UNIVERSITY COLLEGE OF ENGINEERING, THIRUKKUVALAI.

(A Constituent College of Anna University :: Chennai)

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INTERNET OF THINGS REPORT

SUBMITTED BY

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BACHELOR OF ENGINEERING

IN

COMPUTER SCIENCE AND ENGINEERING

COMPANY PROFILE

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Samcore solution / Software Hardware/Development &Testing

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INTERNET OF THINGS

The **Internet of Things (IoT)** refers to the growing network of physical objects—devices, vehicles, appliances, and other items—embedded with sensors, software, and other technologies to connect and exchange data with other devices and systems over the internet. This interconnectedness enables these "things" to collect and share data, automate processes, and interact with their environments.

Key Concepts in IoT:

1. **Connectivity**: Devices are connected via the internet or other networks, allowing them to communicate with each other, often through cloud platforms or edge computing systems.
2. **Sensors**: IoT devices are equipped with sensors that collect data about their environment, such as temperature, humidity, light levels, motion, etc.
3. **Data Exchange**: The devices collect and send data to other systems or central servers. This data can be processed to generate insights or trigger automated responses.

4. **Automation and Control**: IoT enables remote monitoring and control of devices. For example, smart home systems allow users to control lighting, heating, and security from a smartphone or computer.
5. **Artificial Intelligence (AI) and Machine Learning (ML)**: IoT systems often integrate AI and ML to make sense of the data they gather and to enable predictive maintenance, process optimization, and decision-making.
6. **Device design:** IoT devices must be designed with consideration for environmental conditions, sensors, data volume, power, range, speed, and cost.

7. **Examples**: Some examples of IoT devices include smart thermostats, fitness trackers, smart traffic control systems, and smart parking systems

Internet of Things (IOT) important

Access to low-cost, low-power sensor technology

Affordable and reliable sensors are making IOT technology possible for more manufacturers.

Connectivity

A host of network protocols for the internet has made it easy to connect sensors to the cloud and to other ―things‖ for efficient data transfer.

Cloud computing platforms

The increase in the availability of cloud platforms enables both businesses and consumers to access the infrastructure they need to scale up without actually having to manage it all.

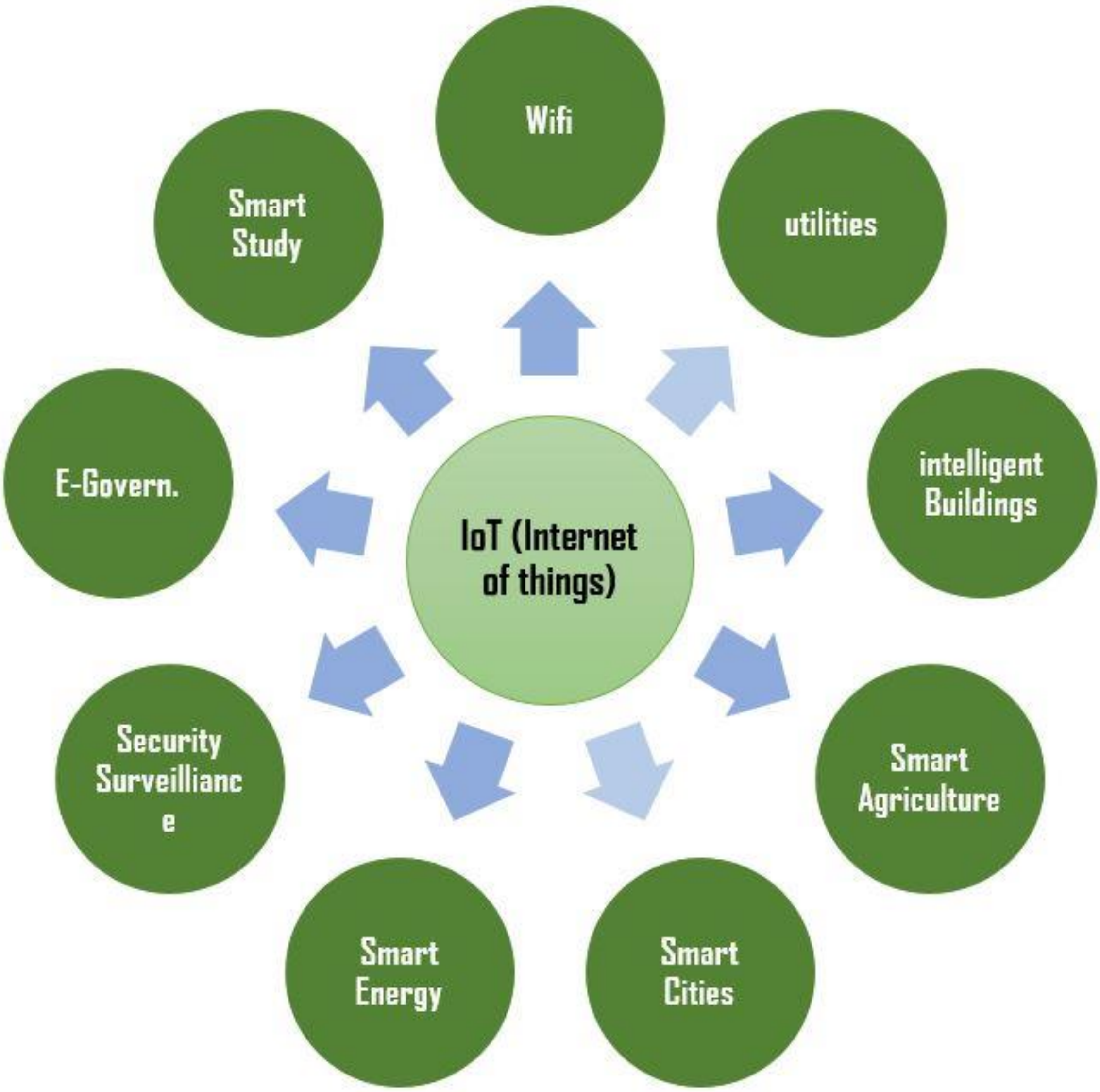
Machine learning and analytics with advances

Machine learning and analytics, along with access to varied and vast amounts of data stored in the cloud, businesses can gather insights faster and more easily. The emergence of these allied technologies continues to push the boundaries of IOT and the data produced by IOT also feeds these technologies.

Conversational artificial intelligence (AI)

Conversational AI is a type of artificial intelligence (AI) that can simulate human conversation. It uses natural language processing (NLP) and machine learning to understand and respond to human language in text or speech.

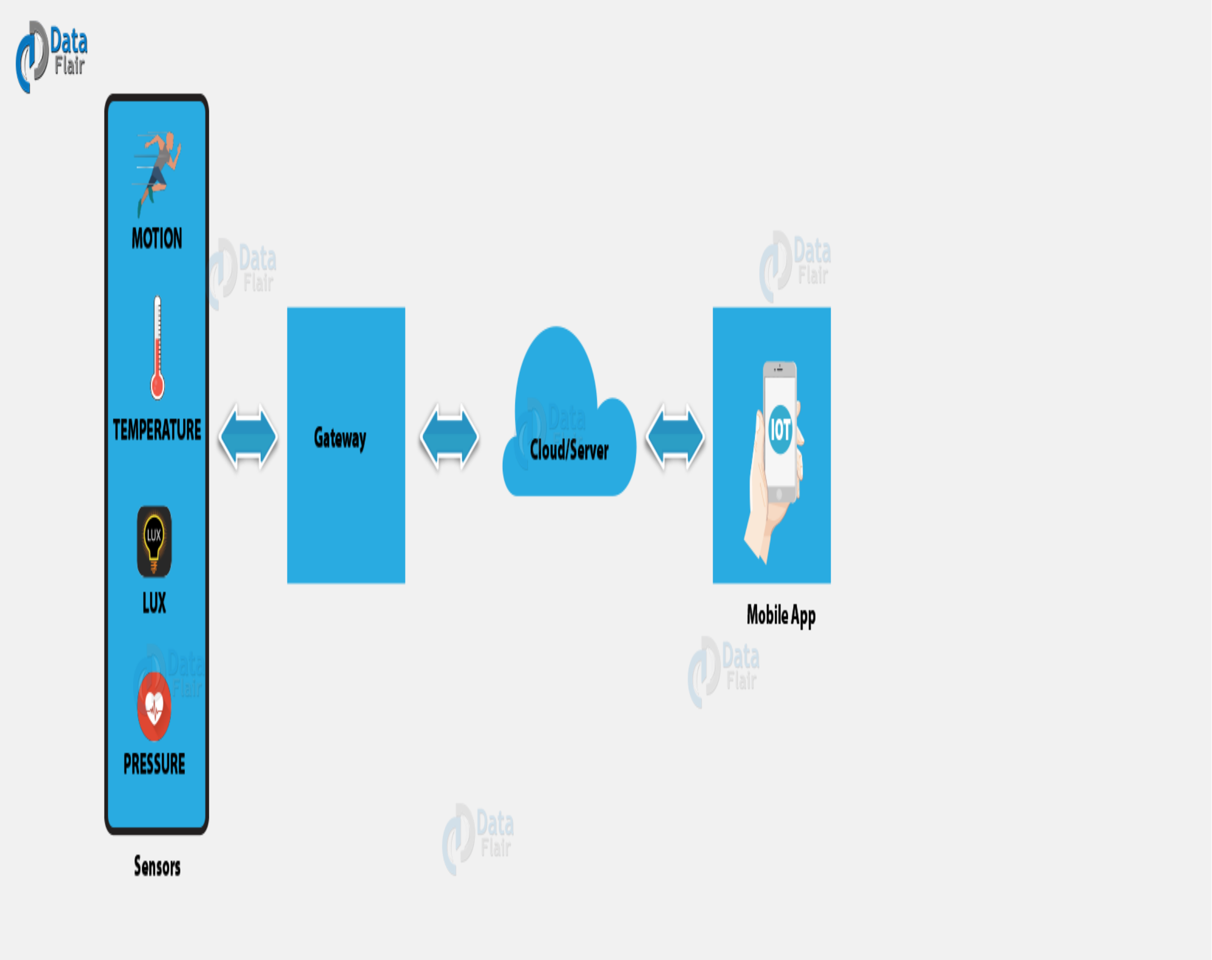
Advances in neural networks have brought natural-language processing (NLP) to IOT devices (such as digital personal assistants Alexa, Cortana, and Siri) and



IoT Works

Just like Internet has changed the way we work & communicate with each other, by connecting us through the World Wide Web (internet), IoT also aims to take this connectivity to another level by connecting multiple devices at a time to the internet thereby facilitating *man to machine* and *machine to machine* interactions.

People who came up with this idea, have also realized that this IoT ecosystem is not limited to a particular field but has business applications in areas of home automation, vehicle automation, factory line automation, medical, retail, healthcare and more.

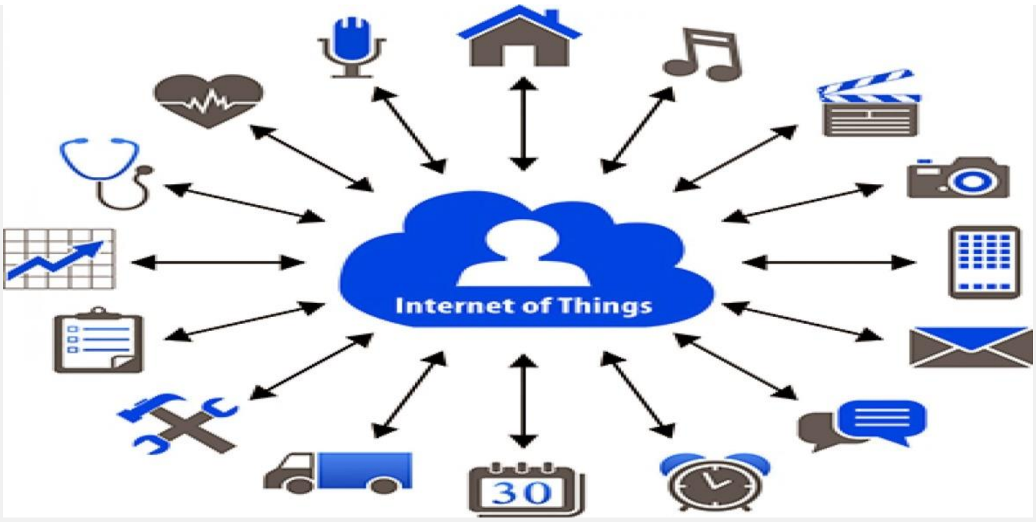


IoT Components

Here, 4 fundamental components of IoT system, which tells us how IoT works.

i. Sensors/Devices

- First, sensors or devices help in collecting very minute data from the surrounding environment. All of this collected data can have various degrees of complexities ranging from a simple temperature monitoring sensor or a complex full video feed.
- A device can have multiple sensors that can bundle together to do more than just sense things. For example, our phone is a device that has multiple sensors such as GPS, accelerometer, camera but our phone does not simply sense things.
- The most rudimentary step will always remain to pick and collect data from the surrounding environment be it a standalone sensor or multiple devices.



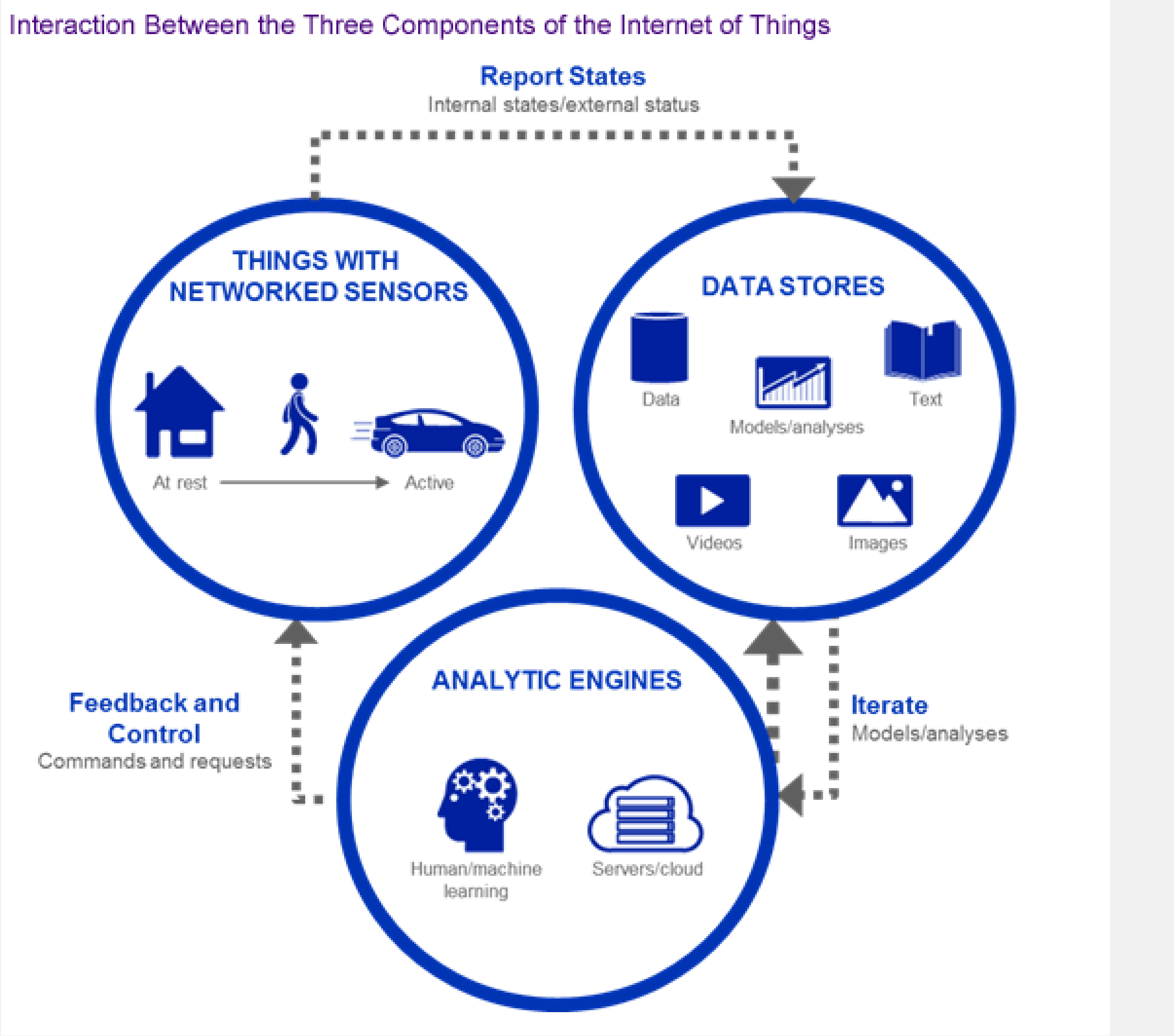
IoT Components – Sensors/Devices

ii. Connectivity

- Next, that collected data is sent to a cloud infrastructure but it needs a medium for transport.
- The sensors can be connected to the cloud through various mediums of communication and transports such as cellular networks, satellite networks, Wi-Fi, Bluetooth, wide-area networks (WAN), low power wide area network and many more.
- Every option we choose has some specifications and trade-offs between power consumption, range, and bandwidth. So, choosing the best connectivity option in the IOT system is important.

iii. Data Processing

- Once the data is collected and it gets to the cloud, the software performs processing on the acquired data.
- This can range from something very simple, such as checking that the temperature reading on devices such as AC or heaters is within an acceptable range. It can sometimes also be very complex, such as identifying objects (such as intruders in your house) using computer vision on video.
- But there might be a situation when a user interaction is required, example- what if when the temperature is too high or if there *is* an intruder in your house? That's where the user comes into the picture.

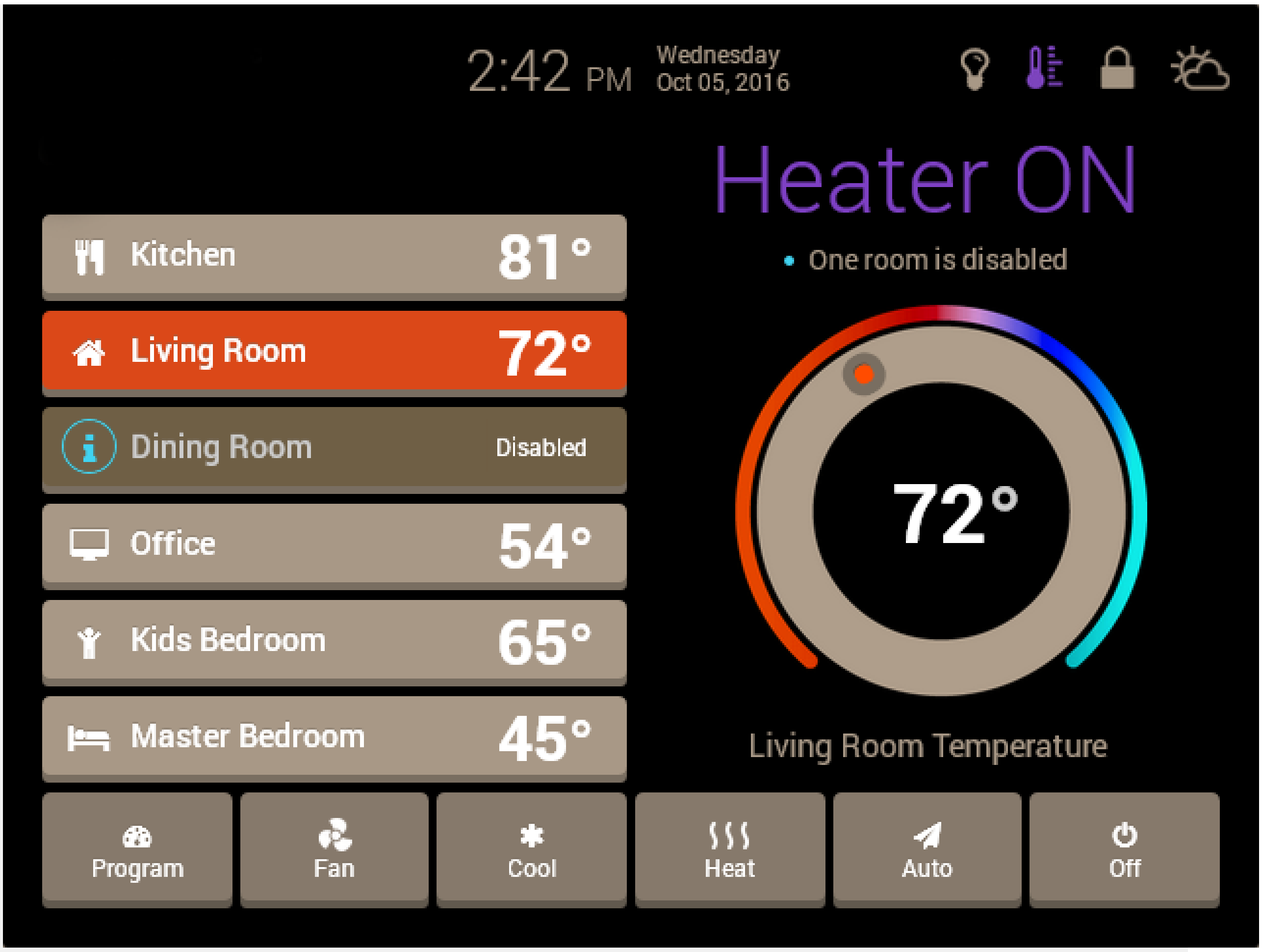


IoT Components – Data Processing

iv. User Interface

- Next, the information made available to the end-user in some way. This can achieve by triggering alarms on their phones or notifying through texts or emails.

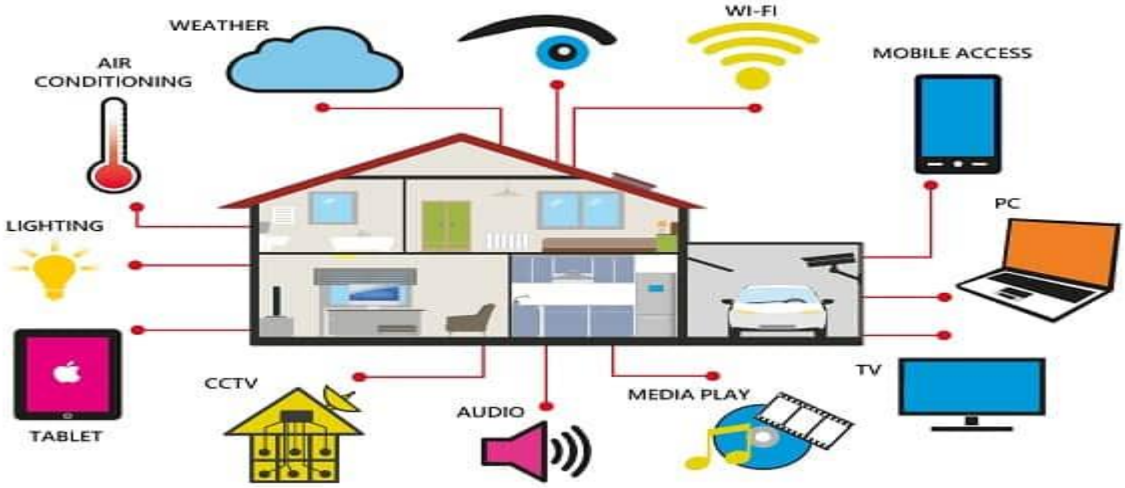
- Also, a user sometimes might also have an interface through which they can actively check in on their IOT system. For example, a user has a camera installed in his house, he might want to check the video recordings and all the feeds through a web server.
- However, it’s not always this easy and a one-way street. Depending on the IoT application and complexity of the system, the user may also be able to perform an action that may backfire and affect the system.
- For example, if a user detects some changes in the refrigerator, the user can remotely adjust the temperature via their phone.
- There are also cases where some actions perform automatically. By establishing and implementing some predefined rules, the entire IOT system can adjust the settings automatically and no human has to be physically present.
- Also in case if any intruders are sensed, the system can generate an alert not only to the owner of the house but to the concerned authorities.



Applications of Internet of Things (IoT)

- The Internet, one of the most significant inventions of all time, helped us to connect with people using computers and Smartphones. The new generation of network IoT (internet of Things), connects things with the ability to sense, control, and communicate. Find out what are the applications of Internet of Things.

Smart Home and Office



Source: Visioforce Automation

- Smart home applications with the use of smart sensors are becoming popular now. Any smart device can be configured and connected to the internet and controlled using a simple mobile application.

- Smart Door access control system

- Smart locks and door access systems are one of the most popular and cost-effective solutions of the Internet of Things. Smart locks are easy to implement and control using a web interface or Smartphone application.

- Integration with RDIF tags, smart door accessing systems can be securely implemented. Users can grant access to the doors using the mobile app and lock them again once the person leaves the premises.

- For example, if a person wants to enter your house while you are not around, you can open the door for that person using the Smartphone application.

Smart lighting for home and office

- Smart lighting is one of the attractive smart home applications using the Internet of Things. In addition to energy saving, it also enables us to manage effectively. Light ambiance can be changed using smart hub devices or smartphone apps.

- Smart lighting can be configured to respond to voice commands and motion detectors/proximity sensors. These sensors will activate the light when someone enters the room or leaves the room. Moreover, it can be configured to turn on when the ambient light is below a certain threshold (turn on when sun light is low).

Automated Gate and garage

- Using smart sensor technology and the Internet of Things, gates and garages can be controlled (operated) conveniently. Once you are about to enter the house or after leaving the premises, you may open or close the gate using mobile devices.

Smart thermostats and humidity controllers

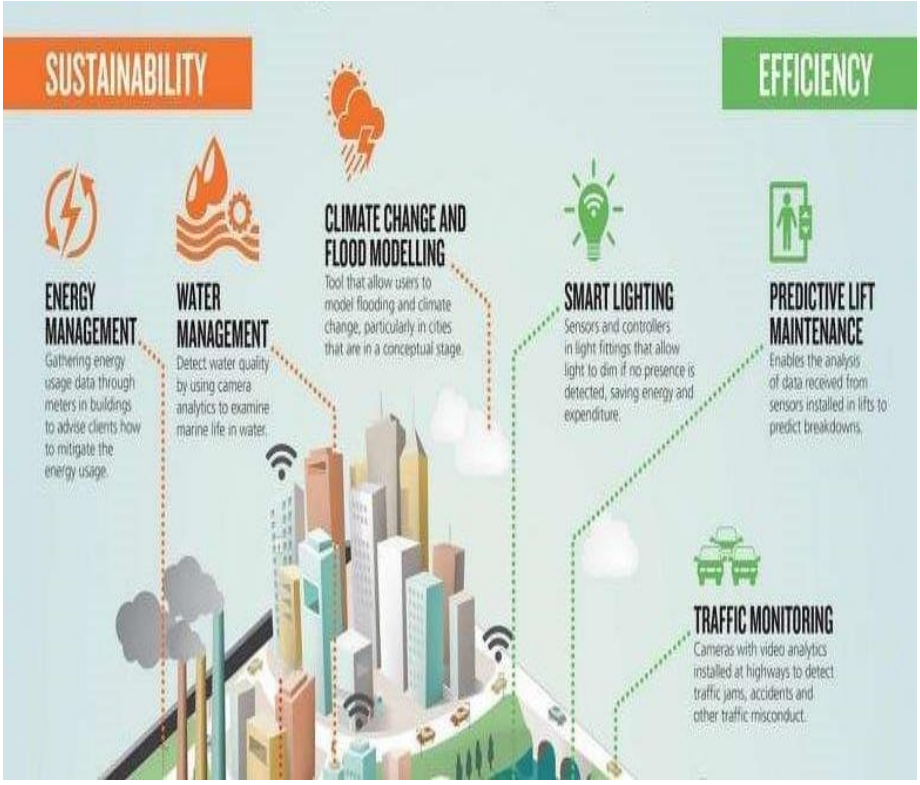
- Smart thermostats are cost-effective and convenient smart-home solutions that can be controlled using an internet connection and smart hub device (or using a Smartphone app).

- Common sensors for home/office automation:

- Motion/proximity sensors
- Voice controlled sensor
- Light sensor
- Temperature and humidity sensors
- Smoke/fire sensor

- Precipitation sensor

Smart City



- One of the most significant applications of Internet of Things is smart city, which ensure efficient energy management, optimized traffic management, waste management and pollution control etc.

Traffic Management

- Analyzing traffic over a period of time gives an insight into possible trends and patterns that could occur during peak hours. It will help to inform commuters to take alternative routes to avoid congestion and delay.

Smart lighting on streets

- Smart lighting is an effective solution to save energy in the cities. Smart sensors can detect the presence of people or vehicles in proximity and increase light intensity when someone passes by.

- Once the person or vehicle is away from that area, smart light will automatically reduce light intensity to save energy. Maximum light intensity will be activated during emergencies to support recovery activities.

- Since the smart lighting systems are connected to the control and monitoring network, any faulty light units will be automatically reported, and necessary maintenance will be initiated.

Pollution monitoring and reporting

- Increasing air pollution is one of the challenges we face in growing cities. To solve this issue, smart sensors are deployed across the cities to monitor any changes continuously.

- Some of the standard sensors are temperature, air quality (like CO2 level, haze, and smoke), moisture, etc… Interconnected smart sensors collect data, sends this data to the monitoring stations, and initiates warning messages during bad air quality detection.

Smart Parking Solutions

- Smart sensors installed in the parking area collect information about the availability of parking slots and update it to the database in real-time. Once the spot is occupied, it will be updated without any delay.

- Service providers and customers can plan and manage parking issues using smart parking solutions.

Water/waste management

- Populations in cities are increasing every year, and based on statistics, this trend will grow in the coming years. An increase in population contributes to an increase in waste as well.

- Many cities are adopting the recycling of water using water treatment units. With an IoT system, the amount of wastewater, consumption in a geographical area, and trend of waste produced can be analyzed effectively.

- IoT and smart sensor technology enable us to manage this issue efficiently. With a smart waste management system, authorities can predict the amount of waste produced in a particular location, how to process it properly, trigger waste clearance, analyze data for future planning, etc…

- Example: smart sensors implemented on trash bins can send alerts to the waste management system once the bin is full (or reached the threshold limit). If the waste quantity in the bin is low, it will not be emptied.

- With analytics solutions, an overview of waste generated in every part of the city and how much waste are generated in duration can be easily assessed. This information will be used to plan during the city expansion and upgrading projects.

- Fleets for waste collection and treatment can be managed, and any changing trends can be predicted via smart analytics solutions.

Wearable Devices

- Wearable smart devices were introduced as smart watches around a decade ago, and many more functions have been added since then. Now our smartwatches and wearables are capable of reading text messages, showing notifications of other apps, tracking location, monitoring workout status, reminding schedules, and continuously monitoring health conditions.

- With the Internet of Things, wearable technology can be used beyond these functions. Major smart wearable manufacturers are developing special operating systems and applications dedicated to smart wearable devices.

- Many people have shared their stories of how a smart watch saved their life during an accident and medical emergencies. Life-saving applications make smart wearables one of the most favourite devices among other IoT devices.

- Parents can track their child's location; caretakers will get a notification if the patient's vitals are low or blood sugar levels are changing. Using wearable technology, doctors and medical professionals can continuously monitor their patient's body conditions in real time.

- Future smart devices like smartwatches and fitness bands will be optimized to perform more functions and connect with other smart IoT devices in the smart home and other applications. Pairing with Smartphone applications will enable these smart wearables to initiate more tasks and get notified promptly.

Future of Wearable Technology

- Future wearable technology will be capable of detecting diseases early and triggering treatment during early stages. Sensitive nano-sensors can detect components in our body fluids (sweat, tears, and saliva) and notify certain physical conditions that could trigger more severe diseases in the future.

- Surgical implanted nano-sensors will indicate possible medical conditions (like cancer) that could develop in our body before it become severe. Finding a medical condition in the early stages has more effectiveness in treatment.

- For example: if we can find out the chances of developing diabetes before it affects our body, we can change our diet and seek medical advice to avoid or delay the disease as much as possible.

- Future healthcare procedures will include more wearable devices for convenient, accurate detection of diseases and monitoring of many medical conditions.

Healthcare

- Source: Intellisoft
- The healthcare industry has been utilizing the possibilities of the Internet of Things for life-saving applications. Starting from collecting vital data from bedside devices, real-time diagnosing process, and accessing medical records and patient information across multiple departments, the entire patient care system can be improved with IoT implementation.
- IoT will offer convenience for medical practitioners, improve accuracy in the information (helps to reduce error in the data), increase overall efficiency, and saves time for each procedure.
- Doctors can monitor patients' status remotely and suggest necessary procedures when required.
- Data loss and mistakes will be reduced to a lower level with IoT devices. Most modern medical devices can be connected to the network, and data can be accessed securely (In the future, all devices will be able to connect to the network).

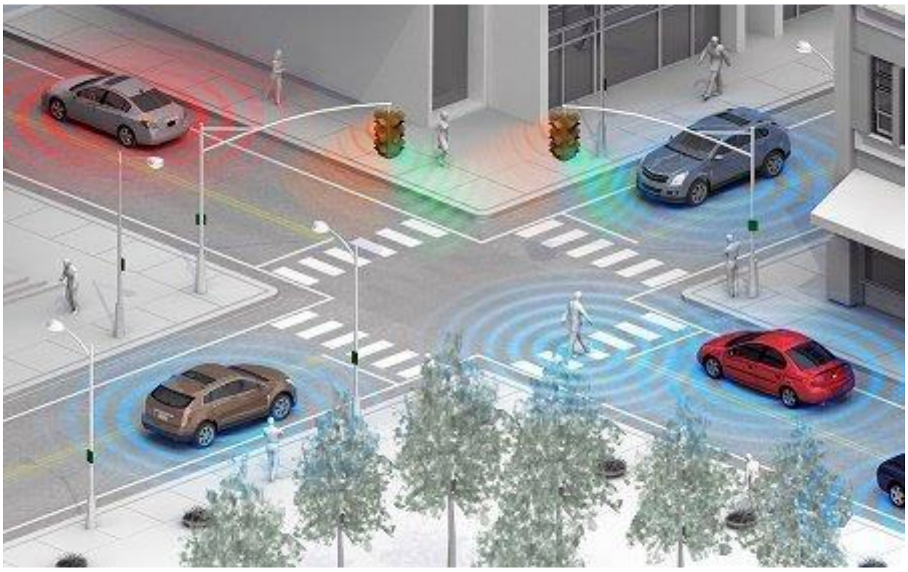
- Round-the-clock patient monitoring is possible with smart IoT devices. Immediate changes in a patient’s vitals will automatically notify responsible medical practitioners in real-time.

- Doctors can prescribe medicine after assessing patients remotely with the help of smart IoT devices. In many cases, hospital visits may not be required.

- Example: Many hospitals are offering telemedicine facilities. Patients can follow up on treatment via video conferencing.

- Besides the healthcare systems’ efficiency and cost-effectiveness, IoT also offers better patient satisfaction. Overall, the hospital experience will be improved with the implementation of IoT in healthcare.

Autonomous Driving



- Autonomous driving is one of the promising applications of IoT, which has been evolving with artificial intelligence and smart sensor technology in the Internet of Things. An earlier generation of autonomous vehicles (partial automation) will assist drivers in driving safely, avoiding collisions, and warning about road and vehicle conditions.

- Examples: cruise control assistance, parking assistance, line changing assistance and efficient fuel /energy management, etc.

- As we collect huge amounts of data from thousands of vehicles (using millions of sensors and camera units), AI can predict certain scenarios on the road and help to implement them in the future generation of vehicles for better safety and efficiency.

- Self-driving cars and connected car concepts will offer a much safer road experience in the future with the use of the Internet of Things and artificial intelligence (AI). One of the significant components of IoT in automobiles is smart sensors, which continually collect information about the vehicle, road condition, other vehicles, objects on the road, and road conditions.

- The system consists of camera units, proximity sensors, RADARs, and RF antenna arrays to collect information and help the vehicle to make decisions based on sudden changes on the road. Vehicles and smart objects can share information with each other using RF technology.

- Example scenarios: ice fall on the road, vehicle breakdown/accident on one line, heavy traffic in a particular direction on the highway, etc…

- Accurate information is significant in making a split-second decision while driving. There would be a bigger impact if the data is not accurate or delayed, and it could even lead to fatal accidents.

- 5G technology offers a faster data rate with a low latency network, which is crucial for autonomous driving technology.

- Sophisticated algorithms are being developed to learn different scenarios from various conditions on the road. With this powerful software with continuously learning AI, manufacturers can enhance the safety of self-driving (full automation) vehicles in the future.

Agriculture and Smart farming

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- There are a lot of challenges in the agriculture and farming industry to produce more crops and vegetables to feed the increasing human population. The Internet of Things can assist farmers and researchers in this area in finding more optimized and cost-effective ways to increase production.

- In developed countries, the young generation is not attracted to conventional farming and agriculture. A lack of support staff could lead to productivity; authorities have to find alternative ways to overcome this issue.

- The Internet of Things is one of the promising solutions to make the entire agriculture and farming industry more efficient with fewer workers. Smart sensor technology will help improve each stage of agriculture, and automation helps to reduce manual labor.

Smart irrigation

- Smart irrigation is a method of efficient use of water for agriculture using the Internet of Things. Smart sensors are deployed into the soil, constantly monitoring and sending information about soil conditions to the control station.

- Once the soil starts to dry or reaches a threshold value defined by the farmer, the control system initiates the water flow, and it will be stopped after a set time. Implementing automated irrigation systems into agriculture can reduce waste or water and manual labor.

Smart Greenhouse using sensors

- Greenhouse farming is one of the successful agricultural methods to artificially control the environment for increased production of vegetables and fruits. Inside the greenhouse, the essential parameters like **CO_2 level**, **temperature,** and **moisture** level are monitored round the clock, and automatic precipitation, light, and moisture control will be activated using an IoT system.

- This smart monitoring system control is much more efficient and cost-effective than the same task workers perform. The data collected using various sensors deployed in the greenhouse will be sent to the cloud, it helps to access the data for further analysis easily.

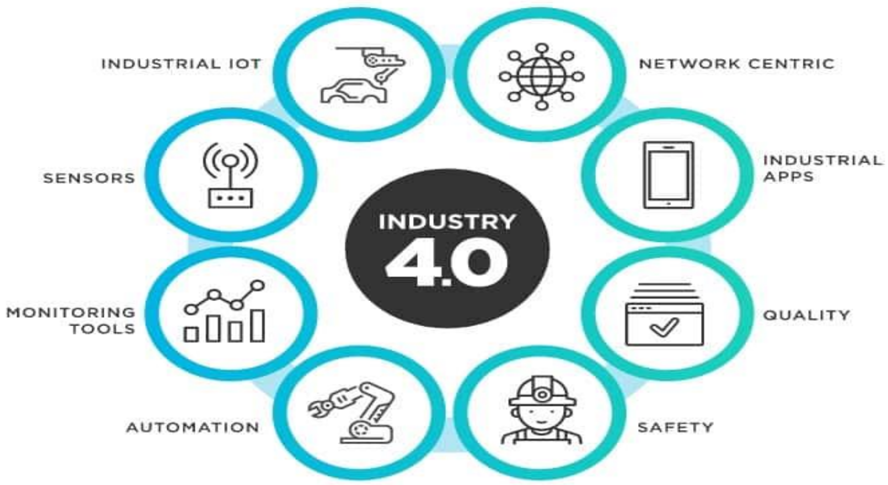
- Predication farming is a method of applying useful information collected over duration of time for improved quantity and quality of agricultural products. Experts will analyze when would be the best time/season for farming, what should be the best parameters for maximum productivity, suitable fertilizers, and how to plan a particular product ready for harvest, etc…

Smart Farming

- The Internet of Things offers many solutions for the convenient tracking of animals with the use of smart RFID tags. Farmers can easily record data of each animal with the implementation of IoT and smart tags.

- For example, movement (cow, sheep) from a particular location, age and weight of the individual, and vaccination details can be stored in the database and easily accessed by just scanning the smart tag.

Industrial IoT for manufacturing



- The manufacturing industry is one of the early adopters of the Internet of Things which entirely changed several stages of a product development cycle. Industrial IoT will help optimize various stages of product manufacturing, such as:

- Monitoring of supply chain and inventory management

- Optimization in product development
- Automate mass production processes
- Quality testing and product improvement
- Improves packaging and management
- Process optimization using data collected from a huge number of sensor networks
- Cost-effective solution for the overall management of factories

IoT in manufacturing is an increasing trend where companies can take advantage of faster networks, smarter devices and improvements in edge technology.

Industries can benefit from IOT

Organizations best suited for IOT are those that would benefit from using sensor devices in their business process.

Manufacturing

- Manufactures can gain a competitive advantage by using production-line monitoring to enable proactive maintenance on equipment when sensors detect an impending failure. Sensors can actually measure when production output is compromised. With the help of sensor alerts, manufacturers can quickly check equipment for accuracy or remove it from production until it is repaired. This allows companies to reduce operating costs, get better uptime, and improve asset performance management. Automotive

- The automotive industry stands to realize significant advantages from the use of IOT applications. In addition to the benefits of applying IOT to production lines, sensors can detect impending equipment failure in vehicles already on the road and can alert the driver with details and recommendations. Thanks to aggregated information gathered by IOT-based applications, automotive manufacturers and suppliers can learn more about how to keep cars running and car owners informed.

Retail

IOT applications allow retail companies to manage inventory, improve customer experience, optimize supply chain, and reduce operational costs. For example, smart shelves fitted with weight sensors can collect RFID-based information and send the data to the IOT platform to automatically monitor inventory and trigger alerts if items are running low. Beacons can push targeted offers and promotions to customers to provide an engaging experience. Healthcare IOT asset monitoring provides multiple benefits to the healthcare industry. Doctors, nurses, and orderlies often need to know the exact location of patient-assistance assets such as wheelchairs. When a hospital's wheelchairs are equipped with IOT sensors, they can be tracked from the IOT assetmonitoring application so that anyone looking for one can quickly find the nearest available wheelchair. Many hospital assets can be tracked this way to ensure proper usage as well as financial accounting for the physical assets in each department.

General Safety Across

All Industries In addition to tracking physical assets, IOT can be used to improve worker safety. Employees in hazardous environments such as mines, oil and gas fields, and chemical and power plants, for example, need to know about the occurrence of a hazardous event that might affect them. When they are connected to IOT sensor–based applications, they can be notified of accidents or rescued from them as swiftly as possible. IOT applications are also used for wearable's that can monitor human health and environmental conditions. Not only do these types of applications help people better understand their own health, they also permit physicians to monitor patients remotely.

Business opportunities with IOT:

Here, we've collected the major trends of the niche to help you to develop your IOT business ideas:

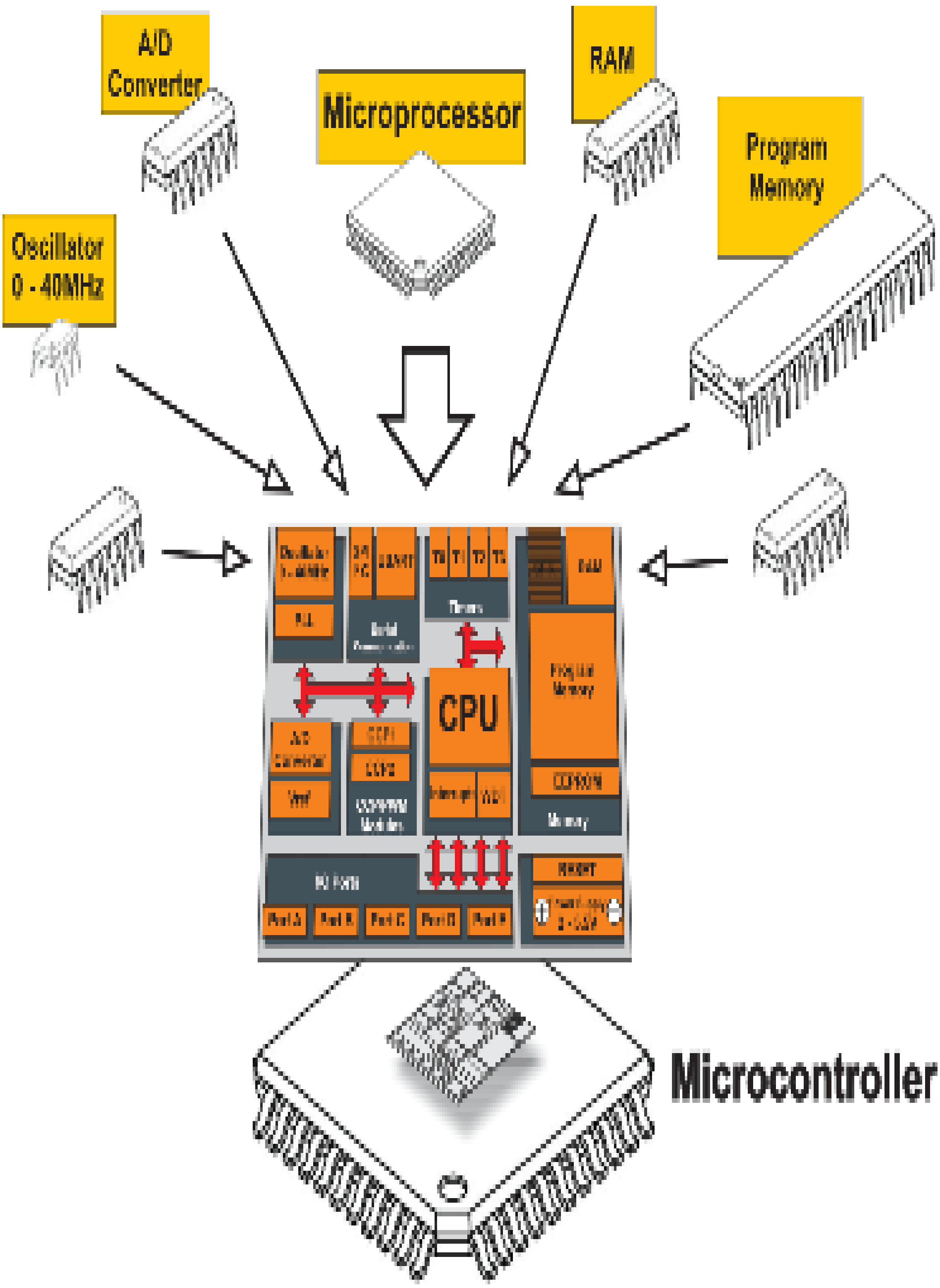
- Patient monitoring
- Transparency within healthcare organizations
- Remote operations
- IOT healthcare soft protection
- Smart sensors in manufacturing
- 3D printing for better quality
- Flexible production chains

Microprocessor

A microprocessor is a computer processor where the data processing logic and control is included on a single integrated circuit or a small number of integrated circuits. The microprocessor contains the arithmetic, logic, and control circuitry required to perform the functions of a computer's central processing unit. The integrated circuit is capable of interpreting and executing program instructions and performing arithmetic operations. The microprocessor is a multipurpose, clock-driven, register-based, digital integrated circuit that accepts binary data as input, processes it according to instructions stored in its memory, and provides results as output. Microprocessors contain both combinational logic and sequential digital logic, and operate on numbers and symbols represented in the binary number system.

Microcontroller

Amicrocontroller (MCU for microcontrollerunit) is a small computer on a single metal-oxidesemiconductor (MOS) integrated circuit (IC) chip. A microcontroller contains one or more CPUs along with memory and programmable input/output peripherals. Program memory in the form of ferroelectric RAM, NOR flash or OTP ROM is also often included on chip, as well as a small amount of RAM. Microcontrollers are designed for embedded applications, in contrast to the microprocessors used in personal computers or other general purpose applications consisting of various discrete chips.



Sensors explanation

Temperature Sensors

Measure the temperature of an environment or object. Examples include thermocouples and thermistors.

Humidity Sensors

Detect the moisture level in the air. Common examples are hygrometers and capacitive humidity sensors.

Pressure Sensors

Measure the pressure of gases or liquids. Examples include barometers and piezoelectric pressure sensors.

Proximity Sensors

Detect the presence or absence of an object or its distance from the sensor. Examples include ultrasonic sensors and infrared sensors.

Light Sensors

Measure light intensity. A device that measures the intensity of light is like a small expert that can tell how bright or dim things are. Examples include photodiodes and light-dependent resistors (LDRs).

Motion Sensors

Detect movement within an area. Examples include passive infrared (PIR) sensors and accelerometers.

Gas Sensors

Detect the presence of gases in the environment. Examples include carbon monoxide sensors and methane sensors.

Sound Sensors

Measure sound levels, Examples include microphones and acoustic sensors.

Infrared (IR) Sensors

Detect infrared radiation or measure heat.

Ultrasonic sensor:

An ultrasonic sensor is like a tiny bat that uses sound to see things around it. These sensors are often found in things like parking sensors in cars or devices that measure distances. When the ultrasonic sensor sends out sound waves, they bounce off nearby objects, and the sensor uses the returning echoes to figure out how far away things are.

COMMUNICATION PROTOCOLS

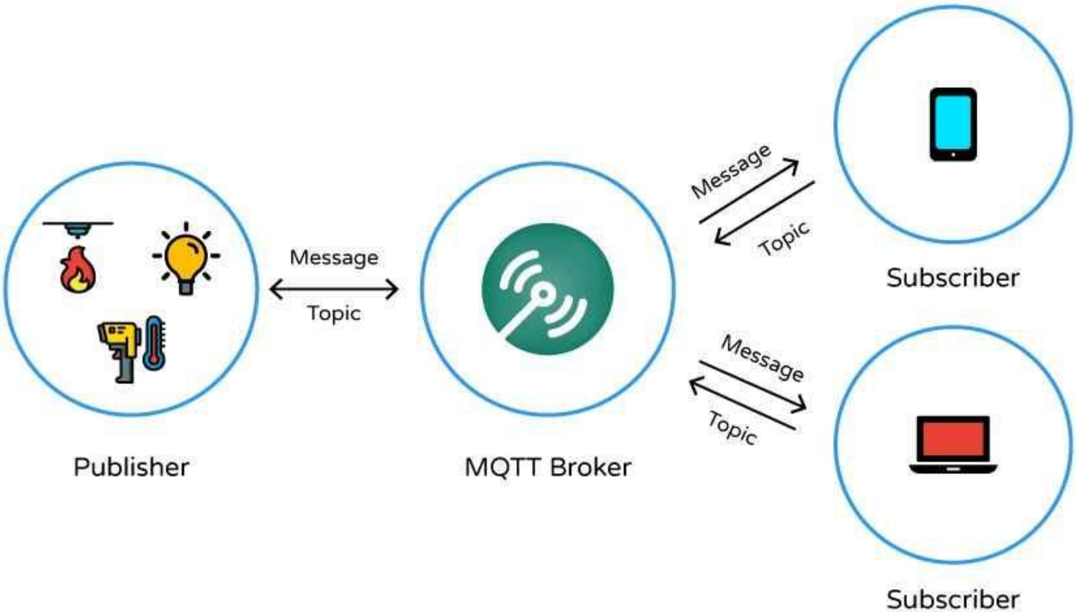
MQTT (Message Queuing Telemetry Transport)

Features:

- Lightweight and efficient.
- Uses a publish/subscribe model.
- Designed for low-bandwidth, high-latency networks.
- Supports Quality of Service (QoS) levels.

Terminologies

- ✓ Publish
- ✓ Subscribe
- ✓ Message
- ✓ Topics MQTT Broker
- ✓ MQTT Client



CoAP : Constrained Application Protocol

- It is a lightweight and efficient communication protocol designed specifically for the Internet of Things (IoT).
- Low bandwidth
- Power consumption is low
- This provide –IDF & TF

- HTTP + TCP = MQTT

  Control Msg

- HTTP + UDP = CoAP

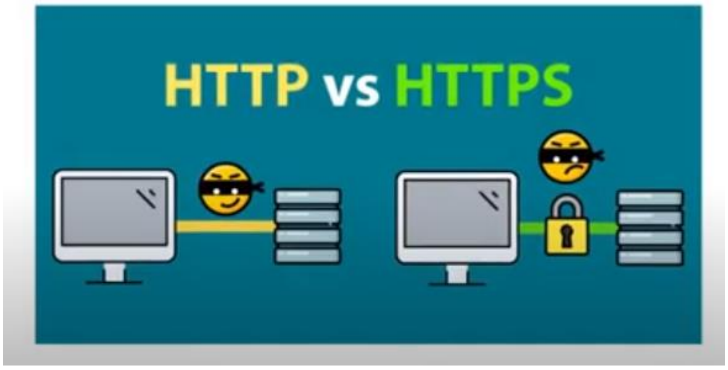
I/O Data Transmit

- **Four Layers of CoAP**

1. Application Layer
2. Request & Response Layer
3. Message Layer
4. UDP Layer

HTTP/HTTPS in IoT

- HTTP (Hypertext Transfer Protocol) and its secure version, HTTPS (Hypertext Transfer Protocol Secure), play essential roles in the Internet of Things (IoT) by facilitating communication between devices and web servers.



IoT SECURITY

IoT security is the process of securing these devices and ensuring they do not introduce threats into a network.

Three types of IOT security include

- **Network Security:** Users need to protect their devices against unauthorized access and potential exploitation. ...
- **Embedded:** Nano agents provide on-device security for IoT devices. ...
- **Firmware Assessment:** Firmware security starts with assessing the firmware of a protected IoT device.

4 levels of IoT security

- Device
- Communications
- Cloud
- Lifecycle Management

IoT attacks

- Device spoofing
- Man-in-the-middle (MitM) attacks
- Distributed denial of service (DDoS) attacks

- Eavesdropping
- Malware attacks
- Zero-day attacks
- Password cracking

7 types of security

- Economic security
- Food security
- Health security environmental security
- Personal security
- Community security
- Political security

Authentication in IoT

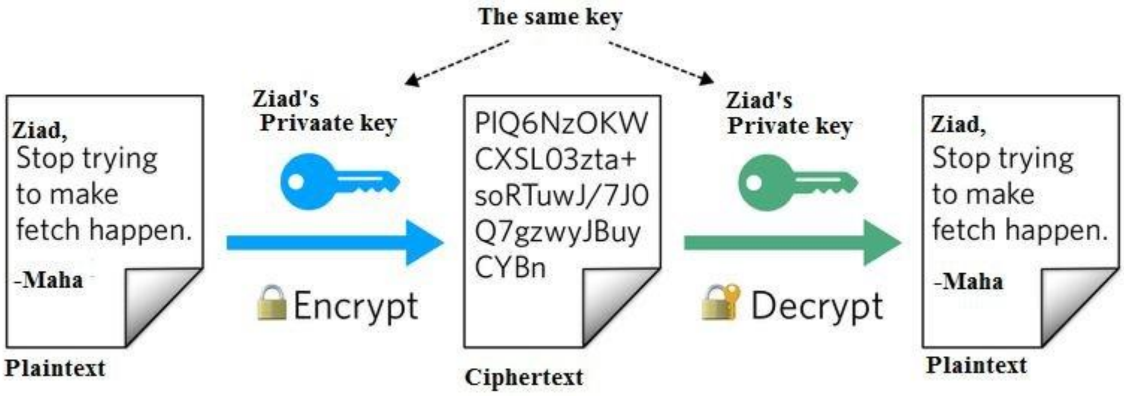
This is the most basic form of IoT device authentication, in which devices or users present something they know to verify their identity. Usernames and passwords are the most popular form of one-factor authentication. Unfortunately, most people recycle usernames and passwords on multiple devices and websites.

Computational security for the IoT

A scheme can be said to be computationally secure if it cannot be cracked in 'reasonable time'. This is a concept that relates to how long it will take a computer to carry out a task.

Data Encryption

- Encrypt data both in transit and at rest to protect it from interception and unauthorized access.
- Use strong encryption algorithms to secure communication between devices and backend servers.



Network Security

- Employ secure network protocols, such as HTTPS, and implement firewalls to control traffic between devices and the network.
- Segment the IoT network to contain potential breaches and limit the impact of compromised devices.

Privacy by Design

- Integrate privacy features into the design of IoT devices and platforms to safeguard user data.
- Clearly communicate privacy policies to users and obtain explicit consent for data collection.

Basic Security Protocols

- SSL/TLS (Secure Sockets Layer/Transport Layer Security)
- HTTPS (Hypertext Transfer Protocol Secure)
- IPsec (Internet Protocol Security)
- SSH (Secure Shell)
- WPA/WPA2/WPA3 (Wi-Fi Protected Access)
- Firewalls
- DNS Security (DNSSEC)

1. **SSL/TLS (Secure Sockets Layer/Transport Layer Security)**

- Encrypts data transmitted between a user's browser and a website, ensuring that sensitive information (such as login credentials) remains confidential.

2. HTTPS (Hypertext Transfer Protocol Secure

- An extension of HTTP that uses SSL/TLS to provide a secure connection between the user's browser and the web server.

3. IPsec (Internet Protocol Security)

- Provides a framework for securing Internet Protocol (IP) communications by authenticating and encrypting each data packet.

Security Protocols for IoT Access N/W

Think of security protocols for IoT access networks as virtual bouncers for your smart gadgets. They're like VIP passes that ensure only authorized devices get into the digital party. These protocols set up rules and codes, making sure your devices talk to each other securely. It's similar to having a secret handshake – if a device doesn't know the handshake, it can't join the conversation.

Security Testing

Security testing is a type of software testing that focuses on evaluating the security of a system or application. The goal of security testing is to identify vulnerabilities and potential threats and to ensure that the system is protected against unauthorized access, data breaches, and other security-related issues.

INTRODUCTION TO 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.

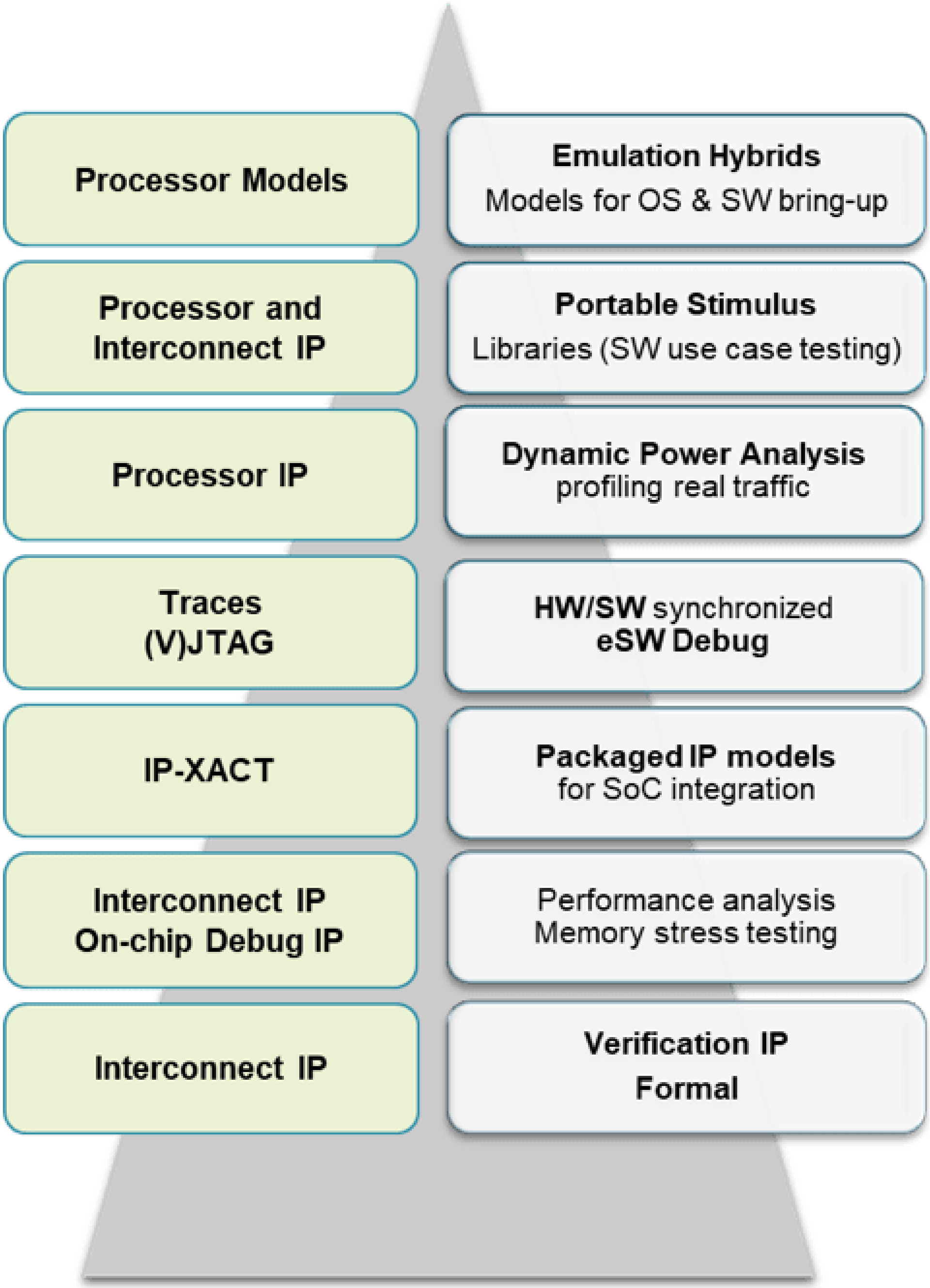
Over the years Arduino has been the brain of thousands of projects, from everyday objects to complex scientific instruments. A worldwide community of makers - students, hobbyists, artists, programmers, and professionals - has gathered around this open-source platform, their contributions have added up to an incredible amount of accessible knowledge that can be of great help to novices and experts alike.

Arduino was born at the Ivrea Interaction Design Institute as an easy tool for fast prototyping, aimed at students without a background in electronics and programming. As soon as it reached a wider community, the Arduino board started changing to adapt to new needs and challenges, differentiating its offer from simple 8-bit boards to products for IoT applications, wearable, 3D printing, and embedded environments.

SOFTWARE

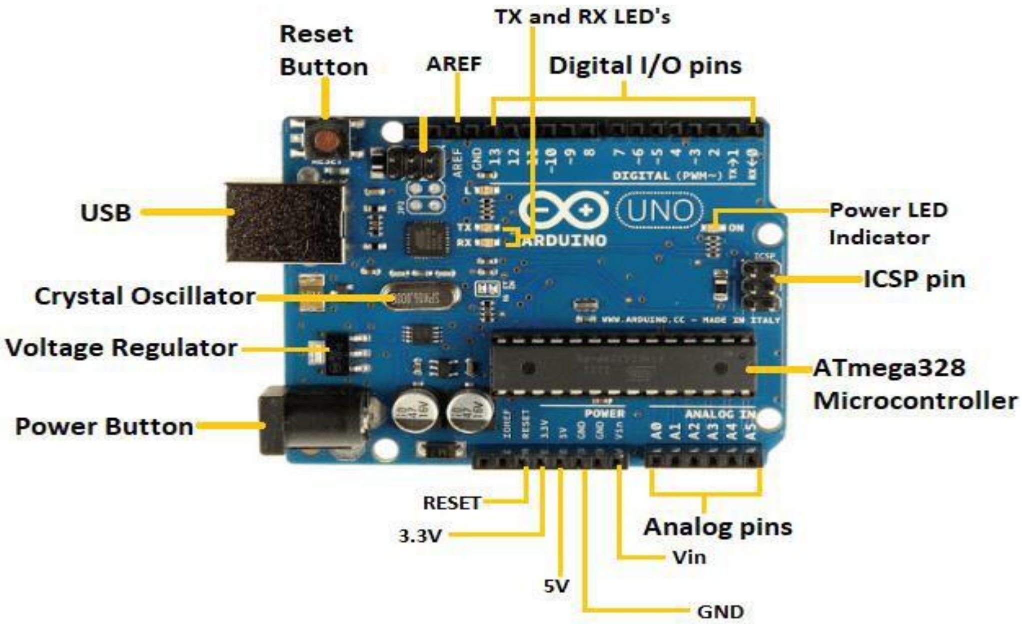
Open source software	Closed source software
Source code is open to all	Source code is closed/protected– Only those who created it can access it
Open source software license promotes collaboration and sharing	Proprietary software license curbs rights
Less costly	High-priced
Less restriction on usability and modification of software.	More restrictions on usability and modification of software.
Big and active community enabling quick development and easy fixes	Development and fixes depend on the discretion of creators.
Support is through forums, informative blogs, and hiring experts	Dedicated support
Immense flexibility as you can add features, make changes, etc.	Limited flexibility (only as proposed by its creators)
Developers are ready to offer improvements hoping to get recognition.	Need to hire developers to integrate improvements.
Can be easily installed into the computer	Needs valid license before installation
Fails and fixes fast	Failure is out of the question
No one is accountable for any failures	Responsibility for failure clearly rests on the vendor

HARDWARE



Processor Models
Emulation Hybrids
Models for OS & SW bring-up
Processor and Interconnect IP
Portable Stimulus
Libraries (SW use case testing)
Processor IP
Dynamic Power Analysis
profiling real traffic
Traces
(V)JTAG
HW/SW synchronized
eSW Debug
IP-XACT
Packaged IP models
for SoC integration
Interconnect IP
On-chip Debug IP
Performance analysis
Memory stress testing
Interconnect IP
Verification IP
Formal

Arduino UNO board



1. Analog input pins

- Six analog input pins(A0 to A5)
- Used to read the signal from an analog sensors.

2.Digital pin

- 14 digital pins (0 to 13)
- 6 pins provide PMW output

3.Tx and Rx pins:

- Tx-Transmitter

- Rx-Receiver

- Arduino uses the pins to communicate with other electronics via serial communication.

USB JACK

- It allows the board to connect to the computer
- Used to upload programs from computer to arduino Board.
- Also used to power up the arduino board.

POWER JACK

- Used to power arduino
- Input voltage range 7v to 12v

Ways of connection

- Rechargeable batteries
- Disposable batteries
- Wall - adapters

- Solar panel

VOLTAGE REGULATOR

- The voltage regulator converts the input voltage to 5V.
- Used to control & stabilize the voltage given to the arduino Board.
- Used by the processor and Other elements.

CRYSTAL OSCILLATOR

- The time factor plays a vital role in receiving and sending signals to peripheral and other physical devices.
- The Crystal oscillator has a frequency of 16MHz and Used to calculate time.

RESET BUTTON

- Used to start our program from the beginning.
- Reset pin.

POWER PINS

• 3.3v-pin -3.3 output voltage.

• 5v – pin -5 output voltage.

• Gnd –used to ground our circuit.

• Vin-can also be use to power thearduino board from an external power source.

Analog pins

- Six Analog input pins (A0-A5)
- Used to read the signal from an analog sensor.

Digital pins

- 14 digital pin 0 to 13
- 6 pins provide Pwm(Pulse width modulation) Output

Tx and RX

- TX- Transmit, Rx- receiver
- arduino use these pins to communicate other electronic via serial communication .

ATMEGA 328 MICROCONTROLLER

- Each Arduino Boards Has Its Own Microcontroller – Brain Of The Board.
- It Is A Single Chip Microcontroller Of The Atmel Family.
- The Processor Code Inside It Is Of 8-bit.
- Used to store data and run program.

POWER ON LED

- To Indicate Us Arduino Board Is Powered By Correctly.
- The on status of led shows the power is activated. when the power is off, the led will not light up.

AREF

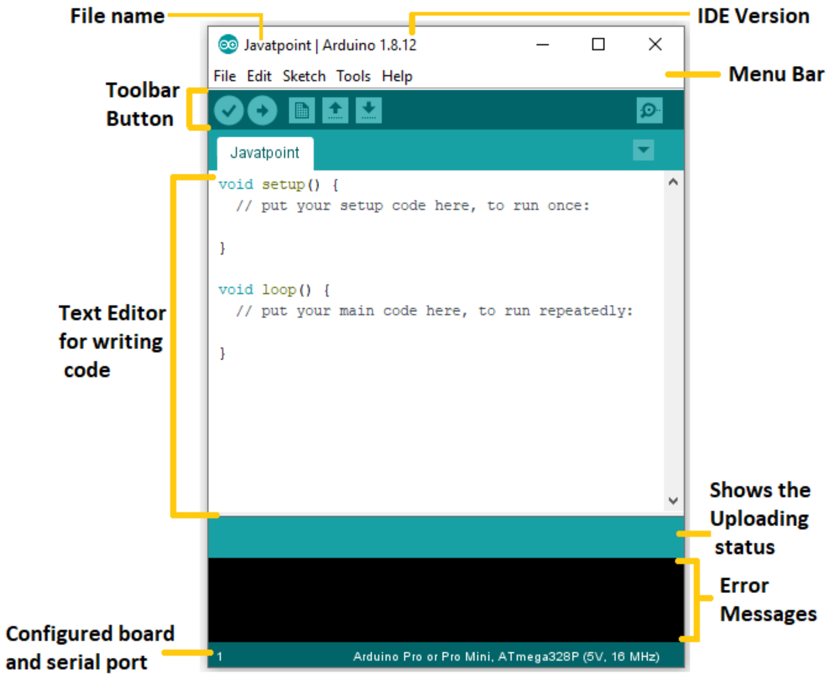
- Stands for analog reference
- Analog input converted into digital output need input voltage

Open source software

Software

- Readymade software.
- Arduino IDE-Integrated Development Environment.
- Write
- Compile
- upload

Arduino IDE



1. Program name and version
2. Menu bar
3. Tool bar
4. Text editor
5. Message area / status area
6. Text console
7. Connection area

Functions

digital i/o functions

pinMode()

- Set input (or) output

syntax :

- pinMode(pin,Mode)
- pin : Arduino pin numbers
- Mode : INPUT,OUTPUT

Write()

digitalWrite()

- Used to write a HIGH or LOW value to a digital pin.

Syntax:

- digitalWrite(pin,value)
- pin : Arduino pin numbers
- Value : HIGH or LOW

Read()

digitalRead()

- Used to read the value from a specified digital pin

Syntax:

- digitalRead(pin,Value)
- Pin : Arduino pin number
- Return : HIGH or LOW

ADC

Analog to digital converter

- Used to convert analog input to digital output.
- Computers/machines only understand and process digital data(0101).

Function

- analogRead()
- analogWrite()
- analogReference()

analogRead()

- Used to read values from the specific analog pins.
- Input value range-0 to 5v.

syntax:

- analogRead(pin)
- pin: name of the analog pin (A0 to A5)

analog reference()

- Used to configure the reference voltage used for analog input
- Default analog reference -5V

Syntax:

- analog reference(type)

- Type: default-5v
- internal-1.1v
- external-the voltage applied to the Aref pin (0 to 5v)

analogWrite()

- Used to write a analog value to a pin with the help of PWM waves.
- PWM –can be used to light at varying brightness or to drive a motor at various speed.
- Generate rectangular wave at PWM pins UNO. PMW pins :3,5,6,9,10,11 in digital pins.

syntax:

- analogWrite(pin, value)
- Pin: Arduino PMW pin

Timing function

delay() millis()

delay()

- Used to the program for the amount of time
- Input parameters in milliseconds

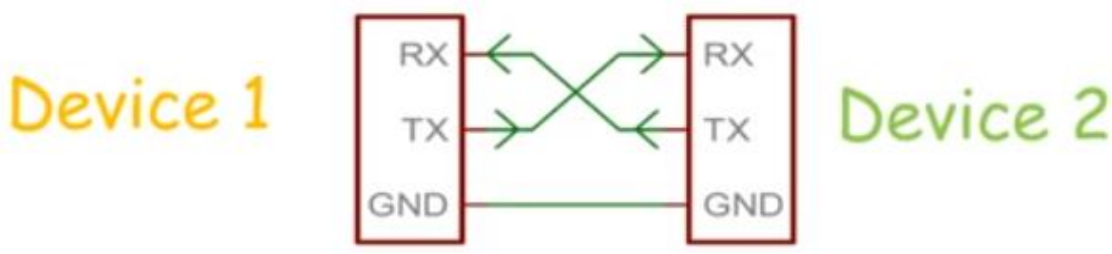
Syntax:

delay(ms)

- ms-the number of milliseconds pause.
- Eg: delay(1000)-1 second pause

Serial communication

- Is a protocol used to establish communication Between two devices.



Serial.begin()

- Used to set the data rate in bits per second (baud rate) for serial data transmission.

Syntax : serial.begin(speed)

- speed in bits per second (baud rate) Example:

serial.begin(9600)

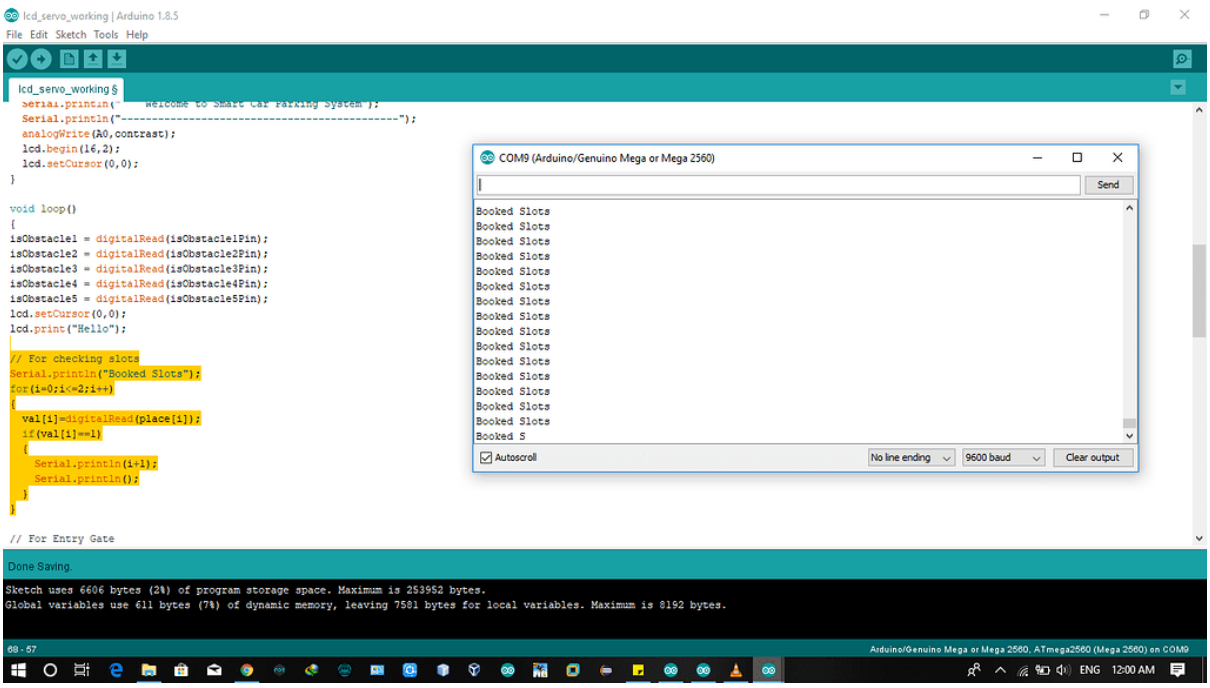
- Open the serial port , set data rate to 9600 bps

Serial.print()

- Print the data to the serial port as human readable ASCII text.

Syntax: Serial.print(val)

  - Val- the value to print Serial.print(val,format)
  - Format-Dec,Hex,Oct,Binary



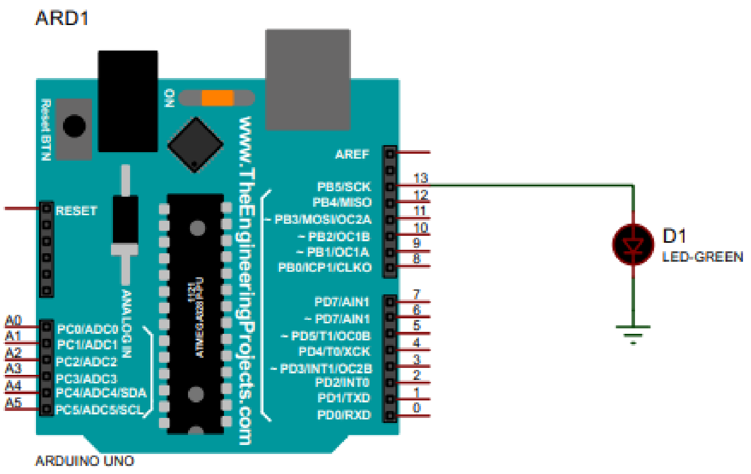
PWM

APPLICATION :

- LED Dimming: Controlling the brightness of LEDs.
- Servo Motors: Setting the position of servo motors.
- DC Motor Speed Control: Regulating the speed of DC motors.
- Audio Signal Generation: Creating sound using a piezo buzzer.

Proteus circuit connection with arduino ide code

LED Blink

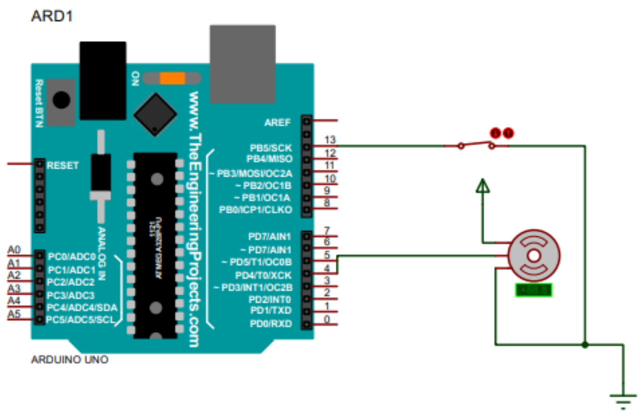


CODE:

```
void setup(){
```

```
pinMode(13,OUTPUT);

}

void loop(){

digitalWrite(13,HIGH);

delay(500);

digitalWrite(13,LOW);

delay(500);

}
```

Servo motor & switch

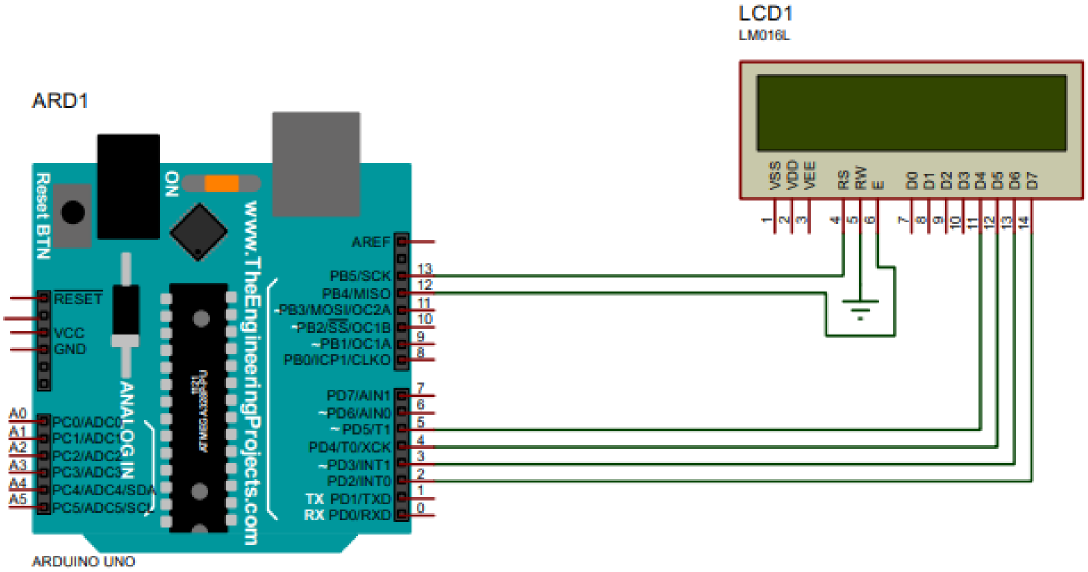


Code:

```
#include <Servo.h>

Servo myservo;

void setup(){

  pinMode(13,INPUT);

  pinMode(5,OUTPUT);

  myservo.attach(5);

}

void loop(){

  if (digitalRead(13)==1){

    digitalWrite(5,HIGH);



  }

  else{

    digitalWrite(5,LOW);
```

```
    }

  }
```

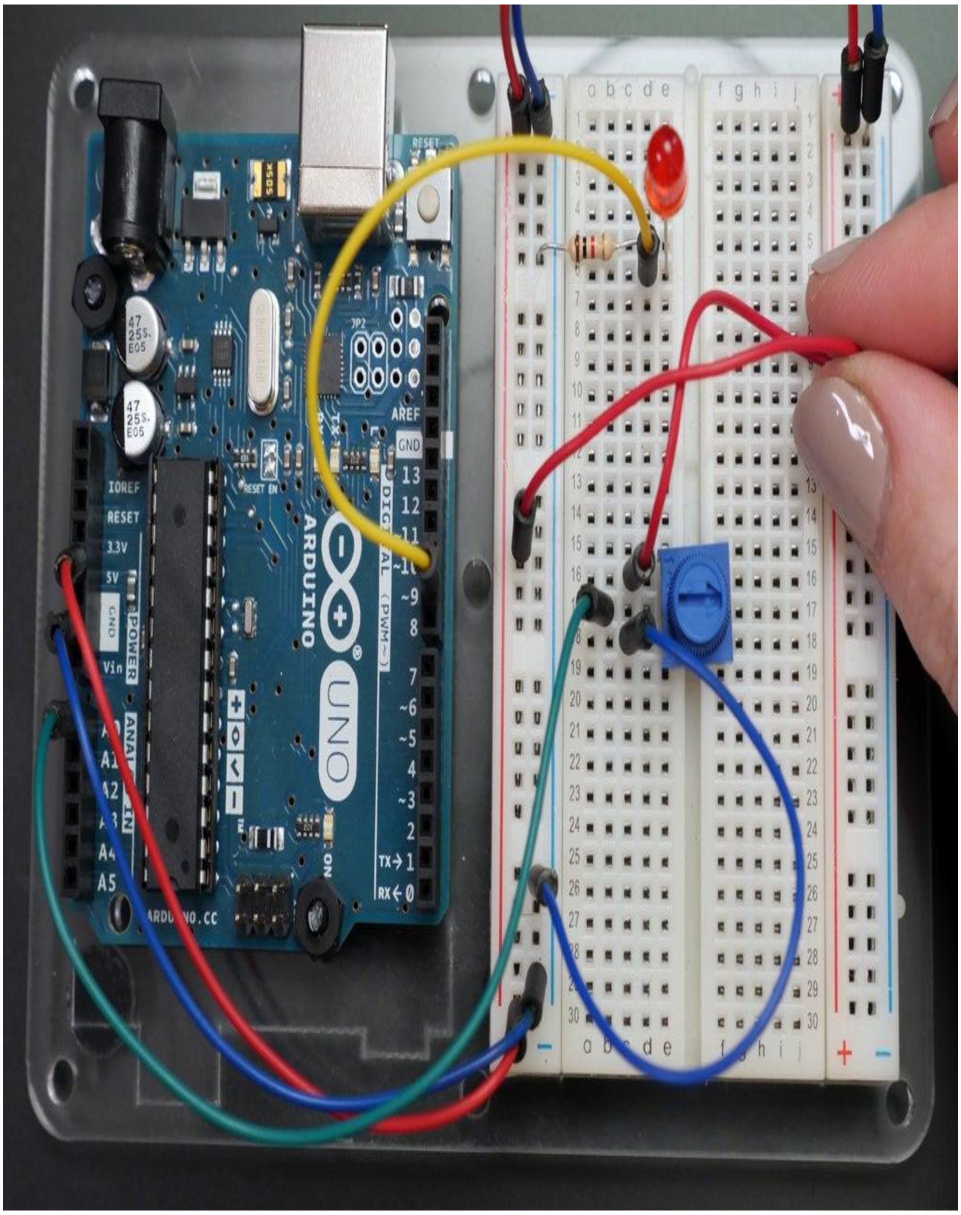
LCD display



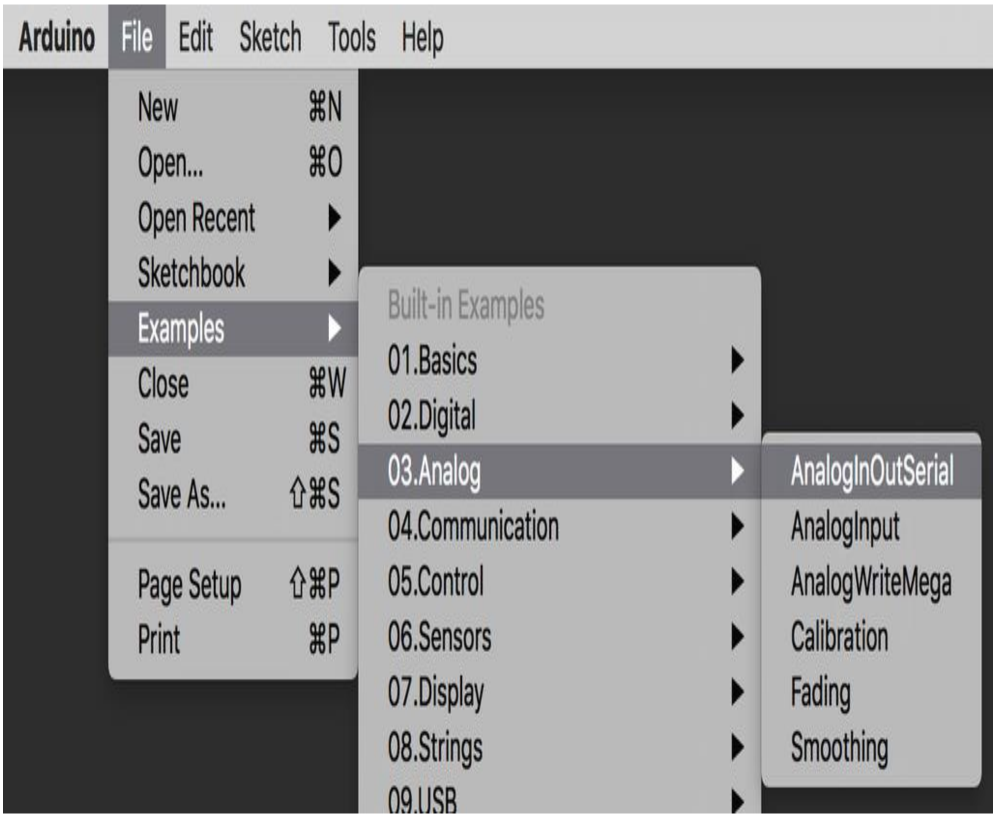
CODE:

```
#include <LiquidCrystal.h>

LiquidCrystal lcd (13,12,5,4,3,2);//RS,EN,D4,D5,D6,D7;

void setup() {

  lcd.begin (16,2);

  lcd.clear();

}

void loop() {

  lcd.setCursor(0,0);

  lcd.print("WELCOME SAMCORE ");

  lcd.setCursor(6,1);

  lcd.print("SOLUTION");

}
```

Connect the center pin of the potentiometer to Arduino analog pin A0, and the other two pins to power and ground respectively. Move your LED's control wire from pin 13 to pin 9, so we can use PWM.

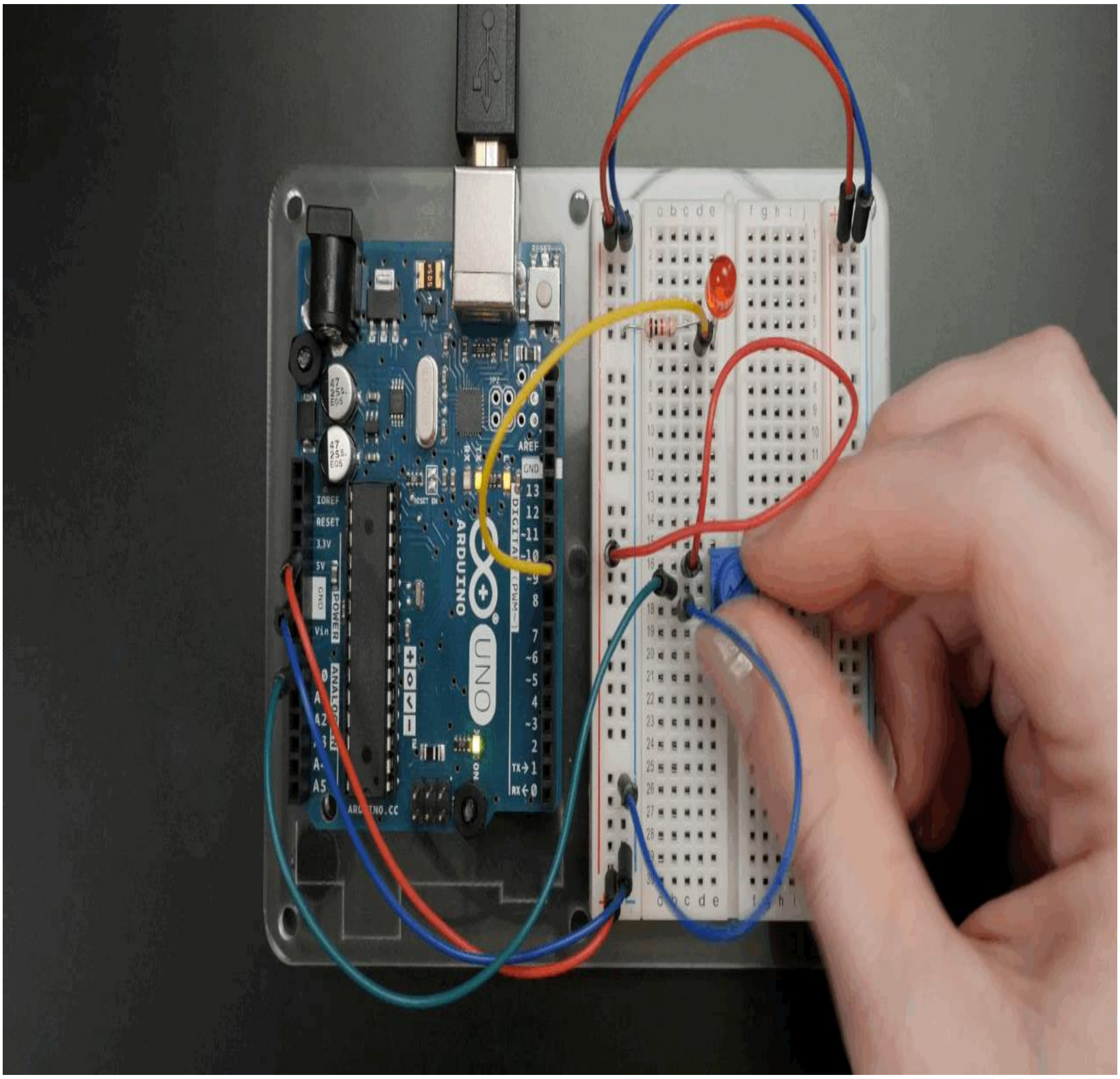


You can get the code from the Tinkercad Circuits module as you have for previous lessons, or find the example by navigating to File -> Examples -> 03.Analog -> AnalogInOutSerial.

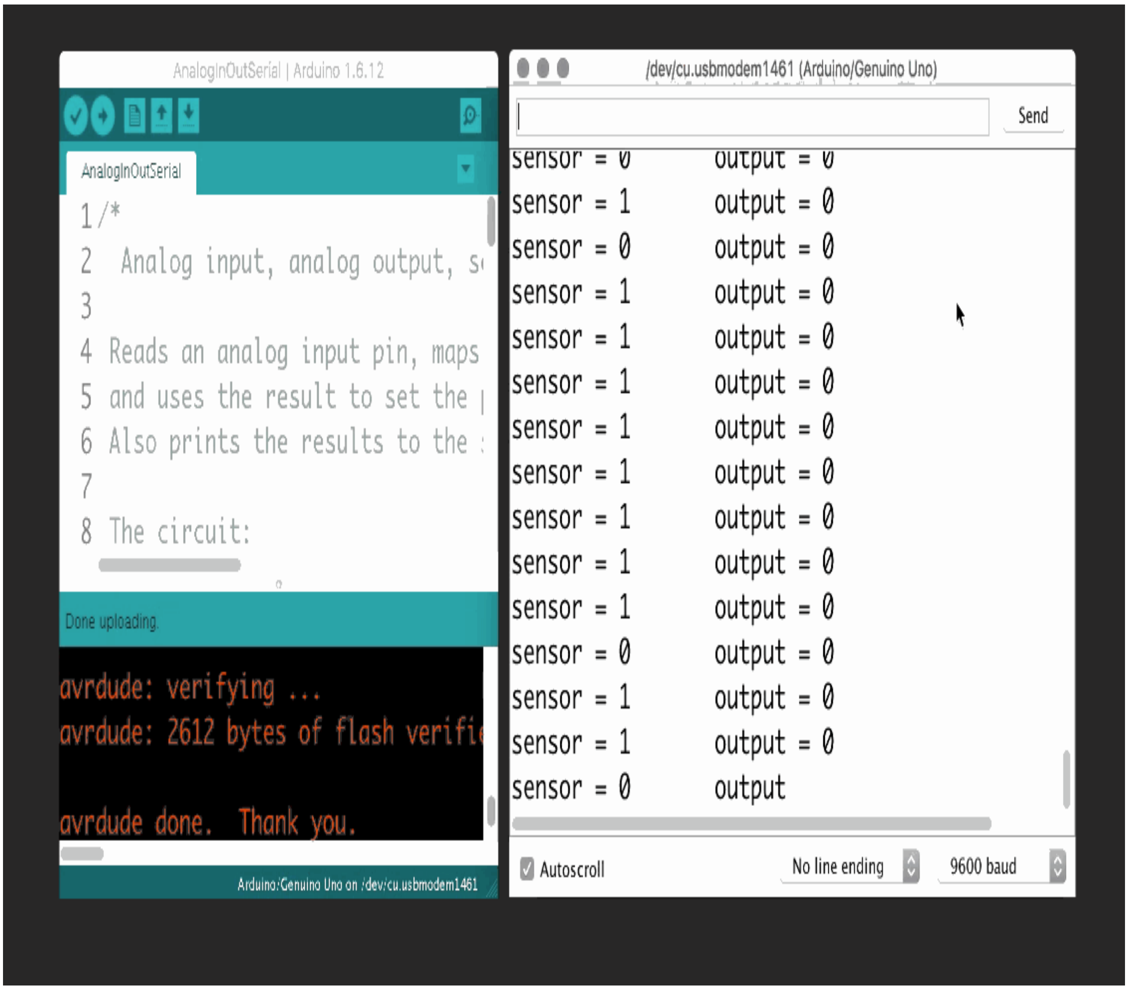


Plug in your USB cable and upload the sketch to your Arduino Uno board.

Open the serial monitor and observe it and the LED as you twist the potentiometer.



The values read by the analog input are printed in the first column, and the brightness values applied to the LED are printed in the second column.



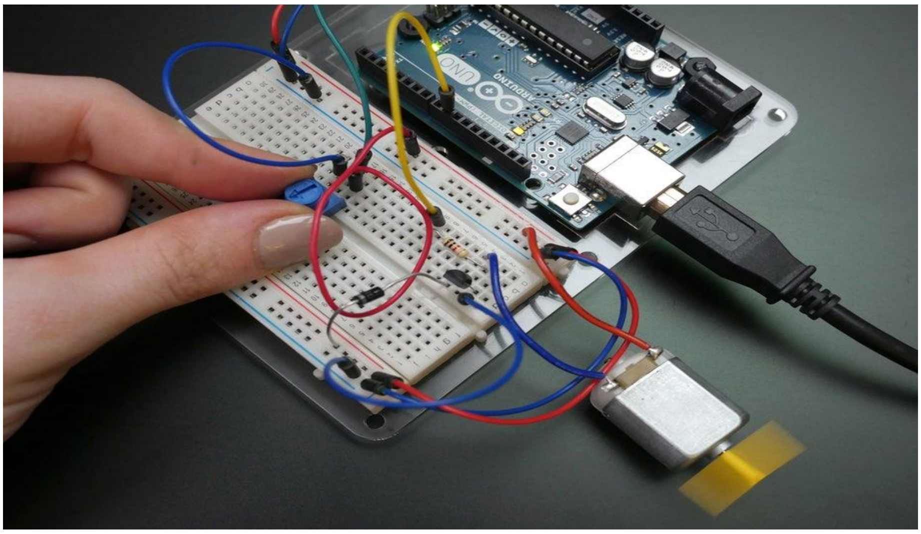
Let's take a closer look at the main loop of this program:

```
35 void loop() {
36   // read the analog in value:
37   sensorValue = analogRead(analogInPin);
38   // map it to the range of the analog out:
39   outputValue = map(sensorValue, 0, 1023, 0, 255);
40   // change the analog out value:
41   analogWrite(analogOutPin, outputValue);
42
43   // print the results to the serial monitor:
44   Serial.print("sensor = ");
45   Serial.print(sensorValue);
46   Serial.print("\t output = ");
47   Serial.println(outputValue);
48
49   // wait 2 milliseconds before the next loop
50   // for the analog-to-digital converter to settle
51   // after the last reading:
52   delay(2);
53 }
```

This sketch uses the `map();` function on line 39, which takes one range of numbers and massages it into another range. It takes five arguments: the value to be changed, the lower bound of the value's current range, the upper bound of the value's current range, the lower bound of the target range, and the upper bound of the target range. So this line of code sets a variable outputValue to a number between 0 and 255 depending on the position of the potentiometer.

The serial printing commands on lines 44-47 print text labels (inside quotes) and the values incoming from the sensor and outgoing to the LED. Seeing these numbers change together in the serial monitor can really help you understand how functions like map(); work. Keep this in mind when composing and troubleshooting your own sketches

A Moment for Motors

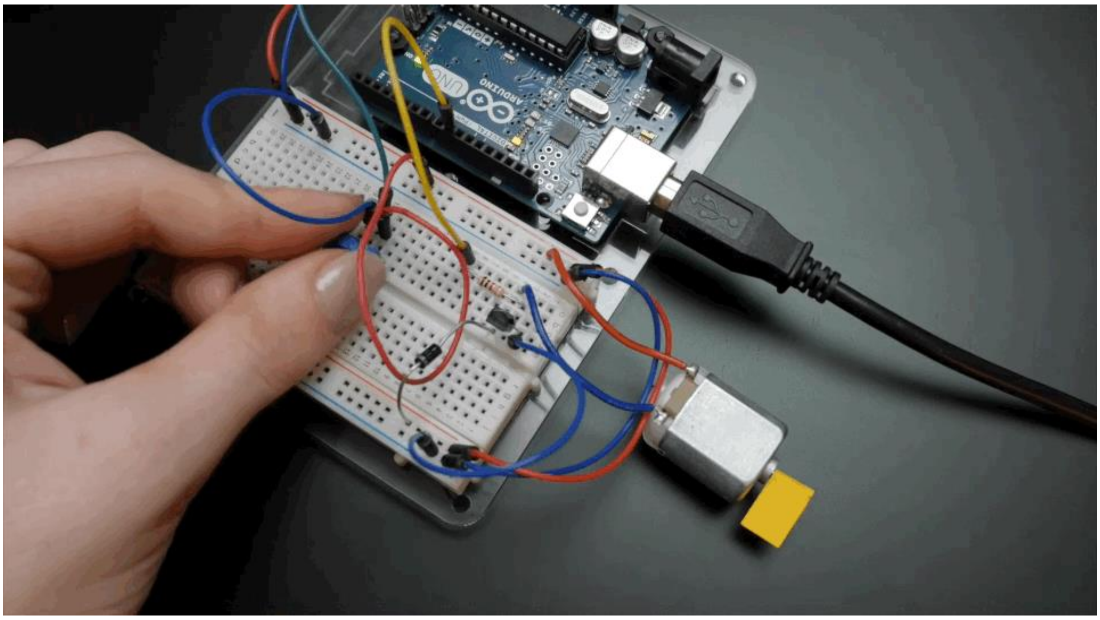


The exact same code used to brighten and dim the LED in the previous circuit can also be used to control the speed of a simple **DC motor**. This basic motor needs a few extra components to help control it: a small resistor (use your 1K or try a 100 ohm marked brown-black-brown-gold), a NPN **transistor** (we're using a PN2222), and a diode (1N4001). The resistor is used to protect the Arduino pin from excessive current draw. The diode prevents the transistor from dumping any blowback voltage anywhere it shouldn't (something motors are prone to doing). The transistor acts like an electronic valve, allowing current to flow between its collector and emitter (PN2222 outer pins) in proportion to the signal it receives at the base (PN2222 center pin). Transistors are handy for controlling a rather power hungry component with a microcontroller pin, which can't deliver enough current directly

Unplug your USB cable and build the circuit according to the diagram, minding the flat side of your transistor (faces away from the Arduino in this circuit), as well as the stripe on your diode (on the side furthest from the transistor). If you're using a different NPN transistor (like the 2N2222), your transistor pin connections may be different than those pictured, so look up the datasheet to be sure you're making the following connections:

- Arduino pin 9 to transistor base through resistor
- 5V to transistor collector through diode
- Ground to transistor emitter
- Motor wires to transistor collector and 5V (either orientation)

Power up your board and see what effect turning the knob has on the speed of the motor (use a piece of tape to make it easier to see the motor shaft spinning).



The motor recommended for this circuit draws less than 250mA, but a larger one could require more power than your computer's USB port can deliver. To power bigger motors, lots of LEDs, and other circuits that use more power, you'll need to use an external power supply, such as an AC adapter or battery pack. Additionally, for any larger of a motor, you'd also need a larger transistor. We'll learn how to calculate your circuit's power needs in the next lesson, but by popular request, here's the same motor circuit powered by an external 6V battery pack (separate power rails, common ground):

CONCLUSION

Along with an exponential growth in connected devices, each thing in IoT communicates packets of data that require reliable connectivity, storage, and security. The Internet is the most unlimited source of information for everyone who can access it. Be it communicating with people sitting at another corner of the world or addressing thousands of people together, the internet has made it possible for all of us within seconds