



# RASPBERRY PI 4 MODEL B: A MULTIFUNCTIONAL PLATFORM FOR ADVANCING IOT SOLUTIONS

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**Abstract :** The Raspberry Pi four version B is a compact, affordable computing tool that gives more suitable processing strength and connectivity. This study examines its function in net of factors (IoT) programs, highlighting its overall performance, energy performance, and integration capabilities with sensors and peripherals. The research demonstrates its effectiveness as a value-efficient platform for prototyping and actual-time IoT structures, helping innovation in each schooling and enterprise.

**IndexTerms - Raspberry Pi four version B, net of factors (IoT), facet computing, embedded systems, prototyping, low-price computing, smart gadgets, sensor integration, actual-time structures..**

## I. INTRODUCTION

The development of embedded systems has spurred the need for flexible, energy-wi-fi, and compact computing systems able to coping with real-time obligations. amongst those systems, the Raspberry Pi version B has emerged as a distinguished desire, combining affordability, open-source flexibility, and strong hardware skills. at first designed for academic functions, the version B has confirmed its effectiveness in each business and studies applications as a powerful opportunity to conventional microcontrollers.

The Raspberry Pi 4 can provide overall performance ranges identical to access-degree computer computers thanks to its quad-center ARM Cortex-A72 processor, as much as 8GB of RAM, and several connectivity alternatives like Gigabit Ethernet, USB 3.0, and dual-band c084d04ddacadd4b971ae3d98fecfb2a (1). due to those characteristics, it is able to be used for a diffusion of net of factors packages, such as smart homes, commercial automation, healthwireless tracking, and educational projects.

This research pursuits to discover the potential of the Raspberry Pi four version B as a core aspect in IoT structures. It evaluates its processing competencies, compatibility with numerous sensors and peripherals, and effectiveness in actual-time programs. The examine additionally analyzes realistic deployment scenarios to evaluate its scalability and reliability in actual-international environments.

## II. LITREATURE REVIEW

The internet of things (IoT) has won big interest in recent years because of its ability to connect and automate bodily systems the usage of embedded devices, sensors, and community verbal exchange. various low-price embedded structures were explored to enable real-time tracking, manipulate, and information series. among these, the Raspberry Pi has emerged as a distinguished side computing platform because of its balance among performance, flexibility, and affordability. complaints, and now not as an unbiased document. Please do not revise any of the modern-day designations.

### 2.1 Evolution of IoT hardware platforms

Traditional IoT implementations usually used microcontrollers like Arduino and ESP32, which can be perfect for easy control-primarily based programs. however, their restrained processing electricity and shortage of running gadget aid restriction their talents in complex, multitasking, or actual-time analytics scenarios (2). In contrast, single-board computer systems (SBCs) which include the Raspberry Pi offer a complete Linux environment, higher acceptable for multitasking and nearby statistics processing.

## 2.2 Function of Raspberry Pi in IoT systems

Studies have proven that Raspberry Pi can efficiently characteristic as an IoT gateway, local server, or part processing unit because of its guide for Python, Linux-based totally OS, GPIO interfacing, and wireless conversation protocols (3). Its more recent variations, especially the Raspberry Pi 4 version B, encompass enormous hardware upgrades which include a quad-middle ARM Cortex-A72 processor and up to 8GB RAM, making it able to running net servers, databases, and light-weight device getting to know fashions (4).

## 2.3 Packages in actual-international scenarios

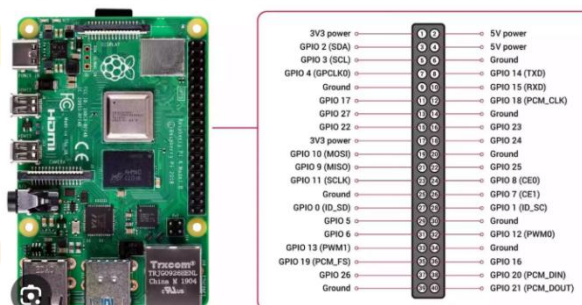
Raspberry Pi has been correctly utilized in smart homes (five), environmental monitoring (7), and fitness care systems (9). as an example, Kulkarni & Sathe (2014) advanced a home automation system that utilized a Raspberry Pi as the primary controller, permitting real-time get right of entry to and control through the net. further, Shafique et al. (2018) built an IoT-based climate tracking station with actual-time records logging the usage of Raspberry Pi and diverse environmental sensors.

## 2.4 Comparative Performance

In comparison to microcontrollers, Raspberry Pi gives better multitasking, GUI development, and 1/3-birthday party library guide (4). however, its better power consumption and boot time are alternate-offs while used in battery-operated or deeply embedded systems. no matter this, for packages in which area analytics or hybrid cloud-area architectures are required, the Raspberry Pi four version B offers an greatest platform (Shi et al., 2016).

## III. HARDWARE AND SOFTWARE SPECIFICATIONS

The Raspberry Pi four model B is a powerful unmarried-board pc (SBC) designed to support superior IoT and side computing applications. It includes the subsequent key hardware features:



### 3.1 Technical Specifications of Raspberry Pi 4 Model B

**Processor:** Broadcom BCM2711, Quad-core Cortex-A72 (ARM v8) 64-bit SoC @ 1.5GHz

**RAM Options:** 2GB, 4GB, or 8GB LPDDR4-3200 SDRAM

**Storage:** microSD card slot (helps boot and storage), USB boot supported

**Networking:** Gigabit Ethernet, twin-band 2.4GHz and 5GHz IEEE 802.11ac, Bluetooth 5 wireless.

**USB Ports:** 2× USB 3.0 ports and a couple of× USB 2. zero ports display guide: 2 × micro-HDMI ports (up to 4K decision)

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**GPIO:** 40-pin GPIO header, fully backward-well suited with preceding models

**Power Supply:** 5V/3A USB-C.

These wireless properties make the Raspberry Pi four model B capable of walking more than one packages simultaneously, hosting local servers, and interfacing with numerous IoT additives

### 3.2 Operating Systems

The Raspberry Pi supports a variety of operating systems, the most common being:

**Raspberry Pi OS (formerly Raspbian):** A Debian-based Linux OS optimized for Pi hardware, providing a stable and user-friendly environment.

**Ubuntu Server / Core:** IoT deployments and cloud integration.

**Windows IoT Core:** Designed for embedded IoT applications but less commonly used due to limited community support.

Raspberry Pi OS is typically used for prototyping due to its ease of use, while Ubuntu Server is preferred for more robust deployments.

### 3.3 Common Software Tools

The Raspberry Pi 4 Model B supports a wide range of software tools for IoT development, including:

**Python:** Primary programming language with rich libraries (e.g., RPi. GPIO, gpiozero) for sensor control and automation.

**Node-RED:** A visual programming tool for wiring together IoT devices and APIs using a flow-based approach.

**MQTT:** A lightweight messaging protocol used for communication between IoT devices.

**MySQL / InfluxDB:** For local data storage and logging.

**Grafana:** For real-time data visualization.

**OpenCV / TensorFlow Lite:** For lightweight AI applications on the edge.

### 3.4 Sensor and Peripheral Compatibility

The Raspberry Pi 4 is compatible with a wide range of sensors and modules through its 40 GPIO pins and I2C/SPI/UART interfaces. Commonly used components include:

**Temperature and Humidity Sensors:** DHT11, DHT22, BMP280

**Motion Sensors:** PIR, Ultrasonic

**Light Sensors:** LDR, TSL2561

**Cameras:** Pi Camera Module (CSI interface)

**Actuators:** Relays, Servos, Motors

**Other Modules:** GPS, GSM, RFID, OLED displays

This extensive compatibility allows the Raspberry Pi 4 to be deployed in diverse IoT applications ranging from smart homes to environmental monitoring.

## IV. MICROCONTROLLER CAPABILITIES AND USE CASES

### 4.1 Microcontroller Capabilities

While the Pi 4 is technically a single-board computer (SBC) rather than a microcontroller, it offers several microcontroller-like features, including:

**GPIO Control:** Equipped with a 40-pin header, the Pi 4 provides 26 GPIO pins that can be programmed for digital I/O, PWM, SPI, I<sup>2</sup>C, and UART communication—essential for interfacing with sensors, actuators, displays, and other hardware modules.

**Real-Time Processing:** Although it lacks a real-time operating system (RTOS) by default, real-time behavior can be emulated through optimized software libraries and kernel-level tuning.

**Multi-threaded Task Handling:** Unlike microcontrollers with limited processing cores, the quad-core CPU of the Pi 4 enables parallel execution of tasks, beneficial for complex systems requiring multitasking (e.g., camera processing alongside motor control).

**High-Speed Interfaces:** It supports USB 3.0, Gigabit Ethernet, HDMI, and CSI/DSI camera/display interfaces, which allow integration into high-speed data acquisition or visual processing systems.

### 4.2 Use Cases

**Home Automation Controllers:** The Pi 4 can serve as a smart home hub, controlling lighting, temperature, and security systems using MQTT or Home Assistant platforms.

**IoT Gateways:** With built-in Wi-Fi and Bluetooth 5.0, it acts as a powerful edge device for collecting, processing, and transmitting sensor data in real-time to cloud servers or local dashboards.

**Industrial Monitoring and Control:** In manufacturing environments, the Pi 4 can monitor machine parameters, log data, and issue commands to actuators using protocols like Modbus or CAN via external interface modules.

**Robotics and Automation:** Its processing power supports real-time video/image processing (using OpenCV), sensor fusion, and autonomous navigation in robotics applications.

**Data Acquisition Systems:** Combined with ADC modules, the Pi 4 can be used for multi-channel analog data acquisition and analysis, suitable for research labs and environmental monitoring stations.

**Edge AI and Machine Learning:** With support for frameworks like TensorFlow Lite, the Pi 4 can perform lightweight AI tasks such as object detection, voice recognition, or predictive maintenance directly on the device.

## V. COMPARISON

Table 5.1

| Feature           | Raspberry Pi 4 Model B                          | Raspberry Pi 3 Model B                        | ESP32                             |
|-------------------|-------------------------------------------------|-----------------------------------------------|-----------------------------------|
| Processor         | Quad-core ARM Cortex-A72 @ 1.5 GHz              | Quad-core ARM Cortex-A53 @ 1.2 GHz            | Dual-core Xtensa LX6 @ 240 MHz    |
| RAM               | 2GB / 4GB / 8GB LPDDR4                          | 1GB LPDDR2                                    | 520KB SRAM + 4MB flash (typical)  |
| GPIO Pins         | 40 (26 usable as GPIO)                          | 40 (26 usable as GPIO)                        | 34 GPIO (some multifunction)      |
| Power Consumption | 3W–7W (depending on use)                        | 2.5W–5W                                       | ~0.5W (very low power)            |
| Connectivity      | Gigabit Ethernet, Wi-Fi 802.11ac, Bluetooth 5.0 | 10/100 Ethernet, Wi-Fi 802.11n, Bluetooth 4.1 | Wi-Fi 802.11 b/g/n, Bluetooth 4.2 |

**Raspberry Pi 4 Model B:** Ideal for AI, robotics, edge computing, and multimedia-rich embedded systems.

**Raspberry Pi 3 Model B:** Suitable for general Linux-based automation and learning projects.

**ESP32:** Great for IoT applications needing Wi-Fi/Bluetooth with real-time behavior and low power.

## VI. LIMITATIONS

**6.1 No Real-Time Capability:** Raspberry Pi 4 runs a full Linux-based operating system, which cannot guarantee real-time responsiveness. This makes it unsuitable for applications requiring precise timing or immediate feedback, such as motor control, industrial automation, or high-frequency sensor polling.

**6.2 No Built-in ADC (Analog to Digital Converter):** Unlike microcontrollers like the Arduino or ESP32, the Pi 4 does not have built-in analog input pins. To read analog sensor data (e.g., temperature, light, pressure), you need to use an external ADC module like MCP3008, adding complexity and cost.

**6.3 High Power Consumption:** The Pi 4 typically consumes between 3W to 7W depending on workload, which is significantly higher than most microcontrollers. This makes it less suitable for low-power or battery-operated embedded applications, where power efficiency is critical.

**6.4 Overheating Under Heavy Load:** During intensive processing tasks (e.g., AI, video processing), the CPU temperature can rise quickly, leading to thermal throttling. This reduces performance unless active cooling (e.g., heatsink or fan) is provided, which adds to size and hardware requirements.

**6.5 Not Designed for Industrial Environments:** Raspberry Pi 4 is not built with industrial-grade components. It lacks protection against voltage fluctuations, temperature extremes, and mechanical shock. Long-term deployment in harsh or mission-critical environments may require extra ruggedization or industrial alternatives.

## VII. ACKNOWLEDGMENT

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## REFERENCES

- [1] <https://datasheets.raspberrypi.com/rpi4/raspberry-pi-4-datasheet.pdf>
- [2] Al-Fuqaha, A., Guizani, M., Mohammadi, M., Aledhari, M., & Ayyash, M. (2015). *Internet of Things: A survey on enabling technologies, protocols, and applications*. IEEE Communications Surveys & Tutorials, 17(4), 2347–2376. <https://doi.org/10.1109/COMST.2015.2444095>
- [3] Gaur, D., & Yadav, P. (2020). *IoT based real-time weather monitoring system using Raspberry Pi*. International Journal of Scientific Research in Engineering and Management, 4(2), 12–18.
- [4] Gubbi, J., Buyya, R., Marusic, S., & Palaniswami, M. (2013). *Internet of Things (IoT): A vision, architectural elements, and future directions*. Future Generation Computer Systems, 29(7), 1645–1660. <https://doi.org/10.1016/j.future.2013.01.010>
- [5] Kulkarni, P., & Sathe, S. (2014). *Automation in home using Raspberry Pi with IoT*. International Journal of Computer Applications, 113(16), 6–10.
- [6] Raspberry Pi Foundation. (2020). *Raspberry Pi 4 Model B datasheet*. <https://datasheets.raspberrypi.com/rpi4/rpi-4-b-datasheet.pdf>
- [7] Shafique, K., Khawaja, B. A., Sabir, F., Qazi, S., & Mustaqim, M. (2018). *Internet of Things (IoT) for weather monitoring and prediction: A study*. IEEE Internet of Things Journal, 5(2), 584–592.
- [8] Shi, W., Cao, J., Zhang, Q., Li, Y., & Xu, L. (2016). *Edge computing: Vision and challenges*. IEEE Internet of Things Journal, 3(5), 637–646. <https://doi.org/10.1109/JIOT.2016.2579198>
- [9] Yadav, S., & Raj, P. (2021). *Smart health monitoring system using IoT and Raspberry Pi*. Journal of Emerging Technologies and Innovative Research, 8(6), 425–431.
- [10] Yaldaie, A., Porras, J., & Drögehorn, O. (2024). *Innovative Home Automation with Raspberry Pi: A Comprehensive Approach to Managing Smart Devices*. Asian Journal of Computer Science and Technology, 13(1), 27–40. <https://doi.org/10.70112/ajcst.2024.13.1.4260>
- [11] *Raspberry Pi in Industry 4.0: A Comprehensive Review of Applications in Industrial IoT and Digital Twin Systems* — Syed Adnan Ali & Atif Ali (2025). A recent review paper discussing how Raspberry Pi devices (including Pi 4) are used in Industry 4.0, digital twins, SCADA, predictive maintenance etc.
- [12] *Performance Characterization of Containers in Edge Computing* — Ragini Gupta, Klara Nahrstedt (2025). Empirical evaluation of containerization overheads (CPU, memory, network, latency) using Raspberry Pi devices in edge scenarios.
- [13] *Con-Pi: A Distributed Container-based Edge and Fog Computing Framework* — Redowan Mahmud & Adel N. Toosi (2021). Describes a framework using multiple Raspberry Pis to serve edge/fog-like IoT workloads with containerization.
- [14] *An Edge Computing Architecture for Object Detection* — (Wireless Internet, WiCON 2019) Compares using Raspberry Pi + Neural Compute Stick for improving object detection performance at the edge
- [15] *IoT Based Home Automation System using Raspberry Pi 4* — T Maragatham, P Balasubramanie, and M Vivekanandhan (2021). A fairly direct application of Raspberry Pi 4 in home automation, with sensor interfacing, remote control via mobile/web, etc.