Introduction to the Internet of Things and Embedded System
&
The Arduino Platform and C Programming

UCI University of California, Irvine

COURSE CERTIFICATE

02.08.2020

Shashank Pundeer

has successfully completed

Introduction to the Internet of Things and Embedded Systems

an online non-credit course authorized by University of California, Irvine and offered through Coursera

Ian Harris
Professor
Department of Computer Science

Verify at coursera.org/verify/ALF5W6Y7UPHA

Coursera has confirmed the identity of this individual and their participation in the course.

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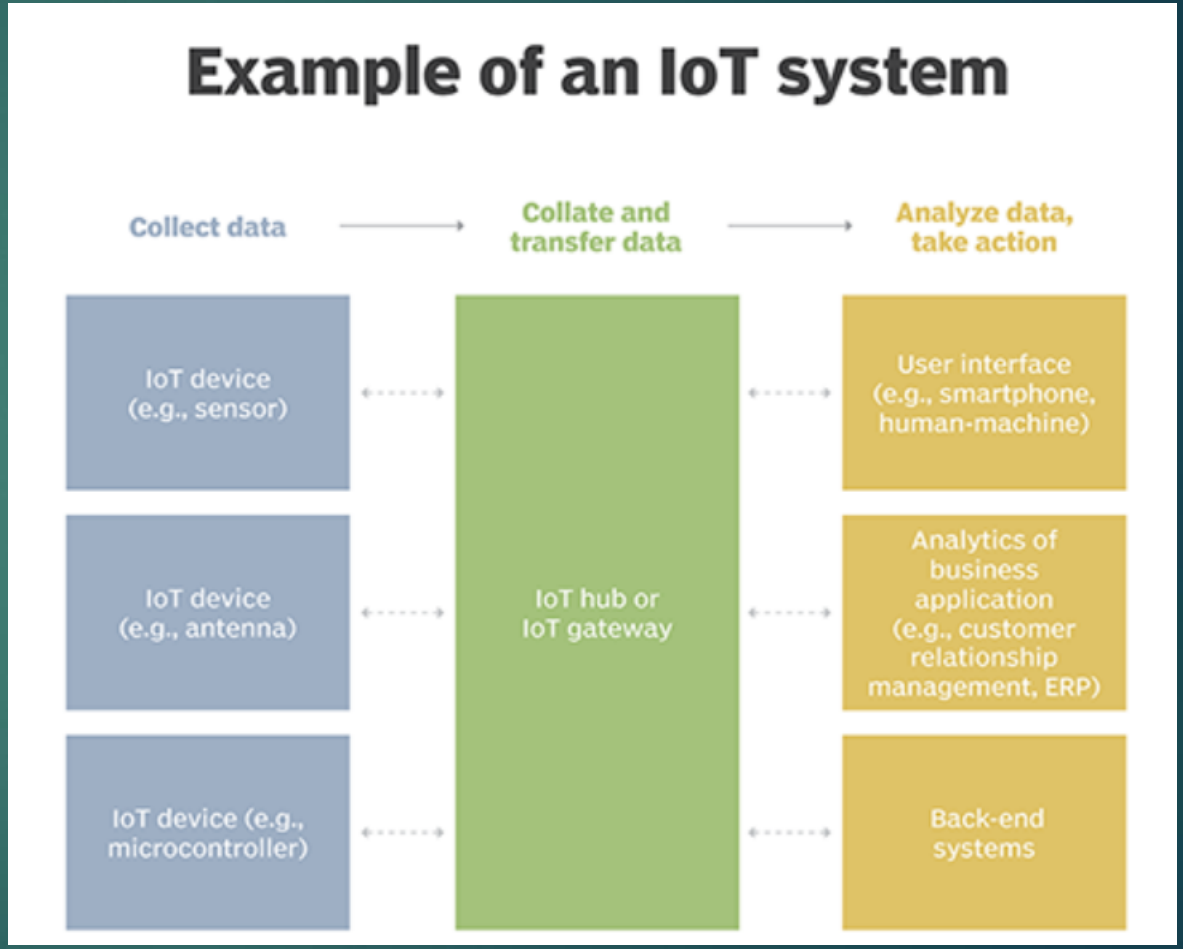
What is a Internet of Things ?

- The internet of things, or IoT refers to the ever-growing network of physical objects that feature an IP address for internet connectivity, and the communication that occurs between these objects and other Internet-enable devices and systems.
- In simple words, IoT is an ecosystem of connected physical objects that are accessible through the internet.
- It is also referred to as Machine-to-Machine(M2M), Skynet or Internet of Everything.



COMPONENTS OF IOT

Collection:
Devices and Sensors are collecting data everywhere.

- Form homes, car , office etc.

Communication:
Sending data and events through networks to some destination.

- A cloud platform
- Private data center

Action:
Taking action based on the information and data.

- Communication with another machine
- Send a notification

Analysis:
Creating information from the data.

- Visualizing the data
- Building reports
- Filtering data(pairing it down).

HOW IOT WORKS

- An IoT ecosystem consists of web-enabled smart devices that use embedded systems, such as processors, sensors and communication hardware, to collect, send and act on data they acquire from their environments. IoT devices share the sensor data they collect by connecting to an IoT gateway or other edge device where data is either sent to the cloud to be analyzed or analyzed locally. Sometimes, these devices communicate with other related devices and act on the information they get from one another. The devices do most of the work without human intervention, although people can interact with the devices -- for instance, to set them up, give them instructions or access the data.

PROS AND CONS OF IOT

Advantages

- Ability to access information from anywhere at any time on any device;
- Improved communication between connected electronic devices;
- Transferring data packets over a connected network saving time and money; and
- Automating tasks helping to improve the quality of a business's services and reducing the need for human intervention.

Disadvantages

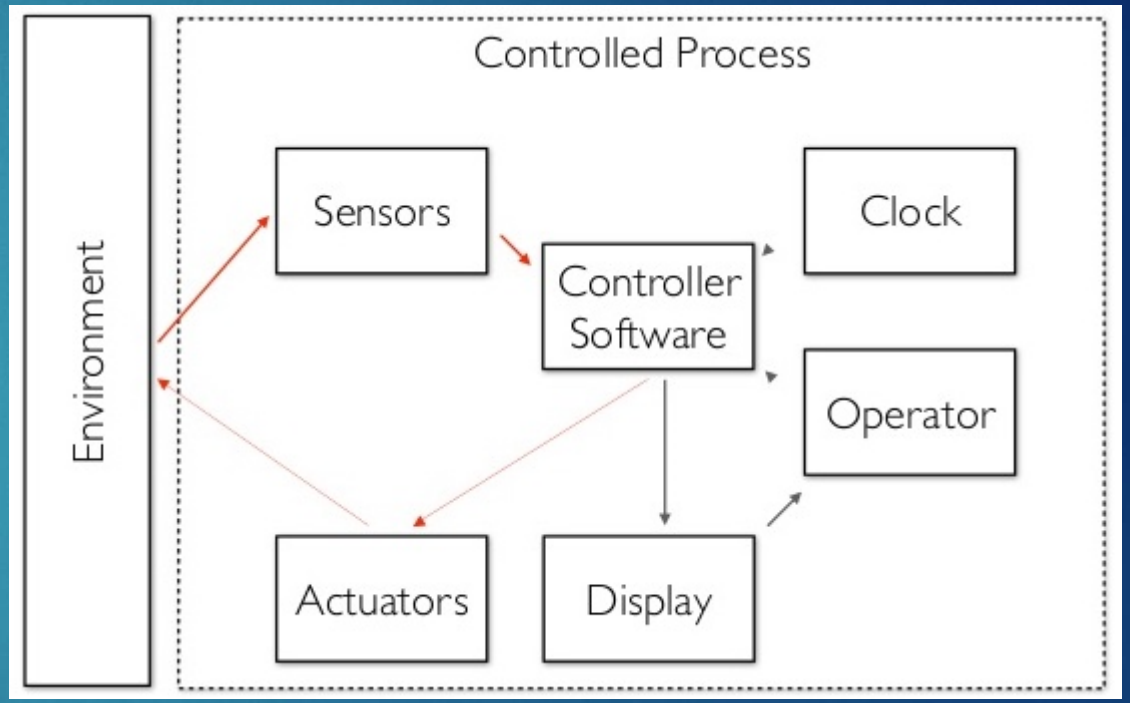
- As the number of connected devices increases and more information is shared between devices, the potential that a hacker could steal confidential information also increases.
- Enterprises may eventually have to deal with massive numbers -- maybe even millions -- of IoT devices, and collecting and managing the data from all those devices will be challenging.
- If there's a bug in the system, it's likely that every connected device will become corrupted.
- Since there's no international standard of compatibility for IoT, it's difficult for devices from different manufacturers to communicate with each other.

What is an Embedded System?

- An embedded system is a microprocessor-based computer hardware system with software that is designed to perform a dedicated function, either as an independent system or as a part of a large system. At the core is an integrated circuit designed to carry out computation for real-time operations.
- Complexities range from a single microcontroller to a suite of processors with connected peripherals and networks; from no user interface to complex graphical user interfaces. The complexity of an embedded system varies significantly depending on the task for which it is designed.
- Embedded system applications range from digital watches and microwaves to hybrid vehicles and avionics. As much as 98 percent of all microprocessors manufactured are used in embedded systems.

Basic Structure of an Embedded System

- **The basic structure of an embedded system includes the following components:**
- Sensor: The sensor measures and converts the physical quantity to an electrical signal, which can then be read by an embedded systems engineer or any electronic instrument. A sensor stores the measured quantity to the memory.
- A-D Converter: An analog-to-digital converter converts the analog signal sent by the sensor into a digital signal.
  Processor & ASICs: Processors assess the data to measure the output and store it to the memory.
- D-A Converter: A digital-to-analog converter changes the digital data fed by the processor to analog data
- Actuator: An actuator compares the output given by the D-A Converter to the actual output stored and stores the approved output.



Difference between Microprocessor and Microcontroller

- Microprocessor and Microcontroller are the typical programmable electronic chips used for distinct purposes. The significant difference between them is that a microprocessor is a programmable computation engine consist of ALU, CU and registers, commonly used as a processing unit (such as CPU in computers) which can perform computations and make decisions. On the other hand, a microcontroller is a specialised microprocessor considered as "computer on a chip" as it integrates components like microprocessor, memory and parallel digital I/O.

BASIS FOR COMPARISON	MICROPROCESSOR	MICROCONTROLLER
Basic	Made up of a single silicon chip comprising an ALU, CU and registers.	Consist of microprocessor, memory, I/O port, interrupt control unit, etc.
Characteristic	Dependent unit	Self-contained unit
I/O Ports	Does not contain built-in I/O port	Built-in I/O ports are present
Type of operation performed	General purpose in design and operation.	Application oriented or domain specific.
Targeted for	High end market	Embedded market
Power consumption	Provides less power saving options	Includes more power saving options

WHAT IS ARDUINO?

- The Arduino is an open-source electronics platform based on easy-to-use hardware and software used to build electronics projects.
- All Arduino boards have one thing in common which is a microcontroller. A microcontroller is basically a really small computer.
- With the Arduino, you can design and build devices that can interact with its surroundings. The Arduino boards are basically a tool for controlling electronics. They are able to read inputs with their onboard microcontroller (example, Light on a sensor, an object near a sensor) and turn it into an output (Drive a motor, ring an alarm, turning on an LED, display information on an LCD).
- However, to do this, you will first have to program the Arduino board. You use a software application called Arduino IDE (integrated development environment) to program the board.

Types of Arduino

Extended Family

Esplora

Lilypad

Pro

Arduino Ethernet

Micro

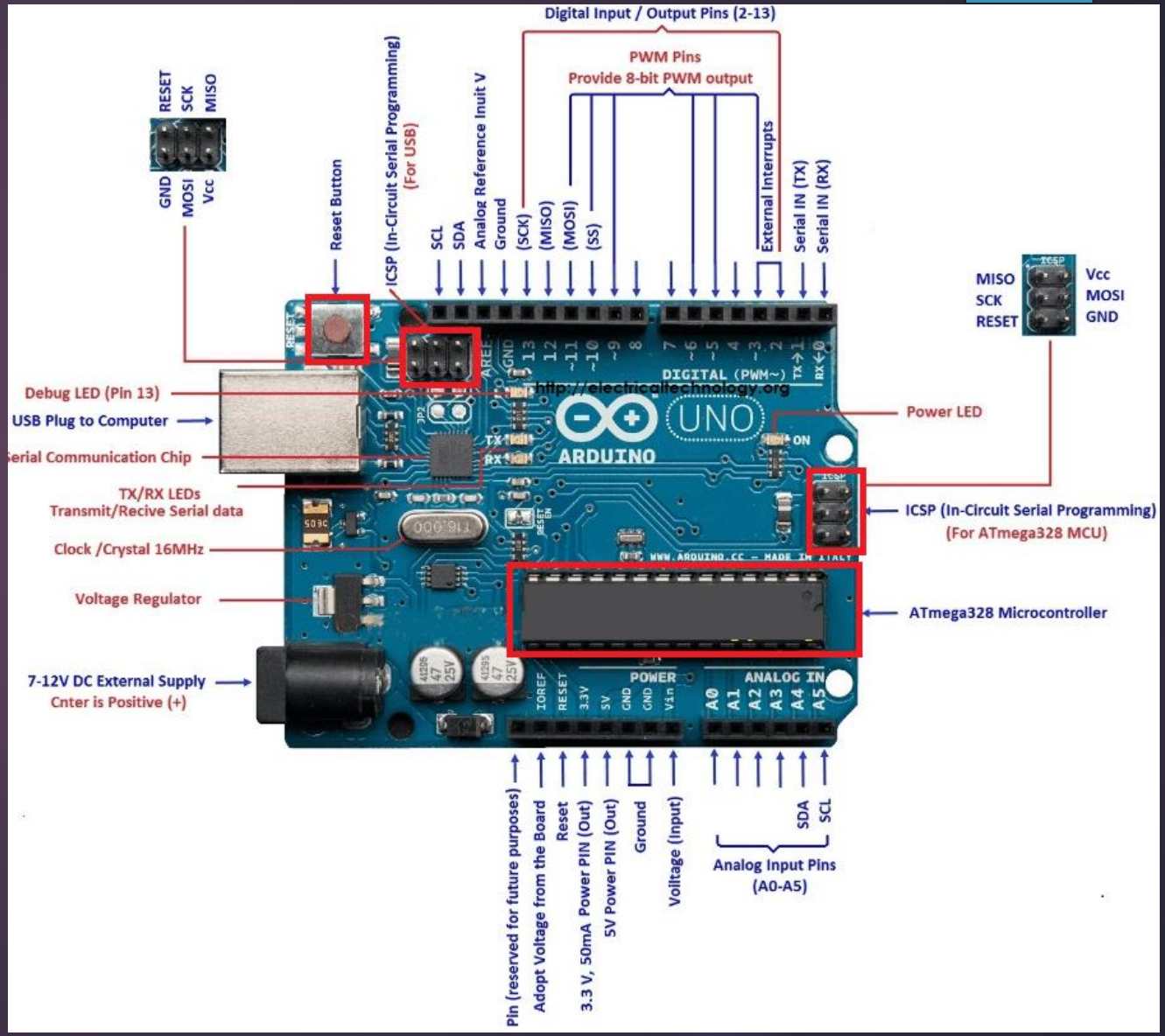
Pro Mini

Nano

Fio

ARDUINO UNO BOARD

- **COMPONENTS OF ARDUINO UNO BOARD**
- A number of pins, which are used to connect with various components :
- i/o Digital pins, which can read and write a single state, on or off.
- i/o Analog pins, which can read a range of values, and are useful for more fine-grained control.
- A power connector, which provides power to both the device itself, and provides a low voltage which can power connected components like LEDs and various sensors, provided their power needs are reasonably low.
- A microcontroller, the primary chip, which allows you to program the Arduino in order for it to be able to execute commands and make decisions based on various input.
- A serial connector, which on most newer boards is implemented through a standard USB port. This connector allows you to communicate to the board from your computer, as well as load new programs onto the device.
- A variety of other small components, like an oscillator and/or a voltage regulator.



ARDUINO IDE

- Arduino IDE makes it easy for you to write code and upload it on your Arduino board.
- This program is cross-platform which means it is able to run on Windows, Mac OS X, and Linux compared to other microcontroller systems which can only run Windows.
- This software can be used with any Arduino board like Arduino UNO, etc.
- The environment is written in Java and based on processing and other open-source software.
- This program uses a simplified version of C++ with syntax highlighting and other features which makes it easier to learn to program which is perfect for beginners to learn programming and coding.
- After you finish writing your code, you can then easily load your code on your Arduino IDE with a USB cable with a click of a button.

STRUCTURE OF ARDUINO PROGRAM

Arduino programs have a minimum of 2 blocks, Preparation & Execution. Each block has a set of statements enclosed in curly braces:

```
void setup( )
{
statement-n;
}
void loop ( )
{
statement-n;
}
```

Here, setup ( ) is the preparation block and loop ( ) is an execution block.

The setup function is the first to execute when the program is executed, and this function is called only once. The setup function is used to initialize the pin modes and start serial communication. This function has to be included even if there are no statements to execute.

After the setup ( ) function is executed, the execution block runs next. The execution block hosts statements like reading inputs, triggering outputs, checking conditions etc.

What is a Sensors and its Types

A sensor is a device that detects and responds to some type of input from the physical environment. The specific input could be light, heat, motion, moisture, pressure, or any one of a great number of other environmental phenomena. The output is generally a signal that is converted to human-readable display at the sensor location or transmitted electronically over a network for reading or further processing.

- **Active vs. Passive Sensors**
- Active sensors: Require an external source of power (excitation voltage) that provides the majority of the output power of the signal.
- Passive sensors: The output power is almost entirely provided by the measured signal without an excitation voltage

- **Digital vs. Analog Sensors**
- Digital sensors: The signal produced or reflected by the sensor is binary.
- Analog sensors: The signal produced by the sensor is continuous and proportional to the measured.

Project

https://www.tinkercad.com/things/8w80L53MPjP-start-simulating/editel?lessonid=EHD2303J3YPUS5Z&projectid=OIYJ88OJ3OPN3EA&collectionid=OIYJ88OJ3OPN3EA&tenant=circuits#/lesson-viewer

Thank You