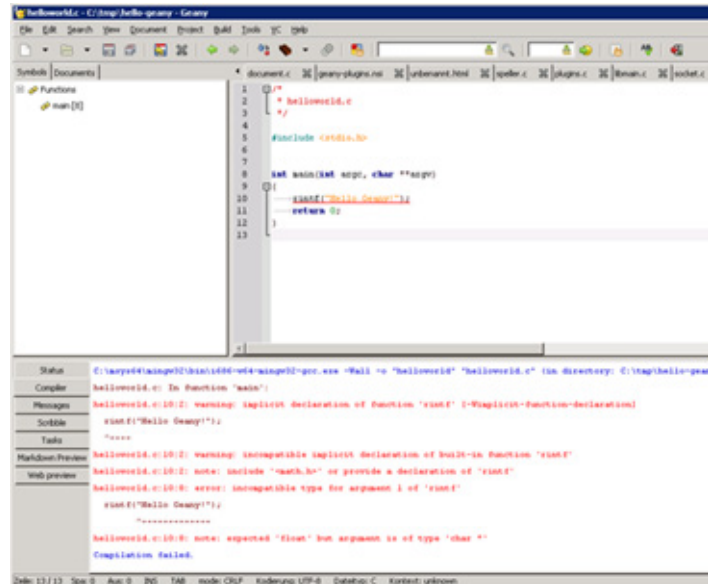

Figure 15. Geany IDE

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