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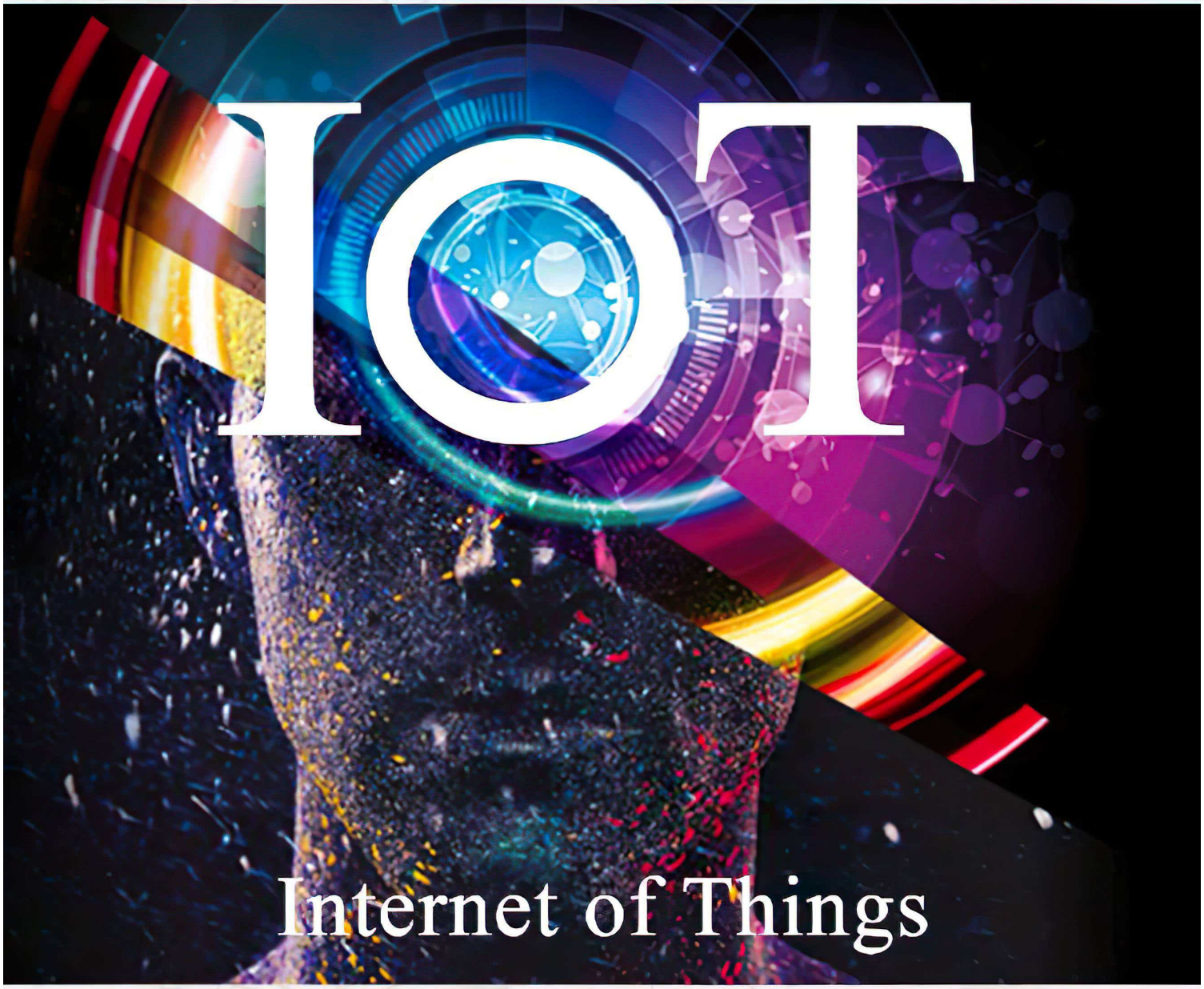

Internet of Things

Jump2Learn - The Online Learning Place

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UNIT - 4

INTRODUCTION TO RASPBERRY PI AND ARDUINO

4.1 Introduction to IoT Devices.

IoT devices are pieces of hardware, such as sensors, actuators, gadgets, appliances, or machines, that are programmed for certain applications and can transmit data over the internet or other networks. They can be embedded into other mobile devices, industrial equipment, environmental sensors, medical devices, and more. There are several standards for device integration, especially for consumer and industry devices. That is, these standards are compactly and constantly optimized toward integrating a wide variety of distributed, decentralized, and disparate devices. However, the ultimate target is to establish smarter environments that readily link cross domain automation modules.

- A home automation device that allows remotely monitoring the status of appliances and controlling the appliances.
- An industrial machine which sends information about its operation and health monitoring data to a server.
- A car which sends information about its location to a cloud based service.

4.2 Basic Building block of an IoT Device

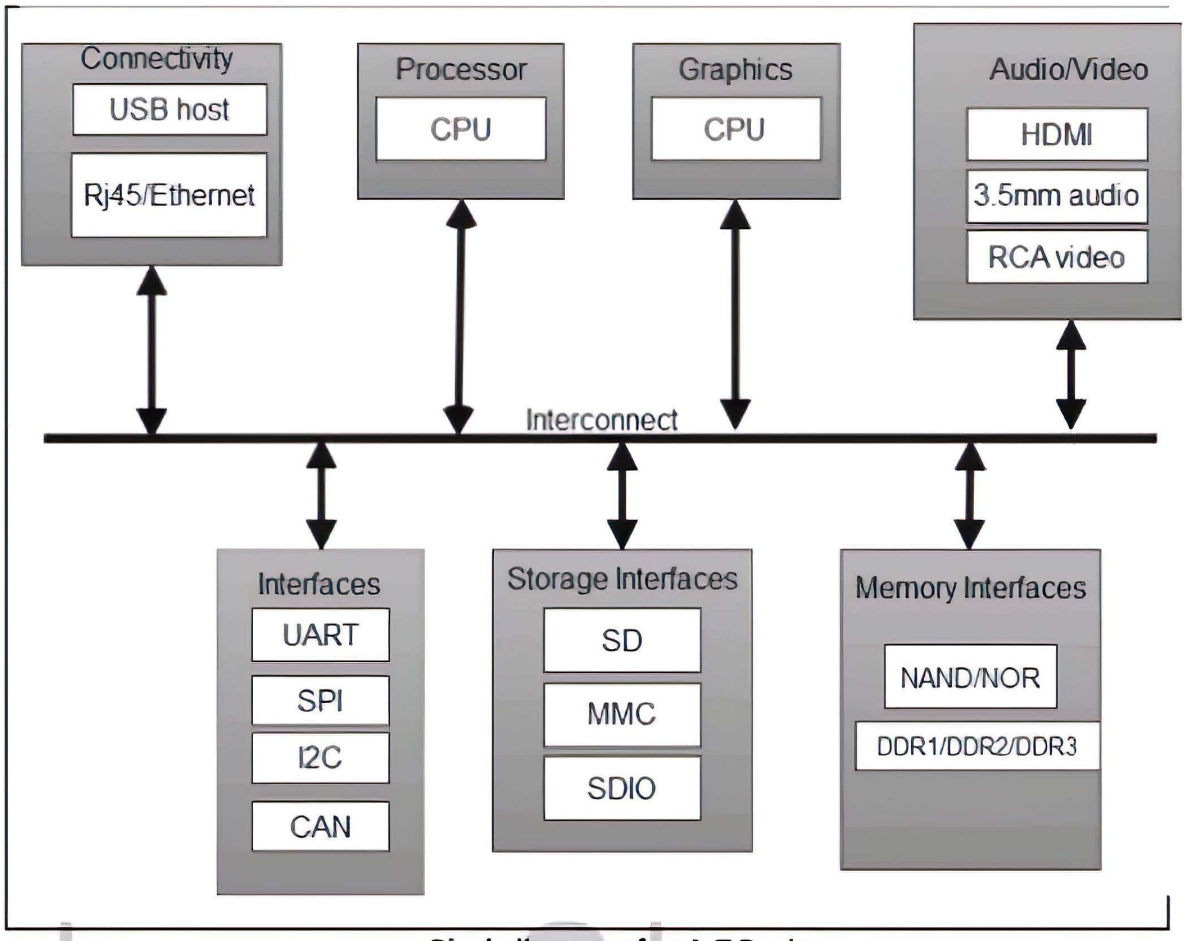
An IoT device can consist of a number of modules based on functional attributes, such as

- **Sensing :** Sensor can be either on-board the IoT device or attached to the device. IoT device can collect various types of information from the on-board or attached sensors such as temperature, humidity, light intensity, etc. The sensed information can be communicated either to other devices or cloud – based servers/storage.
- **Actuation :** IoT devices can have various type of actuators attached that allow taking actions upon the physical entities in the vicinity of the device. For example , a relay switch connected to an IoT device can turn an appliance on/off based on the commands sent to the device.
- **Communication:** Communication modules are responsible for sending collected data to other devices or cloud based servers/storage and receiving data from other devices and commands from remote applications.
- **Analysis & Processing:** Analysis and processing modules are responsible for making sense of the collected data.

  The representative IoT device used for the examples in this book is the widely used single-board mini computer called Raspberry Pi. The use of Raspberry Pi is

international since these device are widely accessible, in expensive, and available from multiple vendors.

Figure shows a generic block diagram of a single – board computer (SBC) based IoT device that include CPU, GPU, RAM, Storage and various type of interfaces and peripherals.



Block diagram of an IoT Device

4.3 Introduction to Raspberry Pi

The Raspberry Pi is a small like credit card but full-featured computer on a single board created by Eben Upton. Raspberry Pi Runs various flavours of Linux and can perform almost all tasks that a normal desktop computer can do. The Raspberry Pi can be used for browsing the web, creating documents and spreadsheets, playing games, watching videos and lots more. It also provides a great environment for learning programming and digital making. You can also connect up hardware (sensor and Actuator) to the Pi's GPIO (general purpose input/output) pins and learn to program using electronics components. The

Raspberry Pi can also be built into custom projects such as home automation solutions, Smart cities solutions etc.it supports Python "out of box".

Purpose or Why Raspberry Pi?

- Inexpensive
- Cross –Platform
- Simple
- Clear programming environment
- Open source and extensible software
- Open source and extensible hardware.

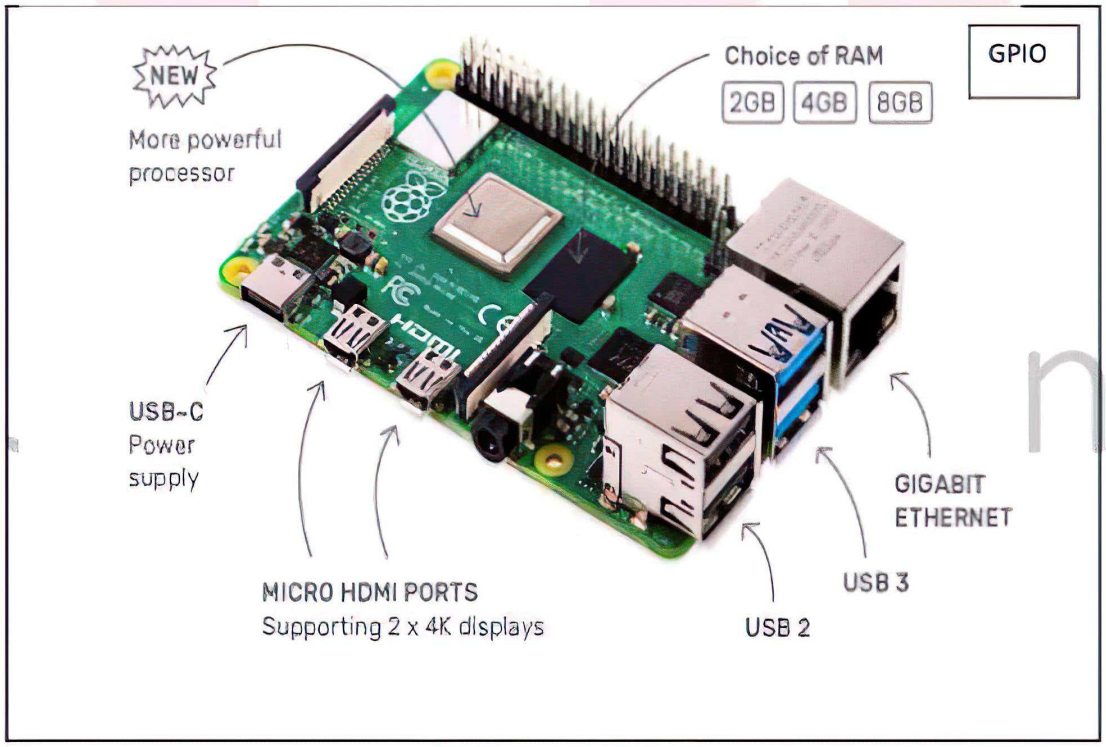
Application Area

- Home Automation
- Smart Cities
- Environment Monitoring
- Logistics Tracking
- Smart Agriculture
- Smart Industry
- Smart Heath Care & Lifestyle

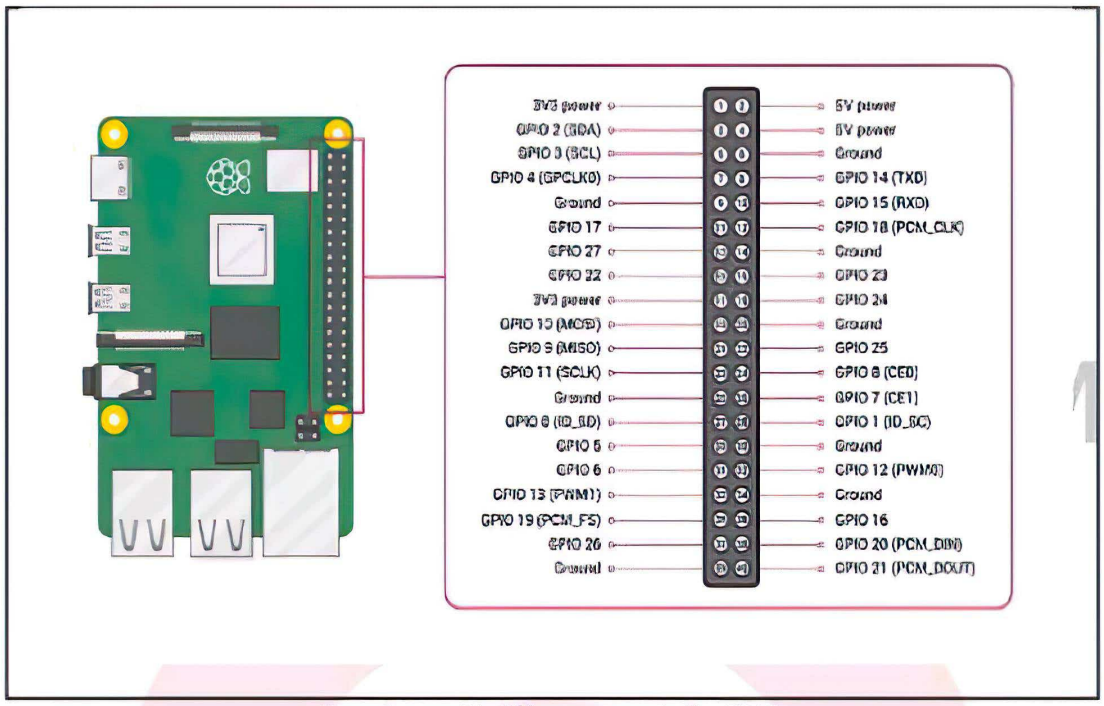
4.4 Components of Raspberry pi

- **Processor & RAM :** Raspberry Pi is based on an ARM processor. The latest version of Raspberry Pi 4 B Comes with Broadcom BCM2711, Quad core Cortex-A72 (ARM v8) 64-bit SoC @ 1.5GHz and 2GB, 4GB or 8GB LPDDR4-3200 SDRAM (depending on model)
- **USB Ports :** Raspberry Pi comes with two USB 2.0 ports. The USB ports on Raspberry Pi can provide a current upto 100mA.For connecting devices that draw current more than 100mA,an external USB powered hub is required.
- **Ethernet Ports :** Raspberry Pi comes with a standard RJ45 Ethernet port. You can connect an Ethernet cable or a USB Wifi adapter to provide internet connectivity.
- **HDMI Output:** The HDMI port on raspberry Pi provides both video and audio output. You can connect the Raspberry Pi to a monitor using as HDMI cable. For monitors that have a DVI port but no HDMI port, you can use an HDMI to DVI adapter/cable.
- **Composite Video Output :** Raspberry Pi comes with a composite video output with an RCA jack that supports both PAL and NTSC video output. The RCA jack can be used to connect old televisions that have an RCA input only.

- **Audio Output :** Raspberry pi has a 3.5 mm audio output jack. This audio jack is used for providing audio output to old televisions along with the RCA jack for video. The audio quality from this jack is inferior to the HDMI output.
- **GPIO Pins :** Raspberry Pi comes with a 40 number of general purpose input/output pins. Figure 7.3 shows the Raspberry Pi GPIO headers. There are four types of pins on Raspberry Pi –true GPIO pins,I2C interface pins, SPI interface pins and serial Rx and tx pins.
- **Display Serial Interface(DSI) :** The DSI interface can be used to connect and LCD panel to Raspberry Pi.
- **Camera Serial Interface(CSI) :** The CSI interface can be used to connect a camera module to Raspberry Pi.
- **Status LEDs :** Raspberry Pi has five status LEDs.
- **SD Card Slot :** Raspberry Pi does not have a built in operating system and storage. You can plug-in an SD card loaded with a Linux image to the SD card slot.
- **Power Input :** Raspberry Pi has a micro - USB Connector for power input.

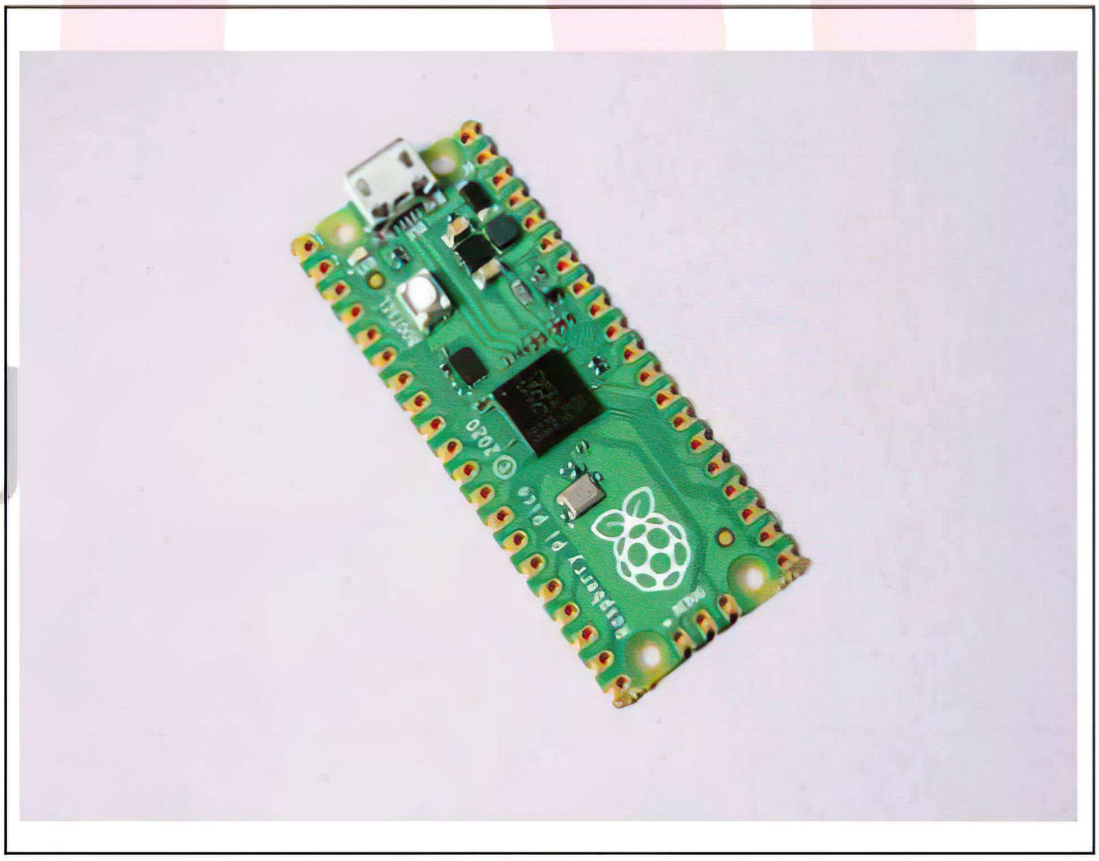


Raspberry Pi Board

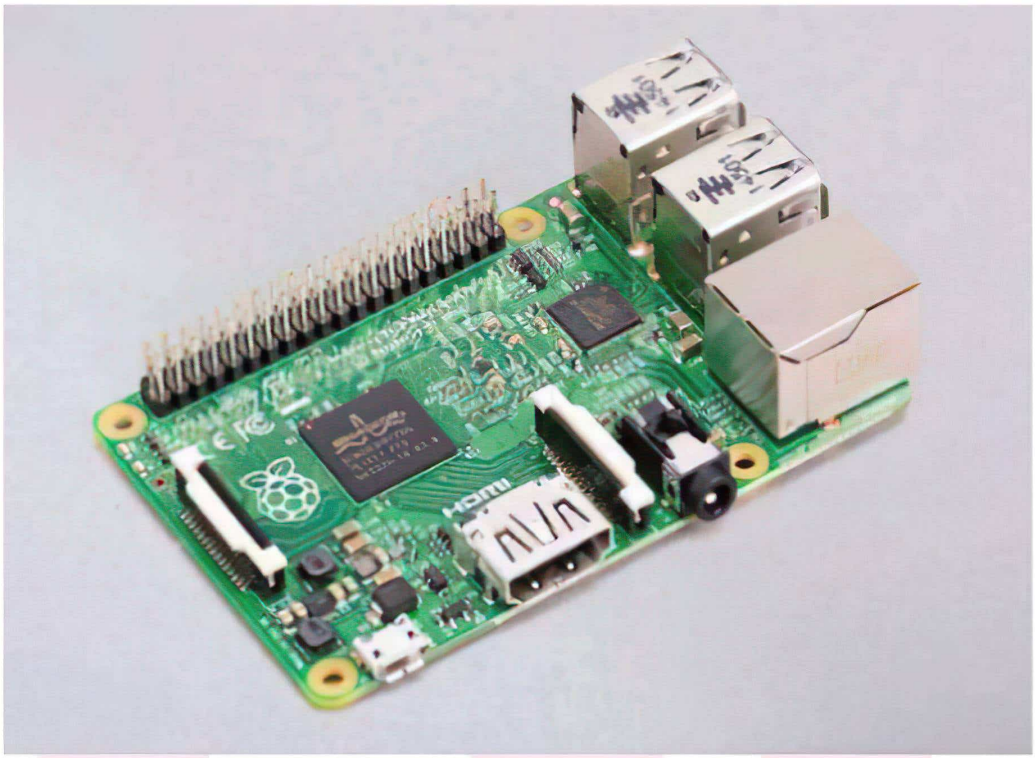


Raspberry Pi different model's GPIO

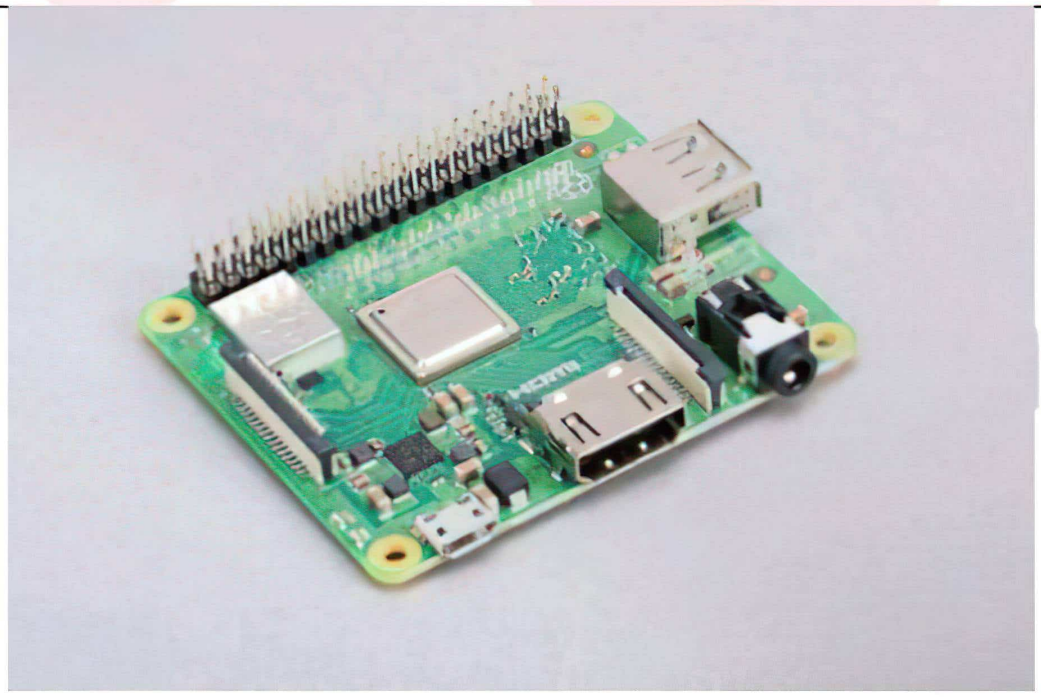
Types of Raspberry Pi Model



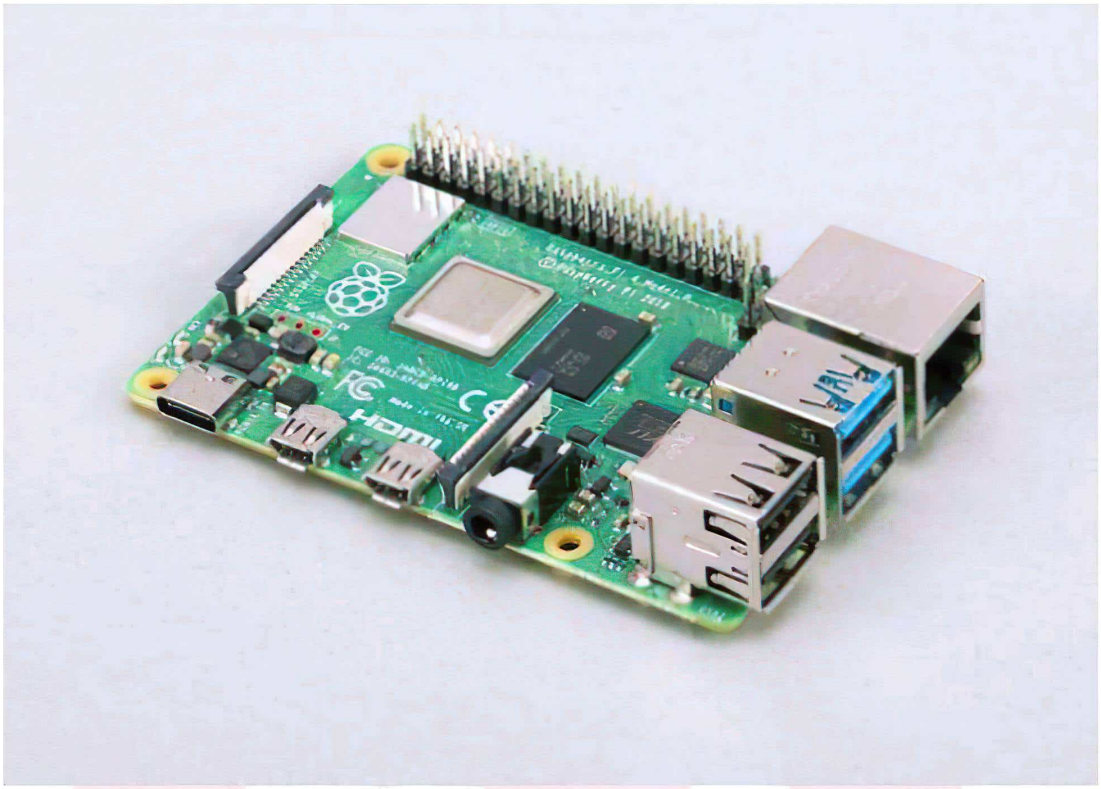
Raspberry Pi Pico



Raspberry Pi 2 Model B



Raspberry Pi 3 model A+



Raspberry Pi 4 model B

4.5 Introduction to Arduino

In 2005, building upon the work of Hernando Barragán (creator of Wiring), Massimo Banzi and David Cuartielles created Arduino. Arduino is an open-source electronics platform based on easy-to-use hardware and software. Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, publishing something online.

You can tell your board what to do by sending a set of instructions to the microcontroller on the board. To do so you use the Arduino programming language (based on Wiring), and the Arduino Software (IDE), based on Processing.

Why Arduino?

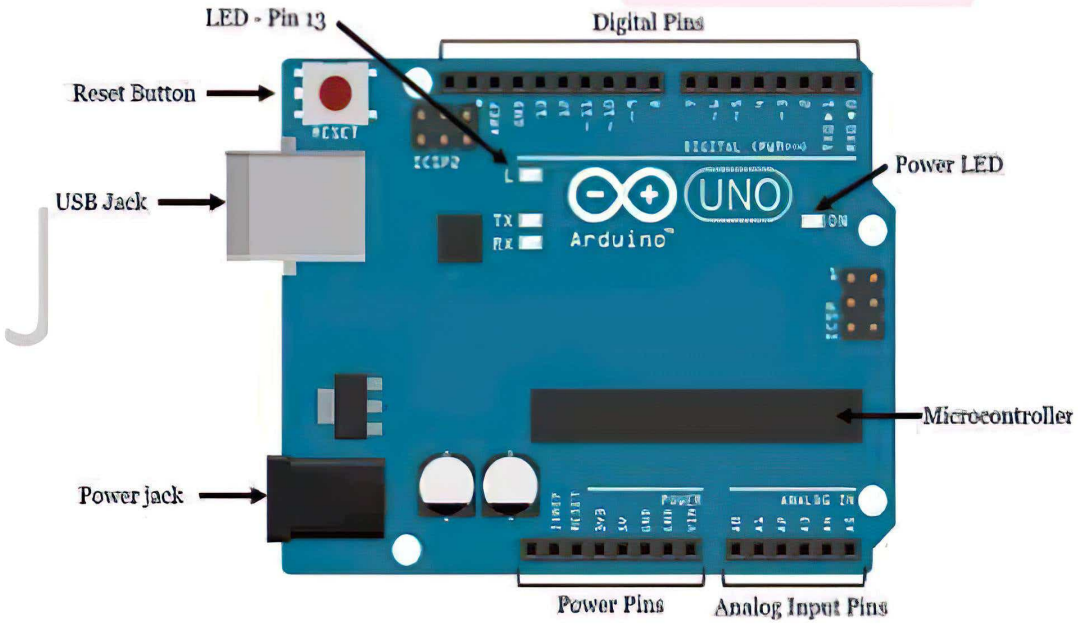
Arduino is an open source product, software/hardware which is accessible and flexible to customers. Arduino is flexible because of offering variety of digital and analog pins, SPI and PWM outputs. Arduino is easy to use, connected to a computer via a USB and communicates

using serial protocol. Inexpensive, Arduino has growing online community where lots of source code is available for use, share and post examples for others to use too.

Arduino is Cross-platform, which can work on Windows, Mac or Linux platforms. Arduino follows Simple, clear programming environment as C language. Arduino is best known for its hardware, but you also need software to program that hardware. Both the hardware and the software are called "Arduino." The combination enables you to create projects that sense and control the physical world. The software is free, open source, and cross-platform.

The boards are inexpensive to buy, or you can build your own (the hardware designs are also open source). In addition, there is an active and supportive Arduino community that is accessible worldwide through the Arduino forums and the wiki (known as the Arduino Playground).

In the ten years since Arduino was released, hundreds of "Arduino boards" are available in the market serving every kind of purpose. Among all in this book we focus on popular Arduino UNO which is used in almost 99% of projects.



Arduino

Components of Arduino

Microcontroller: The ATmega328p is the Arduino brain. Everything on the Arduino board is meant to support this microcontroller.

Digital pins: Arduino has 14 digital pins, labeled from 0 to 13 that can act as inputs or outputs. When set as inputs, these pins can read voltage. They can only read two different states HIGH or LOW. When set as outputs, these pins can apply voltage. They can only apply 5V (HIGH) or 0V (LOW).

PWM pins: These are digital pins marked with a ~ (pins 11, 10, 9, 6, 5 and 3). PWM stands for "pulse width modulation" and allows to make digital pins output "fake" varying amounts of voltage.

LED attached to digital pin 13: This is useful for an easy debugging of the Arduino sketches.

TX and RX pins: these pins blink when there are information being sent between the computer and the Arduino.

Analog pins: the analog pins are labeled from A0 to A5 and are most often used to read analog sensors. They can read different amounts of voltage between 0 and 5V. Additionally, they can also be used as digital output/input pins like the digital pins.

Power pins: The Arduino has 3.3V or 5V supply, which is really useful since most components require 3.3V or 5V. The pins labelled as "GND" are the ground pins.

Reset button: when you press that button, the program that is currently being run in your Arduino will start from the beginning. You also have a Reset pin next to the power pins that acts as reset button. When you apply a small voltage to that pin, it will reset the Arduino.

Power ON LED: will be on since power is applied to the Arduino.

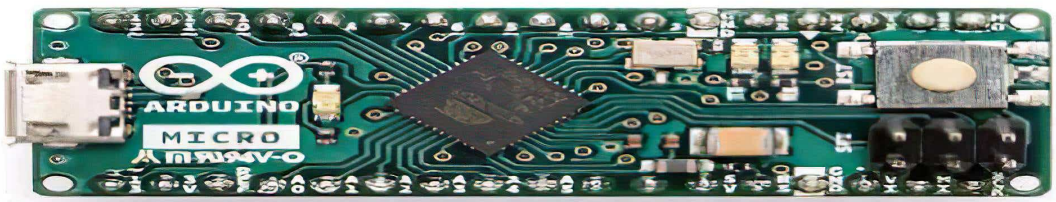
USB jack: a male USB A to male USB B cable is how you upload programs from your computer to your Arduino board. This also powers your Arduino.

Power jack: The power jack is where you connect a component to power up your Arduino (recommended voltage is 5V). There are several ways to power up your Arduino: rechargeable batteries, disposable batteries, wall - warts and solar panel.

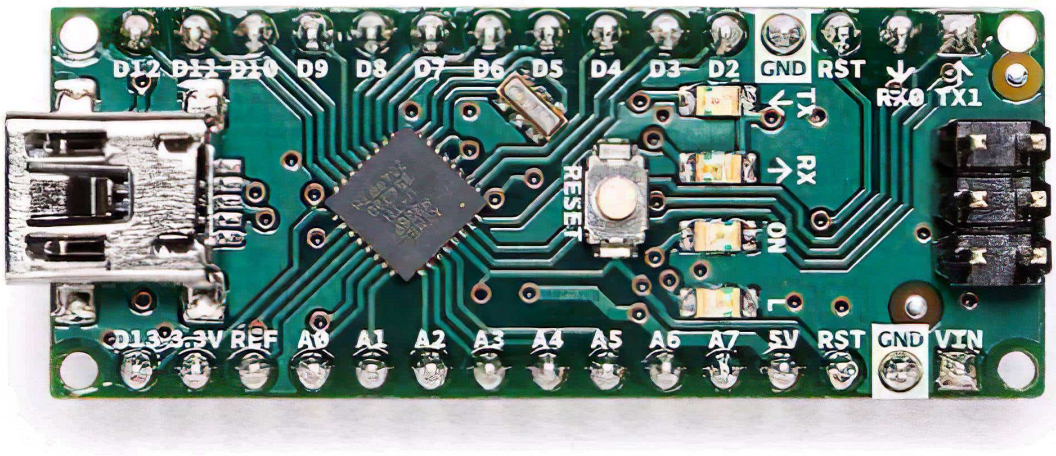
4.6 Difference between Raspberry Pi and Arduino

	Arduino Uno	Raspberry Pi
Known as	Microcontroller	Full-featured computer on a single board
Task	Arduino is usually used for running a single task (or a very small no. of simple tasks) repeatedly, over and over again	Raspberry Pi SBC can perform multiple tasks simultaneously due to its powerful processor and Linux based OS
Components	The Microcontroller on the Arduino Board (like ATmega328P) contains the Processor, RAM, ROM. The board contains supporting hardware (for power and data) and GPIO Pins	All the necessary components like Processor, RAM, Storage, Connectors, GPIO Pins, etc. are situated on the Raspberry Pi Board itself
Programming Language Support	Arduino can be programmed using C or C++ Programming Languages	The main programming languages for developing application in Raspberry Pi are Python, Scratch, Ruby, C, C++
Source	Arduino is developed as open-source hardware and software from the beginning. You can easily get complete information on Arduino's hardware and software	Both the hardware and firmware of Raspberry Pi are closed-source i.e., it is not available for general use
GPIO	GPIO is an important peripheral of any Microcontroller and Arduino UNO is no exception. In Arduino terminology, these pins are called Digital IO (to connect LEDs and Buttons) and Analog IN (to connect analog devices)	Raspberry Pi SBC has several GPIO Pins (the famous 40-pin Raspberry Pi GPIO), using which you can connect different sensors, IO Devices, etc.
Internet	For Arduino, you need additional module or shields to connect to internet because in Arduino There is no wireless connectivity in case of Arduino (at least on board)	You can easily connect to internet using Wi-Fi or Ethernet because Raspberry Pi has the hardware for Bluetooth and Wi-Fi on board
Price	$30(INR 1500 approx.)	$35(INR 2800 approx.)
Size	7.6 × 1.9 × 6.4 cm	8.6cm × 5.4 × 1.7 cm
Memory	0.002MB	512 MB
Clock Speed	16 MHz	700 MHz
On Board Network	None	10/100 wired Ethernet RJ45
Multitasking	No	Yes
Input Voltage	7 to 12 V	5 V
Flash	32KB	SD Card(2 to 18G)
USB	One, Input Only	Two, peripherals OK
Operating System	None	Linux distributors
Integrated Development Environment	Arduino	Scratch, IDLE, anything with Linux Support

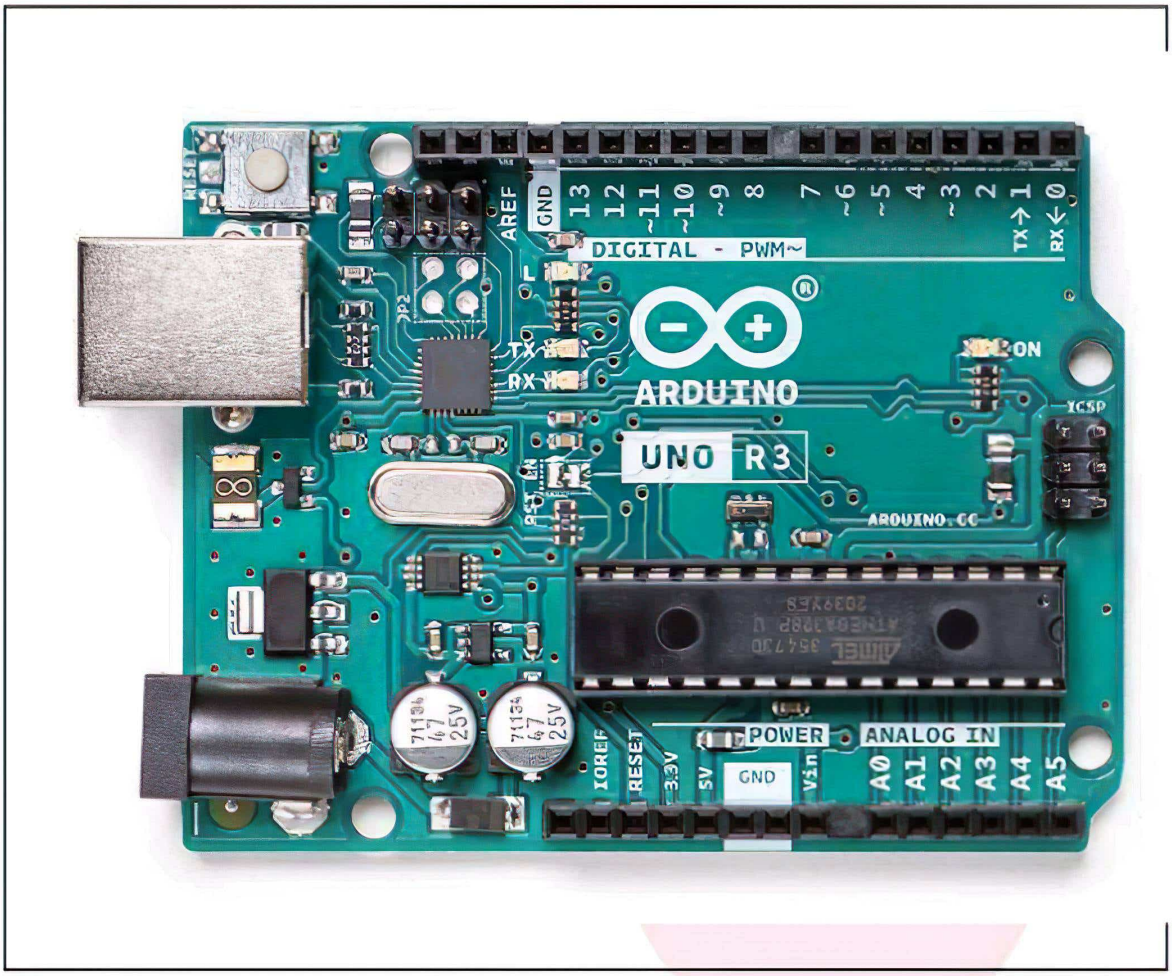
Types of Arduino



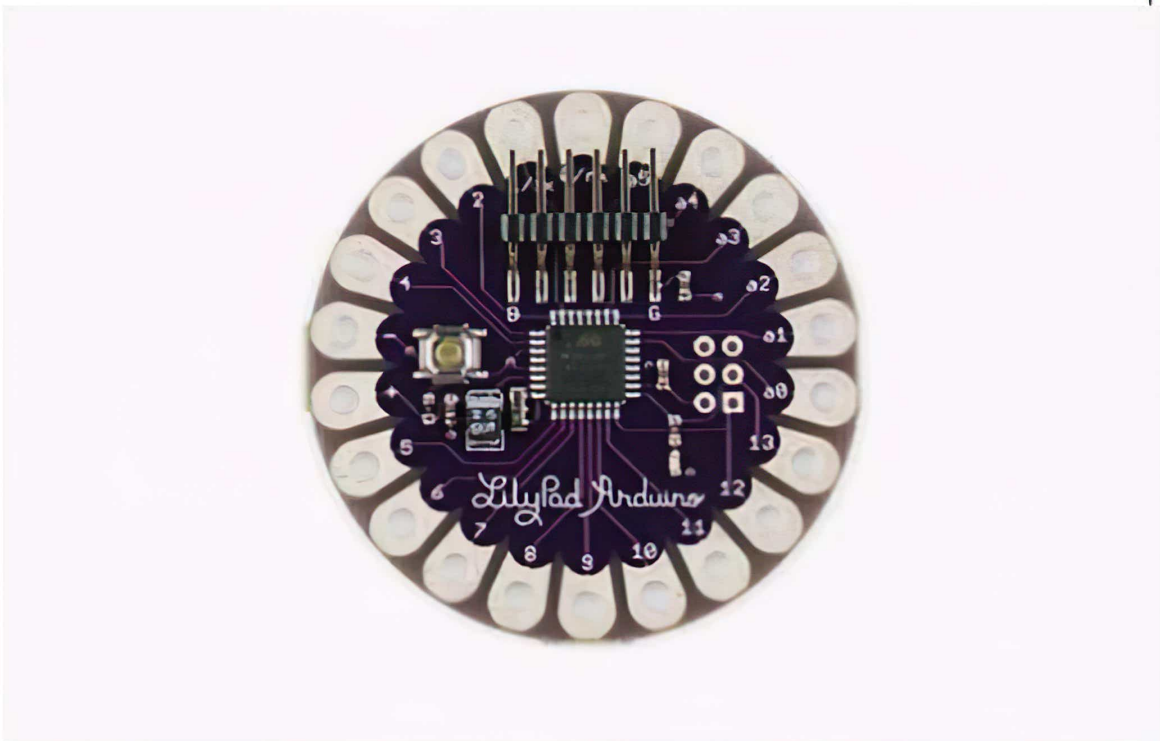
Arduino Micro



Arduino Nano



ARDUINO UNO R3



LilyPad Arduino Main Board

Short Questions

1) What is the use of GPIO pins?
2) What is Sensing and Actuation?
3) What is GPIO Pins?
4) List out basic building blocks of an IoT Device.
5) What is an IoT Device?

Long Questions

1) What is an IoT Device? Explain basic building blocks of an IoT Device.
2) What is Raspberry Pi? Explain its Components.
3) What is Arduino? Explain its Components.
4) Explain Basic building block of an IoT Device.
5) How is Raspberry Pi different from a desktop Computer.
6) Explain Difference between Raspberry Pi and Arduino.

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