Dr.D.Y.Patil Pratishthan's

DR.D.Y.PATILINSTITUTEOFENGINEERING,MANAGEMENT& RESEARCH

ApprovedbyA.I.C.T.E,NewDelhi,MaharashtraStateGovernment,Affiliatedto SavitribaiPhulePuneUniversity Sector No.29, PCNTDA , Nigidi Pradhikaran, Akurdi, Pune 411044.Phone:020–27654470, Fax: 020-27656566Website :www.dypiemr.ac.inEmail : principal.dypiemr@gmail.com

Department of Artificial Intelligence and Data Science

LAB MANUAL InternetofThingsLaboratory (SE) SemesterII

Prepared by:
Mrs.Mital Kadu
Mrs.Sunyana Sutar
Mrs.Jayshri Dhere

InternetofThingsLaboratory

Course Code	Course Name	TeachingScheme (Hrs./ Week)	Credits
217531	InternetofThingsLaboratory	4	2

CourseObjectives:

- Hardwareplatformsandoperatingsystems commonlyusedinIoT systems.
- Helpthestudentsinprovidingagoodlearningenvironmentandalsoworkwithrealtime problems faced in day to day life.

CourseOutcomes:

Oncompletionofthecourse,learnerwillbe ableto–

CO1: Understand IOT Application Development using Raspberry Pi/ Beagle board/ Arduino board CO2: Develop and modify the code for various sensor based applications using wireless sensor modules and working with a variety of modules like environmental modules.
CO3:Makeuseof Cloudplatform to uploadand analyse anysensor data

OperatingSystemrecommended:64-bitOpensourceLinux oritsderivative

Programming tools recommended: Use suitable programming language/Tool for implementation

TableofContents

LabAssignmentNo.	1
Title	Studyof Raspberry-Pi/ Beagle board/ Arduino and other microcontroller (History & Elevation)
Roll No.	
Class	SE
Dateof Completion	
Subject	InternetofThings Laboratory
AssessmentMarks	
Assessor'sSign	

ASSIGNMENTNo:01

Title: StudyofRaspberry-Pi, Beagleboard, Arduino

ProblemStatement: StudyofRaspberry-Pi/Beagleboard/Arduinoandothermicrocontroller (History & Elevation)

Objective:

1. TounderstandofRaspberry-Pi
2. TostudyBeagleboard
3. TostudyArduinoandothermicro controller

Theory:

1. **Raspberry-Pi:-**

The Raspberry Pi is a series of small single-board computers developed in the United Kingdom by the Raspberry Pi Foundation to promote teaching of basic computer science in schools and in developing countries. It does not include peripherals (such as keyboards and mice). The Raspberry Pi is a low cost, credit-card sized computer that plugs into a computer monitor or TV, and uses a standard keyboard and mouse. It is a capable little device that enables people of all ages to explore computing, and to learnhow to program in languages like Scratch and Python. The RaspberryPi is a credit-card-sized computer that costs between $5 and $35. It's available anywhere in the world, and can function as a properdesktop computer or be used to build smart devices. A Raspberry Pi is a general-purpose computer, usuallywith a Linux operating system, and the abilityto run multiple programs. RaspberryPi is like the brain. Its primary advantage comes in processing higher level processing capability. It’s a single board computer.

Figure:-Raspberry-Pi

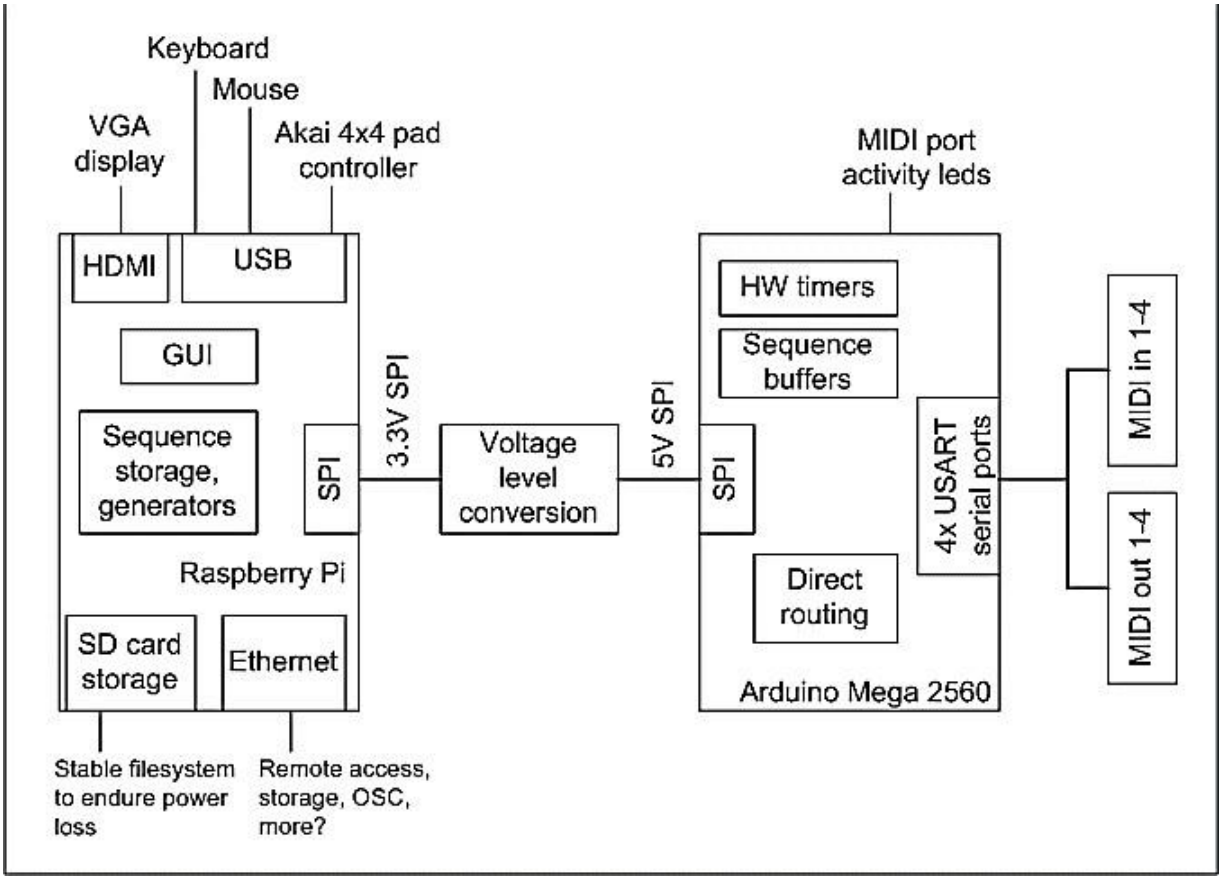


Figure:-Raspberry-PiArchitecture

Here are the various components on the Raspberry Pi board:

- **ARMCPU/GPU**--This isaBroadcom BCM2835Systemon aChip(SoC)that'smadeup ofan ARM central processing unit (CPU) and a Video core 4 graphics processing unit (GPU). The CPU handles all the computations that make a computer work (taking input, doing calculations and producing output), and the GPU handles graphics output.
- **GPIO** -- These are exposed general-purpose input/output connection points that will allow the real hardware hobbyists the opportunity to tinker.
- RCA--An RCAjack allowsconnection of analogTVsandothersimilar output devices.
- **Audio out** -- This is a standard 3.55-millimeter jack for connection of audio output devices such as headphones or speakers. There is no audio in.
- **LEDs**--Light-emittingdiodes,foryourentireindicatorlightneeds.
- **USB** -- This is a common connection port for peripheral devices of all types (including your mouse and keyboard). Model A has one, and Model B has two. You can use a USB hub to expand the number of ports or plug your mouse into your keyboard if it has its own USB port.
- **HDMI** -- This connector allows you to hook up a high-definition television or other compatible device using an HDMI cable.
- **Power** -- This is a 5v Micro USB power connector into which you can plug your compatible power supply.

- **SD card slot** -- This is a full-sized SD card slot. An SD card with an operating system (OS) installed is required for booting the device. They are available for purchase from the manufacturers, but you can also download an OS and save it to the card yourself if you have a Linux machine and the wherewithal.
- **Ethernet** -- This connector allows for wired network access and is only available on the Model B.

Benchmark:

Raspberry Pi:	**ModelA+**	**ModelB+**	**Pi 2 Model B**	**PiZero**	**Pi 3 ModelB**
Release:	Nov 2014	July2014	Feb2015	Nov 2015	Feb2016
Available:	Yes	Yes	Yes	Yes	Yes
Price(US$):	20	25	35	5	35
Processor:	700MHz single core ARM1176J ZF-S	700MHz single core ARM1176J ZF-S	900MHz 32-bit quad-coreARM Cortex-A7	1GHz ARM1176J ZF-Ssingle core	1.2GHz 64-bit quad-coreARM Cortex-A53
SoC:	Broadcom BCM2835	Broadcom BCM2835	Broadcom BCM2836	Broadcom BCM2835	Broadcom BCM2837
RAM:	512MB Shared	512MB Shared	1GB Shared	512MB Shared	1GB Shared
USB 2.0 Ports:	1	4	4	1	4

2. BeagleBoard:-

The **Beagle Board** is a low-power open-source single-board computer produced by Texas Instrumentsin association with Digi-Key and Newark element14. The Beagle Board was also designed with open source software development in mind, and as a way of demonstrating the Texas Instrument's OMAP3530 system-on-a-chip.The board was developed by a small team of engineers as an educational board that could be used in colleges around the world to teach open source hardware and software capabilities. It is also sold to the publicunderthe CreativeCommons share-alikelicense. Theboard was designed using Cadence OrCAD for schematics and Cadence Allegro for PCB manufacturing; no simulation software was used. Beagle Bone Black is a low-cost, open source, community-supported development platform for ARM® Cortex™-A8 processor developers and hobbyists. Boot Linux in under 10-seconds and get started on Sitara™ AM335x ARM Cortex-A8 processor development in less than 5 minutes with just a single USB cable.

Figure:-BeagleBoardBlack

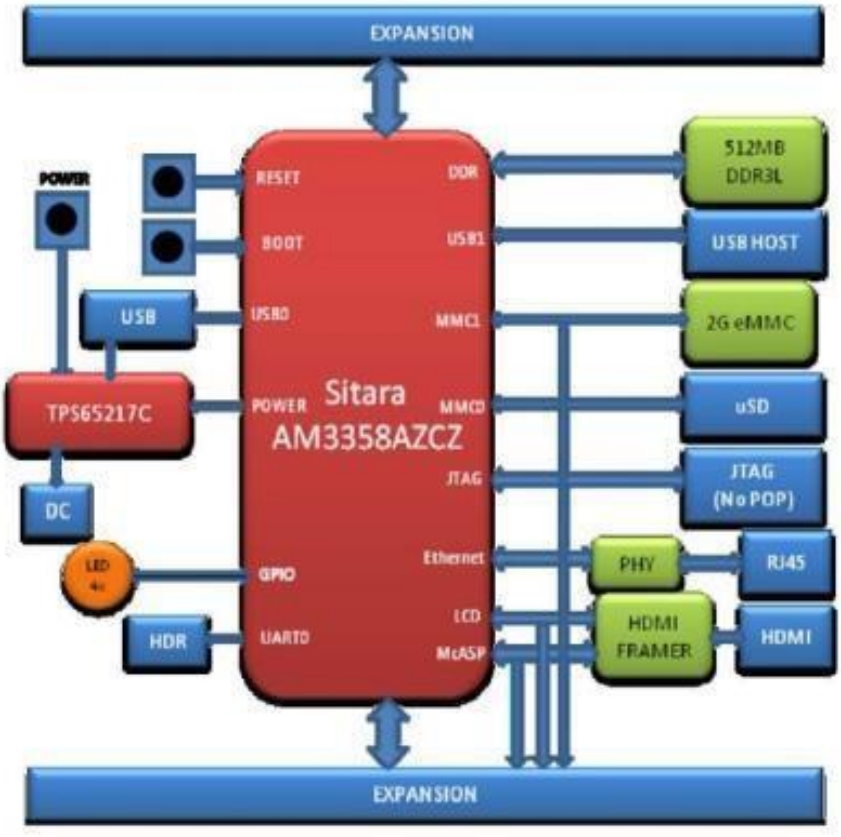


Figure:-BeagleBoardBlack architecture

HerearethevariouscomponentsontheBeagleboard:
Processor: AM335x 1GHz ARM® Cortex-A8

- 512MBDDR3 RAM
- 4GB8-biteMMCon-boardflash storage
- 3Dgraphicsaccelerator
- NEONfloating-pointaccelerator
- 2x PRU32-bitmicrocontrollers

Connectivity

- USBclient forpower& communications
- USBhost
- Ethernet
- HDMI
- 2x46 pin headers

SoftwareCompatibility

- Debian
- Android
- Ubuntu
- Cloud9 IDEonNode.jsw/BoneScriptlibrary
- plus,much more

ProductComparisonTable:

	PocketBeagle	**BeagleBone Black**	**BeagleBoneBlue**	**BeagleBoard-X15**
Processor	AM3358ARM Cortex-A8	AM3358ARM Cortex-A8	AM3358ARM Cortex-A8	AM57282x ARMCortex-A15
Maximum ProcessorSpeed	1GHz	1GHz	1GHz	1.5GHz
Co-processors	2x200-MHz PRUs, ARM Cortex-M3,SGX PowerVR	2x200-MHz PRUs, ARM Cortex-M3,SGX PowerVR	2x200-MHz PRUs, ARM Cortex-M3,SGX PowerVR	4x200-MHz PRUs,2xARM Cortex-M4, 2x SGXPowerVR, 2x HD video
AnalogPins	8(3.3V),6(1.8V)	7 (1.8V)	4 (1.8V)	TBD
DigitalPins	44(3.3V)	65(3.3V)	24(3.3V)	TBD
Memory	512MB DDR3 (800MHzx16), microSDcardslot	512MB DDR3 (800MHzx16), 4GB on-board storage using eMMC,microSD card slot	512MB DDR3 (800MHzx16), 4GB on-board storage using eMMC,microSD card slot	2GBDDR, 4GB on-board storage using eMMC, microSDcardslot

USB	USB2.0 Host/ClientPort, USB 2.0 on expansion header	USB2.0 Host/ClientPort, USB 2.0 Host Port	USB2.0 Host/ClientPort, USB 2.0 Host Port	SSUSB3.0Host, HS USB2.0 OTG Port (TBD)
Network	add-ons	10/100 Ethernet	WiFi, Bluetooth, BLE	2x10/100/1000 Ethernet
Video	SPIdisplays	microHDMI,cape add-ons	SPIdisplays	HDMI,TBD
Audio	add-ons	microHDMI,cape add-ons	add-ons, Bluetooth	3.5mmstereojack
Supported Interfaces	TBD	4x UART, 8x PWM, LCD, GPMC,MMC1, 2x SPI, 2x I2C, A/DConverter, 2xCAN Bus, 4 Timers	TBD	TBD
MSRP	$25	$49	$79	$249

3. Arduino:-

Arduino is an open-source hardware and software company, project and user community that designs andmanufacturessingle-boardmicrocontrollersandmicrocontrollerkitsforbuildingdigitaldevicesand interactive objects that can sense and control objects in the physical and digital world. Arduino board designs use a variety of microprocessors and controllers. The boards are equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards or breadboards (*shields*) and other circuits. The boards feature serial communications interfaces, including Universal Serial Bus (USB) on some models, which are also used for loading programs from personal computers. The microcontrollers are typically programmed using a dialect of features from the programming languagesCandC++. Inadditiontousingtraditionalcompilertoolchains, theArduinoprojectprovides an integrated development environment (IDE) based on the Processing language project. Arduino is open-source hardware. The hardware reference designs are distributed under a Creative Commons Attribution Share-Alike 2.5 license and are available on the Arduino website. Layout and production files for some versions of the hardware are also available.

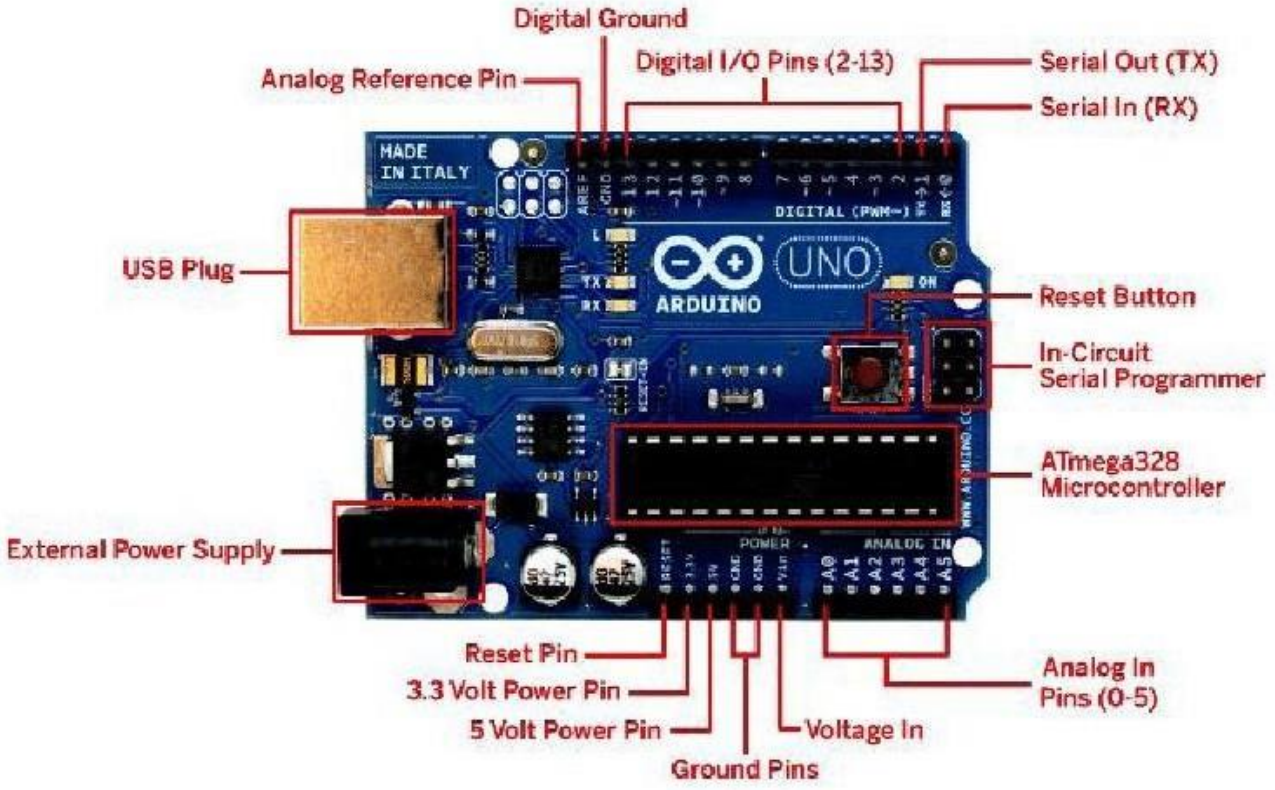


Figure:-ArduinoBoard

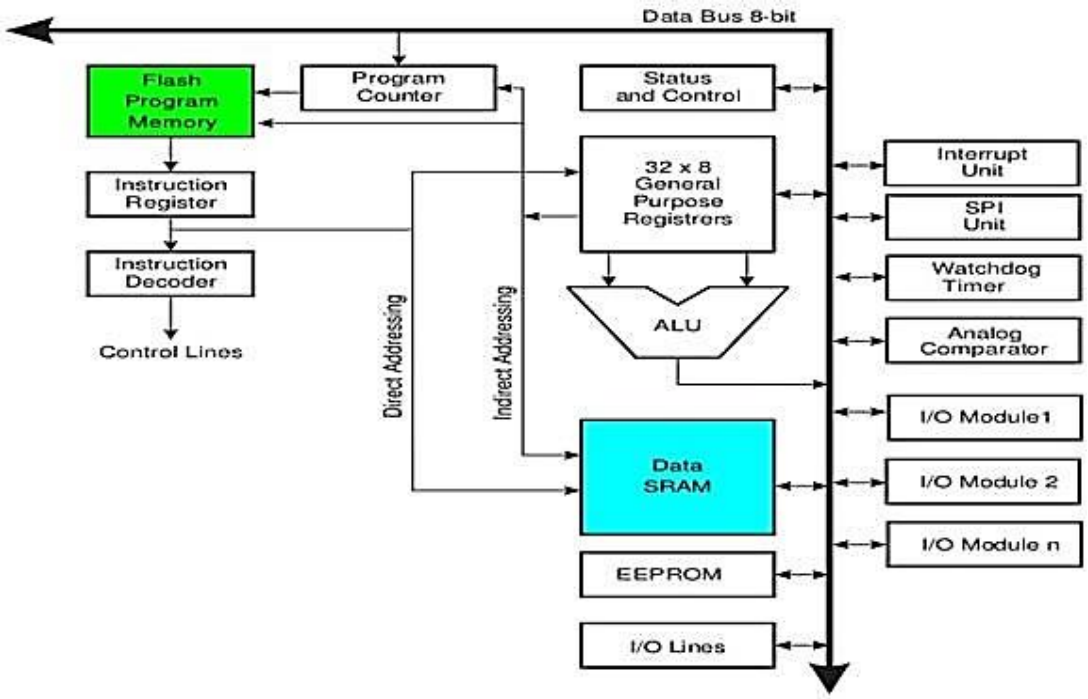


Figure:-ArduinoBoardArchitecture.

HerearethevariouscomponentsontheArduino board:

Microcontrollers

- ATmega328P(usedon mostrecentboards)
- ATmega168(usedon mostArduinoDiecimilaandearlyDuemilanove)
- ATmega8(usedon some olderboard)

DigitalPins

In addition to the specific functions listed below, the digital pins on an Arduino board can be used for general purpose input and output via the pinMode(), digitalRead(), and digitalWrite() commands. Each pin has an internal pull-up resistor which can be turned on and off using digitalWrite() (w/ a value of HIGH or LOW, respectively) when the pin is configured as an input. The maximum current per pin is40 mA.

AnalogPins

In addition to the specific functions listed below, the analog input pins support 10-bit analog-to-digital conversion (ADC) using the analogRead() function. Most of the analog inputs can also be used asdigital pins: analog input 0 as digital pin 14 through analog input 5 as digital pin 19. Analog inputs 6and 7 (present on the Mini and BT) cannot be used as digital pins.

PowerPins

- **VIN** (sometimes labelled "9V"). The input voltage to the Arduino board when it's using an external power source (as opposed to 5 volts from the USB connection or other regulated power source). You can supply voltage through this pin, or, if supplying voltage via the power jack, access it through this pin. Note that different boards accept different input voltages ranges,please see the documentation for your board. Also note that the LilyPad has no VIN pin and accepts only a regulated input.

OtherPins

- **AREF.**Reference voltageforthe analoginputs.Usedwith analogReference().
- **Reset.** (Diecimila-only) Bring this line LOW to reset the microcontroller. Typically used to add a reset button to shields which block the one on the board.
- AnalogReferencepin (orange)
- DigitalGround(light green)
- DigitalPins2-13(green)
- Digital Pins 0-1/Serial In/Out - TX/RX (dark green) - *These pins cannot be used for digital i/o(**digitalRead** and **digitalWrite**) if you are also using serial communication (e.g. **Serial.begin**).*
- ResetButton-S1(darkblue)
- In-circuitSerialProgrammer(blue-green)
- Analog InPins0-5(lightblue)
- PowerandGroundPins(power:orange, grounds: lightorange)
- ExternalPowerSupplyIn(9-12VDC)- X1 (pink)
- Toggles External Power and USB Power (place jumper on two pins closest to desired supply) - SV1 (purple)
- USB (used for uploading sketches to the board and for serial communication between the board and the computer; can be used to power the board) (yellow)

4. **Microcontroller:**

What is a Microcontroller
Computeronasingleintegratedchip

- Processor(CPU)
- Memory(RAM / ROM /Flash)
- I/Oports(USB, I2C,SPI,ADC)

Commonmicrocontrollerfamilies:

- Intel:4004,8008,etc.
- Atmel:ATand AVR
- Microchip:PIC
- ARM: (multiplemanufacturers)

Usedin:

- Cellphones,
- Toys
- Householdappliances
- Cars
- Cameras

TheATmega328PMicrocontroller usedinArdinohas

- AVR8-bitRISCarchitecture
- AvailableinDIPpackage
- Up to 20 MHz clock
- 32kBflashmemory
- 1 kBSRAM
- 23programmableI/O
- channels
- Six 10-bitADCinputs
- Threetimers/counters
- Six PWMoutputs

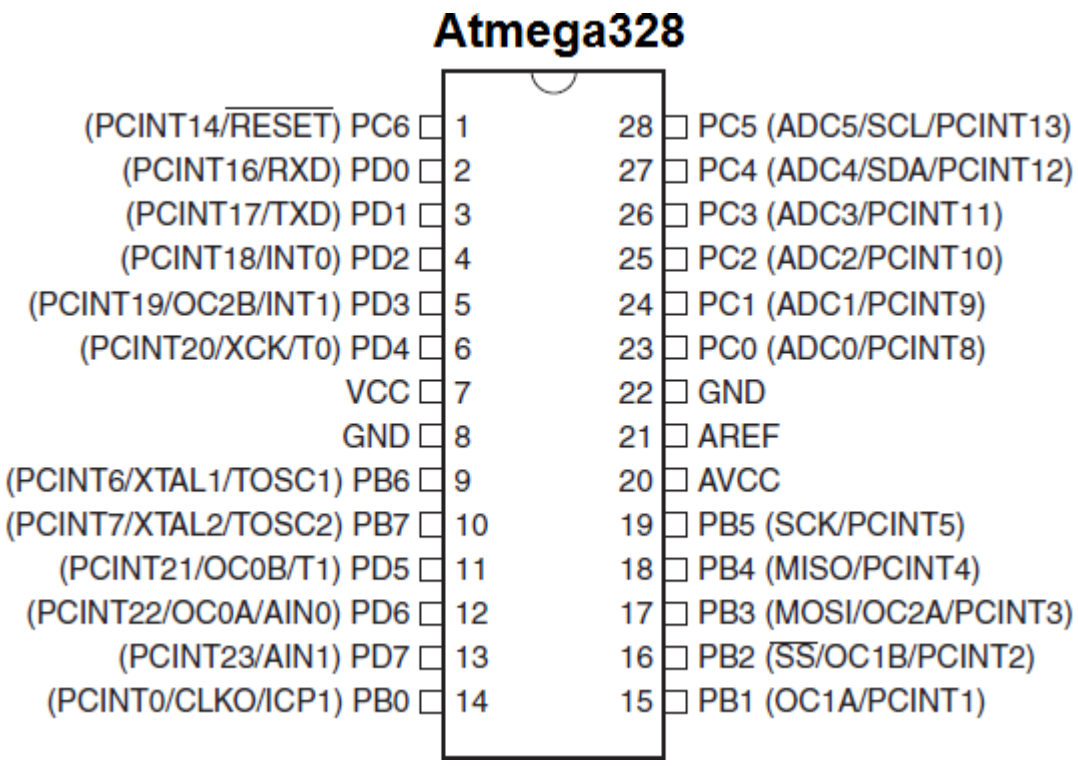


Figure:-ATmega328PMicrocontroller

Thetablebelowgivesadescriptionforeachofthepins,alongwiththeirfunction.

PinNumber	Description	Function
1	PC6	Reset
2	PD0	DigitalPin(RX)
3	PD1	DigitalPin(TX)
4	PD2	DigitalPin
5	PD3	DigitalPin(PWM)
6	PD4	DigitalPin
7	Vcc	PositiveVoltage(Power)
8	GND	Ground
9	XTAL1	CrystalOscillator
10	XTAL2	CrystalOscillator
11	PD5	DigitalPin(PWM)
12	PD6	DigitalPin(PWM)
13	PD7	DigitalPin
14	PB0	DigitalPin
15	PB1	DigitalPin(PWM)
16	PB2	DigitalPin(PWM)
17	PB3	DigitalPin(PWM)

18	PB4	DigitalPin
19	PB5	DigitalPin
20	AVCC	PositivevoltageforADC(power)
21	AREF	ReferenceVoltage
22	GND	Ground
23	PC0	AnalogInput
24	PC1	AnalogInput
25	PC2	AnalogInput
26	PC3	AnalogInput
27	PC4	AnalogInput
28	PC5	AnalogInput

Conclusion: ThuswehavestudiedofRaspberry-Pi/Beagleboard/Arduinoandothermicrocontroller

LabAssignmentNo.	2
Title	StudyofdifferentoperatingsystemsforRaspberry-Pi/Beagle board/Arduino. Understanding the process of OS installation
Roll No.	
Class	SE
Dateof Completion	
Subject	InternetofThings Laboratory
AssessmentMarks	
Assessor'sSign	

ASSIGNMENTNo:02

Title: Studyofdifferent operatingsystemsforRaspberry-Pi/Beagle board/Arduino.

ProblemStatement: StudyofdifferentoperatingsystemsforRaspberry-Pi/Beagle board/Arduino. Understanding the process of OS installation

Objective:

- Studyof different operatingsystems forRaspberry-Pi /Beagle board/Arduino.
- UnderstandingtheprocessofOSinstallationonRaspberry-Pi/Beagleboard/Arduino.

Theory:

1. **Raspberry-Pi:-**

The Pi can run the official Raspbian OS, Ubuntu Mate, Snappy Ubuntu Core, the Kodibased media centers OSMCand LibreElec,thenon-Linux basedRiscOS(oneforfansof1990sAcorncomputers).It can also run Windows 10 IoT Core, which is very different to the desktop version of Windows, as mentioned below.

OSwhichinstallon Raspberry-Pi:

- Raspbian,
- Ubuntu MATE,
- SnappyUbuntu,
- Pidora,
- Linutop,
- SARPi,
- ArchLinuxARM,
- GentooLinux,etc.

HowtoinstallRaspbianonRaspberry-Pi:

- **Step1:**DownloadRaspbian
- **Step 2:** Unzip the file. The Raspbian disc image is compressed, so you'll need to unzip it. The file uses the ZIP64 format, so depending on how current your built-in utilities are, you need to use certain programs to unzip it.
- **Step 3:** Write the disc image to your microSD card. Next, pop your microSD card into your computer and write the disc image to it. The process of actually writing the image will beslightly different across these programs, but it's pretty self-explanatory no matter what you're using. Each of these programs will have you select the destination (make sure you've picked your microSD card!) and the disc image (the unzipped Raspbian file). Choose, double-check,and then hit the button to write.

- **Step 4:** Put the microSD card in your Pi and boot up. Once the disc image has been written tothe microSD card, you're ready to go! Put that sucker into your Raspberry Pi, plug in the peripherals and power source, and enjoy. The current edition to Raspbian will boot directly tothe desktop. Your default credentials are username pi and password raspberry.

2. **BeagleBoneBlack:-**

The BeagleBone Black includes a 2GB or 4GB on-board eMMC flash memory chip. It comes with the Debian distribution factory pre-installed. You can flash new operating systems including Angstrom, Ubuntu, Android, and others.

OswhichinstallonBeagleBoneBlack:

- Angstrom,
- Android,
- Debian,
- Fedora,
- Buildroot,
- Gentoo,
- NervesErlang/OTP,
- Sabayon,
- Ubuntu,
- Yocto,
- MINIX3

HowtoinstallDebianonBeagleBoneBlack:

- **Step1:**Download Debian img.xzfile.
- **Step2:**Unzipthefile.
- **Step 3:** Insert your MicroSD (uSD) card into the proper slot. Most uSD cards come with a full-sized SD card that is really just an adapter. If this is what you have then insert the uSD into the adapter, then into your card reader.
- **Step 4:** Now open Win32 Disk imager, click the blue folder icon, navigate to the debian img location, and double click the file. Now click Write and let the process complete. Depending on your processor and available RAM it should be done in around 5 minutes.
- **Step 5:** Alright, once that's done, you'll get a notification pop-up. Now we're readyto get going. Remove the SD adapter from the card slot, remove the uSD card from the adapter. With theUSB cable disconnected insert the uSD into the BBB.
- **Step 6:** Now, this next part is pretty straight forward. Plug the USB cable in and wait some more. If everything is going right you will notice that the four (4) leds just above the USB cable are doing the KIT impression. This could take up to 45 minutes, I just did it again in around 5 minutes. Your mileage will vary. Go back and surf reddit some more.
- **Step 7:** If you are not seeing the leds swing back and forth you will need to unplug the USB cable, press and hold down the user button above the uSD card slot (next to the 2 little 10 pin ICs) then plug in the USB cable. Release the button and wait. You should see the LEDsswinging back and forth after a few seconds. Once this happens it's waiting time. When all 4 LEDs next to the USB slot stay lit at the same time the flash process has been completed.

- **Step 8:** Remove the uSD card and reboot your BBB. You can reboot the BBB by removing and reconnecting the USB cable,orhitting the reset button abovethe USB cablenearthe edge ofthe board.
- **Step 9:** Nowusingputty, or yourSSHflavorof choice, connect to the BBBusingthe IP address 192.168.7.2. You'll be prompted for a username. Type root and press Enter. By default, there is no root password. I recommend changing this ASAP if you plan on putting your BBB on the network. To do this type password, hit enter, then enter your desired password. You will be prompted to enter it again to verify.

3. **Arduino:-**

The Arduino itself has no real operating system. You develop code for the Arduino using the Arduino IDE which you can download from Arduino - Home. Versions are available for **Windows**, **Mac** and **Linux**. The Arduino is a constrained microcontroller.
Arduino consists of both a physical programmable circuit board (often referred to as a microcontroller) and a piece of software, or IDE (Integrated Development Environment) that runs on your computer, **used** to write and upload computer code to the physical board. You are literally writing the "firmware" when you write the code and upload it. It's both good and its bad.

Conclusion: Thus, we have studied of how to install operating systems for platforms such as Raspberry-Pi/Beagle board/Arduino.

LabAssignmentNo.	3
Title	Study of different GATES (AND, OR, XOR), Sensors and basicbinary operations.
Roll No.	
Class	SE
Dateof Completion	
Subject	InternetofThings Laboratory
AssessmentMarks	
Assessor'sSign	

ASSIGNMENTNo:03

Title: Studyof differentGATES (AND, OR, XOR),Sensors and basic binaryoperations.

ProblemStatement: StudyofdifferentGATES(AND,OR,XOR),Sensorsandbasicbinary operations.

Objective:

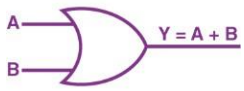
- Studyof different GATES (AND, OR, XOR),
- Studyof differentSensors
- Studyofdifferent basic binaryoperations.

Theory:

1. **Basic LogicGates:**
   Logic gates are an important concept if you are studying electronics. These are important digital devices that are mainly based on the Boolean function. Logic gates are used to carry out logical operations on single or multiple binaryinputs and give one binaryoutput. In simple terms, logic gates are the electronic circuits in a digital system.

   TypesofBasicLogicGates:
   There are several basic logic gates used in performing operations in digital systems. The common ones are:

   - **OR Gate:**
     InORgatetheoutputofanORgateattainsthestate1ifoneormoreinputsattainthe state 1.



TheBooleanexpressionofORgateisY =A+B,readasYequalsA‘OR’B. The truth table of a two-input OR basic gate is given as;

A	B	Y
0	0	0
0	1	1
1	0	1
1	1	1

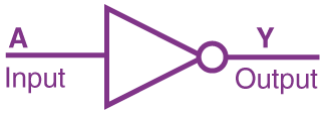
- **ANDGate:**
  InANDgatetheoutputofanANDgateattainsthestate1ifandonlyifalltheinputsareinstate1.

TheBooleanexpressionofANDgateisY=A.B

Thetruthtableofatwo-inputANDbasicgateisgivenas;

A	B	Y
0	0	0
0	1	0
1	0	0
1	1	1

- **NOT Gate:**
  InNOTgatethe outputof a NOTgate attainsthestate 1ifand only iftheinputdoesnotattainthe state 1.

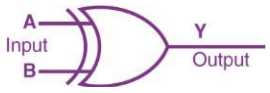


TheBooleanexpressionisY=\bar{A}$\bar{A}$,readasYequalsNOTA. The truth

table of NOT gate is as follows;

A	Y
0	1
1	0

- **XORGate:**
  In XOR gate the output of a two-input XOR gate attains the state 1 if one adds only input attains the state 1.



TheBooleanexpressionoftheXORgateis$A.\bar{B}+\bar{A}.B$or$Y=A\oplus B$

ThetruthtableofanXORgateis;

A	B	Y
0	0	0
0	1	1
1	0	1
1	1	0

2. Basicbinary operations:

Binary operations such as binary addition, binary subtraction, binary multiplication and binary division are calculated similarly as the arithmetic operations are calculated in numerals. These are four types of binary operations namely

- **Binary Addition**

The result obtained after adding two binarynumbers is the binarynumber itself. Binary addition is the simplest method to add any of the binary numbers. It can be calculated easily if we know the following rules.

Rules

- 0 +0 =0
- 0 +1 =1
- 1 +0 =1
- 1 +1 =10

Letustakeanytwobinarynumbersandaddthem. Add:

10001 + 11101 = 101110

- **Binary Subtraction**

The result obtained after subtracting two binary numbers is the binary number itself. Binary subtraction is also the simplest method to subtractany of the binary numbers. It can becalculated easily if we know the following rules.

Rules

- 0 – 0 =0
- 0– 1 =1 (with aborrow of 1)
- 1 – 0 =1
- 1 – 1 =0

Letus takeanytwobinarynumbersand subtract them.

- **Binary Multiplication**

The binary multiplications are calculated similarly as the other arithmetics numerals are calculated. Let us take any two binary numbers and multiply them.It can be calculated easily if we know the following rules.

Rules

- 0 ×0 =0
- 0 ×1 =0
- 1 ×0 =0
- 1 ×1 =1

Example

1101* 1010 =10000010

- **Binary Division**

The method of binary division is similar to the 10 decimal system other than the base 2 system. It can be calculated easily if we know the following rules.

- 1 ÷ 1=1
- 1 ÷ 0 =0
- 0 ÷ 1 =Meaningless
- 0 ÷ 0=Meaningless

3. Sensors:

The Internet of Things (IoT) offers great potential to change the way in which systems function and businesses operate – providing not only a leap in automation but deep visibility driven bythe massive amounts of data that can be collected, analyzed, reported, and acted upon – often without the need for human interaction or involvement.

The ability to efficiently collect data starts with the use of sensors. Sensors are devices that respond to inputs from the physical world and then take those inputs and display them, transmit them for additional processing, or use them in conjunction with artificial intelligence to make decisions or adjust operating conditions. As applied to an Industrial Internet of Things, data collected from sensors is used to help business owners and managers make intelligent decisions about their operations, and help clients and users more efficiently use that business' productsand services.

Asthe IoTinitiativeexpands,moreandmoresensorsaregoingtobe used tomonitorandcollect dataforanalysisand processing. Inthisarticle,a reviewofsomeofthedifferenttypesofsensors that will drive the data collection in the IoT initiative is presented.

IoTSensorTypes

Sensors are designed to respond to specific types of conditions in the physical world, and then generate a signal (usually electrical) that can represent the magnitude of the condition being monitored.Thoseconditionsmaybelight,heat,sound,distance,pressure,orsomeothermore

specific situation, such as the presence or absence of a gas or liquid. The common IoT sensors that will be employed include:

- Temperaturesensors
- Pressuresensors
- Motion sensors
- Levelsensors
- Imagesensors
- Proximitysensors
- Waterqualitysensors
- Chemicalsensors
- Gassensors
- Smoke sensors
- Infrared(IR)sensors
- Accelerationsensors
- Gyroscopicsensors
- Humiditysensors
- Opticalsensors

Adescriptionof eachofthesesensorsisprovidedbelow.

- **Temperaturesensors**

Temperature sensors detect the temperature of the air or a physical object and concert that temperature level into an electrical signal that can be calibrated accurately reflect the measured temperature. These sensors could monitor the temperature of the soil to help with agricultural output or the temperature of a bearing operating in a critical piece of equipment to sense when it might be overheating or nearing the point of failure.

- **Pressuresensors**

Pressure sensors measure the pressure or force per unit area applied to the sensor and can detect things such as atmospheric pressure, the pressure of a stored gas or liquid in a sealed systemsuch as tank or pressure vessel, or the weight of an object.

- **Motionsensors**

Motion sensors or detectors can sense the movement of a physical object by using any one of severaltechnologies,includingpassiveinfrared(PIR),microwavedetection,orultrasonic,which uses sound to detect objects. These sensors can be used in security and intrusion detection systems, but can also be used to automate the control of doors, sinks, air conditioning and heating, or other systems.

- **Levelsensors**

Level sensors translate the level of a liquid relative to a benchmark normal value into a signal. Fuel gauges display the level of fuel in a vehicle's tank, as an example, which provides a continuous level reading. There are also point level sensors, which are a go-no/go or digital representation ofthelevel oftheliquid.Someautomobiles havealight that illuminates when the fuel level tank is very close to empty, acting as an alarm that warns the driver that fuel is aboutto run out completely.

- **Imagesensors**

Image sensors function to capture images to be digitally stored for processing. License plate readers are an example, as well as facial recognition systems. Automated production lines can use image sensors to detect issues with quality such as how well a surface is painted afterleaving the spray booth.

- **Proximitysensors**

Proximitysensorscan detect thepresenceor absenceof objects that approach the sensorthrough a variety of different technology designs. These approaches include:

  - Inductivetechnologieswhichareusefulforthedetectionofmetal objects
  - Capacitive technologies, which function on the basis of objects havinga different dielectric constant than that of air
  - Photoelectrictechnologies,whichrelyonabeam oflighttoilluminateand reflect back from an object, or
  - Ultrasonic technologies, which use a sound signal to detect an object nearing the sensor

- **Waterqualitysensors**

The importance of water to human beings on earth not only for drinking but as a key ingredient needed in many production processes dictates the need to be able to sense and measure parameters around water quality. Some examples of what is sensed and monitored include:

  - chemicalpresence(suchaschlorinelevelsorfluoride levels)
  - oxygenlevels(whichmayimpactthe growthofalgaeandbacteria)
  - electricalconductivity(whichcan indicatethelevelof ionspresentin water)
  - pHlevel (a reflection oftherelativeacidityor alkalinityof thewater)
  - turbiditylevels (ameasurement ofthe amount of suspended solids in water)

- **Chemicalsensors**

Chemicalsensorsaredesignedtodetectthe presenceofspecific chemical substanceswhichmay have inadvertently leaked from their containers into spaces that are occupied by personnel and are useful in controlling industrial process conditions.

- **Gassensors**

Related to chemical sensors, gas sensors are tuned to detect the presence of combustible, toxic, or flammable gas in the vicinity of the sensor.

- **Smokesensors**

Smoke sensors or detectors pick up the presence of smoke conditions which could be an indication of a fire typically using optical sensors (photoelectric detection) or ionization detection.

- **Infrared(IR)sensors**

Infrared sensor technologies detect infrared radiation that is emitted by objects. Non-contact thermometers make use of these types of sensors as a way of measuring the temperature of an object without having to directly place a probe or sensor on that object. They find use in analyzing the heat signature of electronics and detecting blood flow or blood pressure inpatients.

- **Accelerationsensors**

While motion sensors detect movement of an object, acceleration sensors, or accelerometers as they are also known, detect the rate of change of velocity of an object. This change may be due to a free-fall condition, a sudden vibration that is causing movement with speed changes, or rotational motion (a directional change).

- **Gyroscopicsensors**

Gyroscopes or gyroscopic sensors are used to measure the rotation of an object and determine the rate of its movement called the angular velocity, using a 3-axis system. These sensors enable the determination of the object's orientation without having to visibly observe it.

- **Humiditysensors**

Humidity sensors can detect the relative humidity of the air or other gas, which is a measure of the amount of water vapor contained in that gas. Controlling environmental conditions is critical in the production processes of materials and humidity sensors enable readings to be taken and changes made to mitigate increasing or decreasing levels. A common application is in HVAC systems to maintain desired comfort levels.

- **Opticalsensors**

Optical sensors respond to light that is reflected off of an object and generate a corresponding electrical signal for use in detecting or measuring a condition. These sensors work by either sensing the interruption of a beam of light or its reflection caused by the presence of the object.

Conclusion: Thus,wehavestudieddifferentGATES(AND,OR,XOR),Sensorsandbasicbinary operations

LabAssignmentNo.	4
Title	Study of Connectivity and configuration of Raspberry-Pi /Beagle board/Arduino circuit with basic peripherals like LEDS. Understanding GPIO and its use in the program.
Roll No.	
Class	SE
Dateof Completion	
Subject	InternetofThings Laboratory
AssessmentMarks	
Assessor'sSign	

ASSIGNMENTNo:04

Title: StudyofConnectivityandconfigurationofRaspberry-Pi/Beagleboard/Arduinocircuitwith basic peripherals like LEDS.

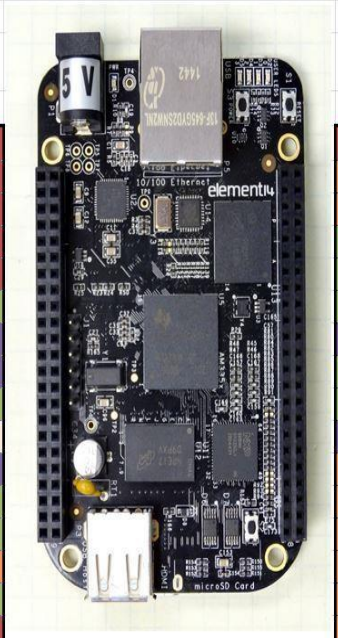
Problem Statement: Study of Connectivity and configuration of Raspberry-Pi /Beagle board/Arduinocircuitwithbasicperipheralslike LEDS.UnderstandingGPIOanditsuseinthe program.

Objective:

- StudyofConnectivityandconfigurationofRaspberry-Pi/Beagleboard/Arduinocircuitwith basic peripherals like LEDS.
- UnderstandingGPIO anditsuse in the program.

Theory:

Beaglebone Black Pinout Diagram



P9

Function	Physical Pins		Function
DGND	1	2	DGND
VDD 3.3 V	3	4	VDD 3.3 V
VDD 5V	5	6	VDD 5V
SYS 5V	7	8	SYS 5V
PWR_BUT	9	10	SYS_RESET
UART4_RXD	11	12	GPIO_60
UART4_TXD	13	14	EHRPWM1A
GPIO_48	15	16	EHRPWM1B
SPIO_CSO	17	18	SPIO_D1
I2C2_SCL	19	20	I2C_SDA
SPIO_DO	21	22	SPIO_SLCK
GPIO_49	23	24	UART1_TXD
GPIO_117	25	26	UART1_RXD
GPIO_115	27	28	SP11_CSO
SP11_DO	29	30	GPIO_112
SP11_SCLK	31	32	VDD_ADC
AIN4	33	34	GND_ADC
AIN6	35	36	AIN5
AIN2	37	38	AIN3
AIN0	39	40	AIN1
GPIO_20	41	42	ECAPWMO
DGND	43	44	DGND
DGND	45	46	DGND

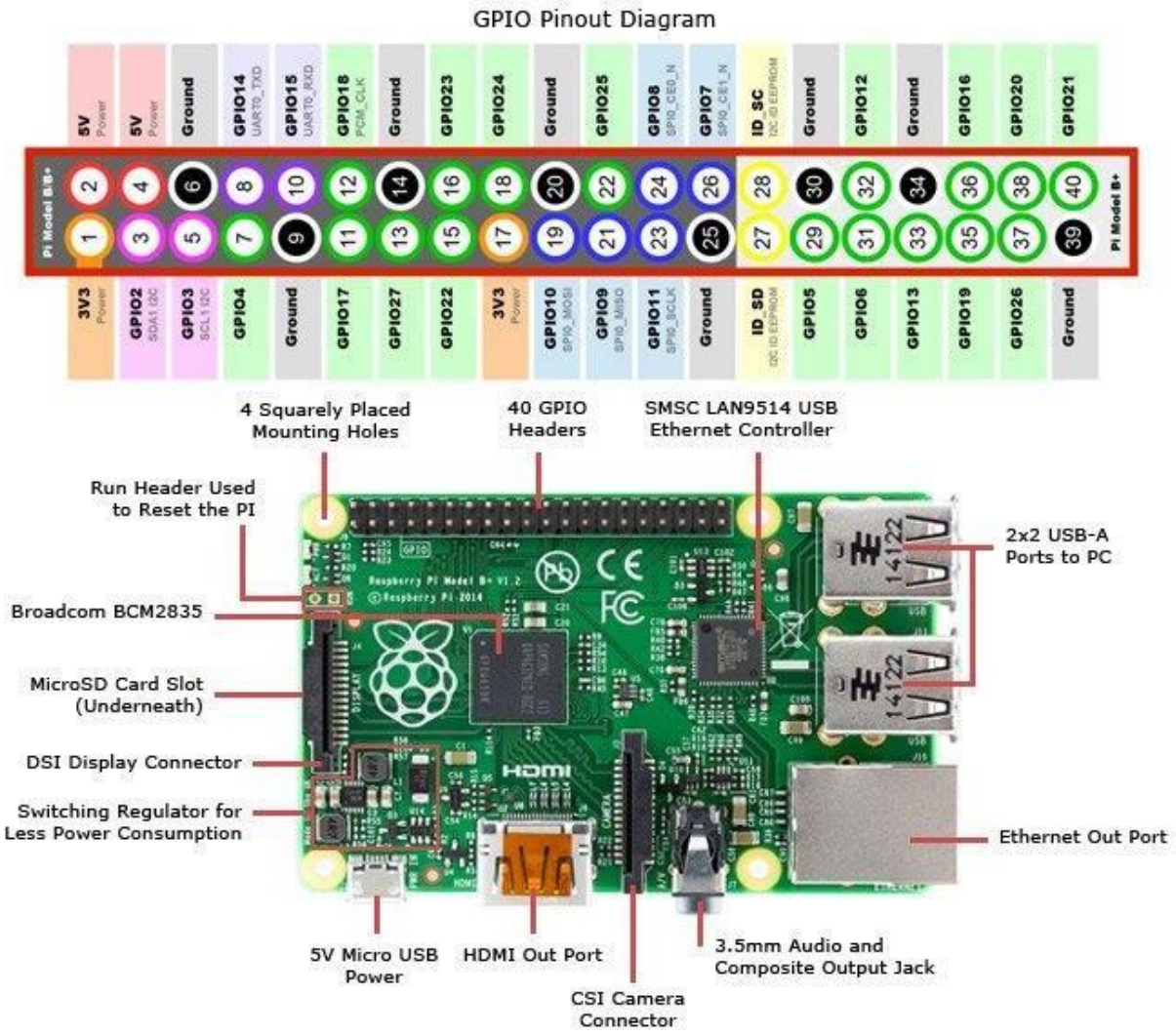
LEGEND
Power, Ground, Reset
Digital Pins
PWM Output
1.8 Volt Analog Inputs
Shared I2C Bus
Reconfigurable Digital

P8

Function	Physical Pins		Function
DGND	1	2	DGND
MMC1_DAT6	3	4	MMC1_DAT7
MMC1_DAT2	5	6	MMC1_DAT3
GPIO_66	7	8	GPIO_67
GPIO_69	9	10	GPIO_68
GPIO_45	11	12	GPIO_44
EHRPWM2B	13	14	GPIO_26
GPIO_47	15	16	GPIO_46
GPIO_27	17	18	GPIO_65
EHRPWM2A	19	20	MMC1_CMD
MMC1_CLK	21	22	MMC1_DAT5
MMC1_DAT4	23	24	MMC1_DAT1
MMC1_DATO	25	26	GPIO_61
LCD_VSYNC	27	28	LCD_PCLK
LCD_HSYNC	29	30	LCD_AC_BIAS
LCD_DATA14	31	32	LCD_DATA15
LCD_DATA13	33	34	LCD_DATA11
LCD_DATA12	35	36	LCD_DATA10
LCD_DATA8	37	38	LCD_DATA9
LCD_DATA6	39	40	LCD_DATA7
LCD_DATA4	41	42	LCD_DATA5
LCD_DATA2	43	44	LCD_DATA3
LCD_DATA0	45	46	LCD_DATA1

You can see that the Beaglebone has a large number of pins. There are two headers. Make sure you orient your Beaglebone n the same direction as mine in the picture, with the five volt plugon the top. In this orientation, the pin header on the left is referred to as “P9” and the pin header on the right isreferred to as “P8”.The legend in the diagram above shows the functions, or the possible functions of the various pins. First, we have shaded in red the various 5V, 3.3V, 1.8V and ground pins. Note that VDD_ADC is a 1.8 Volt supply and is used to provide a reference for Analog Read functions. The general purpose GPIO pins have been shaded in green. Note some of these green pins can also be used for UART serial communication. If you want to simulate analog output, between 0 and 3.3 volts, you can use the PWM pins shaded in purple. The light blue pins can be used as analog in. Please note that theAnalogInreadsbetween0and1.8volts.Youshouldnotallowthese pinstoseehighervoltagesthat
1.8 volts. When using these pins, use pins 32 and 34 as your voltage reference and ground, as pin 32 outputs a handy 1.8 volts.The pins shaded in light orange can be used for I2C.The dark orange pins are primarily used for LCD screen applications.

Raspberry Pi3Model BPin Diagram

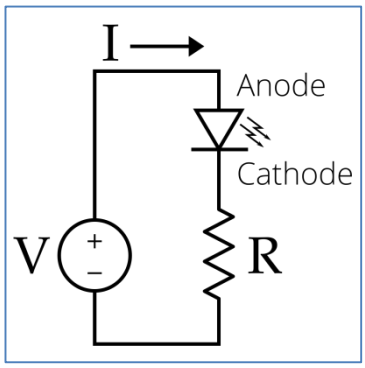


BasicPeripherals

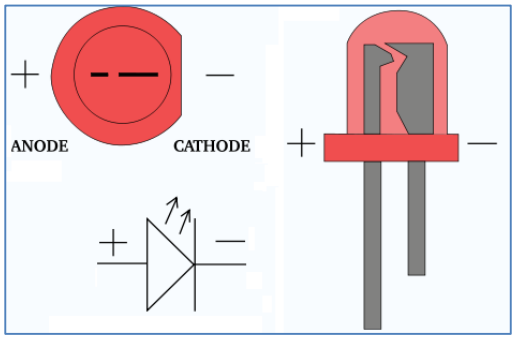
1. LED

A light-emitting diode (LED) is a semiconductor device that emits light when an electric current is passed through it. Light is produced when the particles that carry the current (known as electrons and holes) combine together within the semiconductor material.

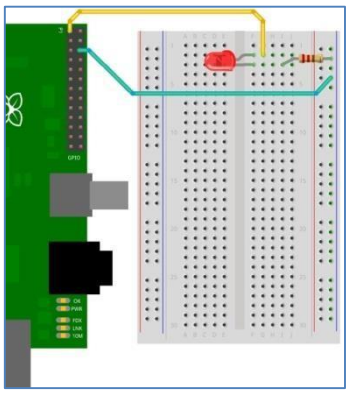
Since light is generated within the solid semiconductor material, LEDs are described as solid-state devices. The term solid-state lighting, which also encompasses organic LEDs (OLEDs), distinguishes this lighting technology from other sources that use heated filaments (incandescent and tungstenhalogen lamps) or gas discharge (fluorescent lamps).



LEDCircuitDiagram



LEDSymbol



LEDConnectionwithRaspberrypi

Programto GlowLED

- LEDhas twopins oneispositive(longend) and oneis negative(small end)
- ConnectpositiveendtoGPIOpinp810ofbeagleboneorpin17of raspberrypiusingjumper cable

- ConnectnegativeendtoanyGNDpin onbeagleboneor raspberrypiasshown in diagram.
- Onceconnectionisdone runpythoncodeled.py

#led.py forBeagleboneblackwhereled isconnected topin p8 10

```
importAdafruit_BBIO.GPIOasGPIO
import time

GPIO.setup("P8_10",GPIO.OUT)

while True:
   GPIO.output("P8_10",GPIO.HIGH)
   time.sleep(0.5)
   GPIO.output("P8_10",GPIO.LOW)
  time.sleep(0.5)
```

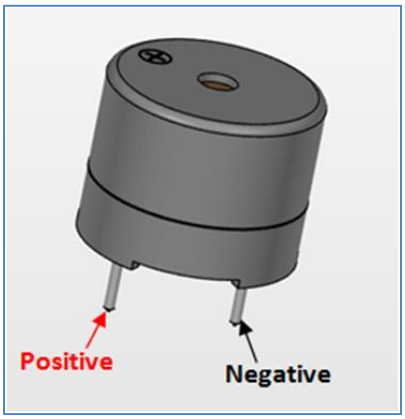
or

#led.pyforRaspberrypiwhereledisconnectedtopin 17

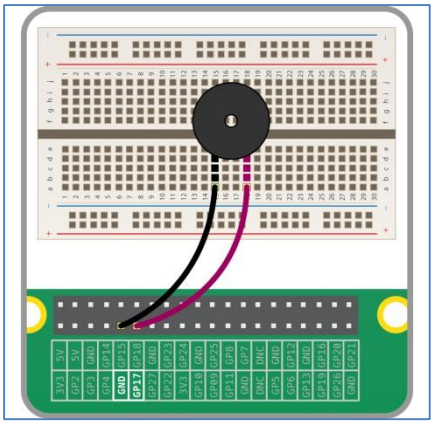
```
import RPi.GPIO as GPIO
import time
GPIO.setmode(GPIO.BCM)
GPIO.setup(17,GPIO.OUT)
try:

        while True:
                GPIO.output(17,True)
                time.sleep(2)
                GPIO.output(17,False)
                time.sleep(2)
exceptKeyboardInterrupt:
        GPIO.cleanup()
```

3. Buzzer

Abuzzeris anelectricaldevicethatis used tomakeabuzzingsound.



Buzzer



BuzzerConnectedtoRaspberrypi

Programto ON/OFFBuzzer

- Buzzerhastwopinsone ispositive(longend) andoneisnegative(small end)
- Connectpositiveendto GPIOpin 17 of raspberrypiusingjumpercable
- ConnectnegativeendtoanyGNDpin ofraspberrypi asshown in diagram.
- Onceconnectionisdone runpythoncodebuzzer.py

#buzzer.py

```
import RPi.GPIO as GPIO
import time
GPIO.setmode(GPIO.BOARD)
GPIO.setup(17,GPIO.OUT)
try:
        while True:
                GPIO.output(17,True)
                time.sleep(2)
                GPIO.output(17,False)
                time.sleep(2)
exceptKeyboardInterrupt:
        GPIO.cleanup()
```

2. IR Sensor

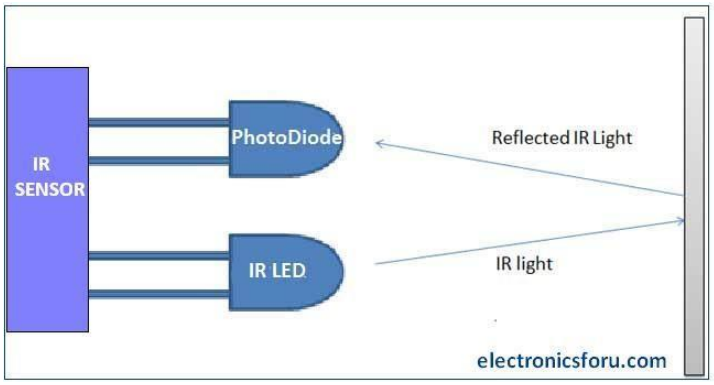
AnIRsensorisadevicethatdetectsIRradiationfallingonit.Proximitysensors(usedintouchscreen phones and edge avoiding robots), contrast sensors (used in line following robots) and obstruction counters/sensors (used for counting goods and in burglar alarms) are some applications involving IR sensors.

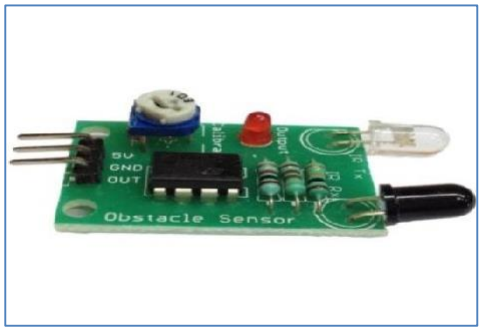
PrincipleofWorking

AnIRsensorconsistsoftwoparts,theemittercircuitandthereceivercircuit.Thisis collectively known as a photo-coupler or an optocoupler.

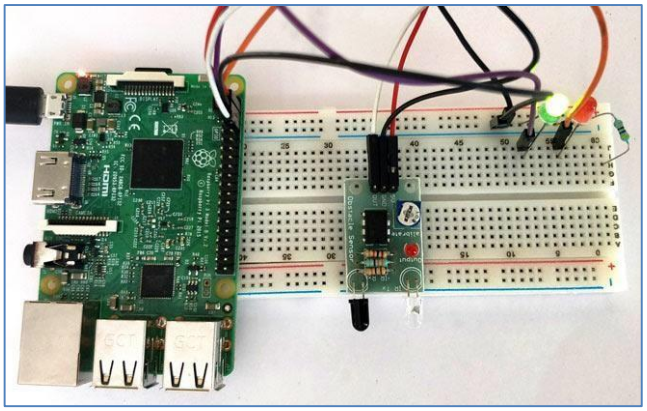
Theemitterisan IR LED andthedetectorisan IR photodiode.The IRphototdiodeissensitivetothe IR lightemittedbyan IR LED.Thephoto-diode'sresistanceandoutputvoltagechangeinproportiontothe IR light received. This is the underlying working principle of the IR sensor.

The type of incidence can be direct incidence or indirect incidence. In direct incidence, the IR LED is placed in front of a photodiode withno obstacle in between. In indirect incidence, both the diodes are placed side by side with an opaque object in front of the sensor. The light from the IR LED hits the opaque surface and reflects back to the photodiode.





IR Sensor



IRconnectedtoRaspberrypi

ProgramforIR Sensor

- ConnectIRSensoronbreadboard.
- IRsensorhasthreepins:VCC,GNDand Data.
- ConnectVCC and GNDpins to anyVCCpin andGND pin ofraspberrypi
- Connectdatapin to 37GPIO pin ofraspberrypi.
- Onceconnectionisdone run IR.pycode

#IR.py

```
import RPi.GPIO as GPIO
import time
GPIO.setmode(GPIO.BOARD)
GPIO.setup(37,GPIO.IN)#IRorPIR
try:
        while(True):
                if (GPIO.input(37)==1):
                        print("IRDetected")
                else:
                        print("IRnotdetected")
except:
        GPIO.cleanup()
```

Conclusion: Thuswehavestudied,connectivityandconfigurationofRaspberry-Piwithbasic peripherals, LEDS, buzzer and IR understanding GPIO and its use in program.

LabAssignmentNo.	5
Title	WriteaprogramusingArduinotocontrolLED(Oneormore ON/OFF). Or Blinking
Roll No.	
Class	SE
Dateof Completion	
Subject	InternetofThings Laboratory
AssessmentMarks	
Assessor'sSign	

ASSIGNMENTNo:05

Title: WriteaprogramusingArduinotocontrolLED (OneormoreON/OFF).OrBlinking

ProblemStatement: ToblinkaLEDusingArduino

Objective:

- blinkstheon-boardLED

Theory:

Apparatus: Arduino Uno board,Micro-IoT sensor actuatorboard, Power adaptor.

Interface:LED	ArduinoPin
LED1	0
LED2	1
LED3	2
LED4	4

Procedure:
Step1: ConnecttheArduinoboardtotheMicro-IoTSensorboardusingtheFRCcableprovidedwith the board.
Step2: ConnectthePowersupplyadaptor and poweron thecircuit.
Step3: OpenArduinoIDEandcreate anewsketch(program)forLEDblinkingusingtheabovepins.
Step4: IntheArduino IDEgototools→PortandselecttheappropriateCOMport.

Step5: IntheArduinoIDEclickontheuploadbutton()tocompileanddownloadthecodeintothe Arduino UNO. When successfully downloaded the code will start running and you can observe the LED's blinking on the board.

Conclusion: YoucanobservetheLED'sturningONandOFF.Youcanalsochangethedelayand see the changes.

LabAssignmentNo.	6
Title	Create a program that illuminates the green LED if the counter is less than 100, illuminates the yellow LED if the counter isbetween 101 and 200 and illuminates the red LED if the counter is greater than 200
Roll No.	
Class	SE
Dateof Completion	
Subject	InternetofThings Laboratory
AssessmentMarks	
Assessor'sSign	

ASSIGNMENTNo:06

Title: Create a program that illuminates the green LED if the counter is less than 100, illuminates the yellow LED if the counter is between 101 and 200 and illuminates the red LED if the counter is greater than 200

ProblemStatement:
Objective:

- Illuminationof LED aspercountervalue

Theory:

Apparatus: Arduino Uno board,Micro-IoT sensor actuatorboard, Power adaptor.

Interface:LED	ArduinoPin
LED1	0
LED2	1
LED3	2
LED4	4

Procedure:
Step 1: Connect the Arduino board to the Micro-IoT Sensor board using the FRC cable provided with the board.
Step2: ConnectthePowersupplyadaptor and poweron thecircuit.
Step3: OpenArduinoIDEandcreate anewsketch(program)usingtheabovepins.
Step4: IntheArduino IDEgototools→PortandselecttheappropriateCOMport.

Step5: In the Arduino IDE click on the upload button () to compile and download the code into the Arduino UNO. When successfully downloaded the code will start running and you can observe the LED's getting illuminated after the count is changed on the board.

Conclusion: You can observe the LED's turning ON after the specific counter has expired. Additionally you can print the value of the counter on the serial terminal using the ***serial.println*** function.

LabAssignmentNo.	7
Title	Create a program so that when the user enters ‘b’ the green light blinks, ‘g’ the green light is illuminated ‘y’ the yellow light is illuminated and ‘r’ the red light is illuminated
Roll No.	
Class	SE
Dateof Completion	
Subject	InternetofThings Laboratory
AssessmentMarks	
Assessor'sSign	

ASSIGNMENTNo:07

Title: Create a program so that when the user enters ‘b’ the green light blinks, ‘g’ the green light is illuminated ‘y’ the yellow light is illuminated and ‘r’ the red light is illuminated

Problem Statement: To create a program so that when the user enters ‘b’ the green light blinks,‘g’ the green light is illuminated, ‘y’ the yellow light is illuminated and ‘r’ the red light is illuminated using Arduino.

Objective:

- IlluminationofLEDusingkeyboard

Theory:

Apparatus: Arduino Uno board,Micro-IoT sensor actuatorboard, Power adaptor.
Interface:

LED	ArduinoPin
LED1	0
LED2	1
LED3	2
LED4	4

SerialterminalofArduinoIDE.

Procedure:
Step 1: Connect the Arduino board to the Micro-IoT Sensor board using the FRC cable provided with the board.
Step2: ConnectthePowersupplyadaptor and poweron thecircuit.
Step3: OpenArduinoIDEandcreate anewsketch(program)usingtheabovepins.
Step4: IntheArduino IDEgototools→PortandselecttheappropriateCOMport.

Step 5: In the Arduino IDEclick on theuploadbutton ( )to compile and download thecodeinto the Arduino UNO. When successfully downloaded the code will start running.

Step 6: Open the serial monitor from **Tools→Serial Monitor**. Set the baud rate to 9600 and type ‘b’,‘g’, ‘y’ or ‘r’ and check the color of the LED.

Conclusion: You can observe that when the user enters ‘b’ the green LED blinks, when the user enters ‘g’ the green light is turned ON, when the user enters ‘y’ the yellow LED is ON and when the user enters ‘r’ the red LED in ON.

LabAssignmentNo.	8
Title	Write a program thatasks the userfor anumber and outputs thenumber squared that is entered
Roll No.	
Class	SE
Dateof Completion	
Subject	InternetofThings Laboratory
AssessmentMarks	
Assessor'sSign	

ASSIGNMENTNo:08

Title: Writeaprogram thatasks theuserforanumberandoutputs thenumbersquaredthat is entered

ProblemStatement: To calculatethesquare of thenumbergiven bytheuser, usingArduino.

Objective:

- Squarethe number
- Interfacemonitor

Theory:

Apparatus: Arduino Uno board,Micro-IoT sensor actuatorboard, Power adaptor.
Interface: SerialterminalofArduino IDE.
Procedure:
Step 1: Connect the Arduino board to the Micro-IoT Sensor board using the FRC cable provided withthe board.
Step2: ConnectthePowersupplyadaptor and poweron thecircuit.
Step3: OpenArduinoIDEandcreate anewsketch(program)usingtheabovepins.
Step4: IntheArduino IDEgototools→PortandselecttheappropriateCOMport.

Step 5: In the Arduino IDEclick on theuploadbutton ( )to compile and download thecodeinto the Arduino UNO. When successfully downloaded the code will start running.

Step 6: Open the serial monitor from**Tools**→**Serial Monitor**. Set the baud rate to 9600 and givethenumber as input to the program and observe the output.

Conclusion: In the Arduino IDE open the serial monitor and set the baud rate to 9600. When the program RUNs it prompts the user to input a number. Type (input) a number and observe that the program calculates and gives the square of the input number as output on the serial monitor.

LabAssignmentNo.	9
Title	Write a program to control the color of the LED by turning 3 different potentiometers. One will be read for the value of Red,one for the value of Green, and one for the value of Blue
Roll No.	
Class	SE
Dateof Completion	
Subject	InternetofThings Laboratory
AssessmentMarks	
Assessor'sSign	

ASSIGNMENTNo:09

Title: Write a program to control the color of the LED by turning 3 different potentiometers. One will be read for the value of Red, one for the value of Green, and one for the value of Blue

ProblemStatement: TochangethecoloroftheRGBLEDusingtheinputfrom3different potentiometers, using Arduino.

Objective:

- Control LEDusingpotentiometer

Theory:

Apparatus: Arduino Uno board,Micro-IoT sensor actuatorboard, Power adaptor.
Interface:

Peripheral	ArduinoPin
RGB_red	5
RGB_green	6
RGB_blue	3
POT_red	A0
POT_green	A2
POT_blue	A3

Procedure:
Step 1: Connect the Arduino board to the Micro-IoT Sensor board using the FRC cable provided with the board.
Step2: ConnectthePowersupplyadaptor and poweron thecircuit.
Step3: OpenArduinoIDEandcreate anewsketch(program)usingtheabovepins.
Step4: IntheArduino IDEgototools→PortandselecttheappropriateCOMport.

Step 5: In the Arduino IDEclick on theuploadbutton ( )to compile and download thecodeinto the Arduino UNO. When successfully downloaded the code will start running.
Step6:changethePotentiometersPot_P1,Pot_p2andPot_P3andobservethecolourchangeinthe RGB LED.

Conclusion: When you change the value of Potentiometers P1, P2 and P3, we can observe that the corresponding color on the RGB led changes in intensity. Using all the 3 potentiometers we can see the whole spectrum of the color space.

LabAssignmentNo.	10
Title	Write a program read the temperature sensor and send the valuesto the serial monitor on the computer
Roll No.	
Class	SE
Dateof Completion	
Subject	InternetofThings Laboratory
AssessmentMarks	
Assessor'sSign	

ASSIGNMENTNo:10

Title: Writeaprogramreadthetemperaturesensorandsendthevaluestotheserialmonitoronthe computer

Problem Statement: Read the temperature sensor and send the values to the serial monitor, using Arduino.

Objective:

- Studyof temperaturesensor
- Measuretemperatureusingserial monitor

Theory:

Apparatus: Arduino Uno board,Micro-IoT sensor actuatorboard, Power adaptor.

Interface:Peripheral	ArduinoPin
LM35	A0

Procedure:
Step 1: Connect the Arduino board to the Micro-IoT Sensor board using the FRC cable provided with the board.
Step2: ConnectthePowersupplyadaptor and poweron thecircuit.
Step3: OpenArduinoIDEandcreate anewsketch(program)usingtheabovepins.
Step4: IntheArduino IDEgototools→PortandselecttheappropriateCOMport.

Step 5: In the Arduino IDEclick on theuploadbutton ( )to compile and download thecodeinto the Arduino UNO. When successfully downloaded the code will start running.
Step 6: Open the Serial Monitor in Arduino IDE Tools→Serial Monitor and observe the values of the temperature sensor.

Conclusion: The LM35 sensor is an analog sensor which outputs a voltage corresponding to the temperature. For every 1 degree the sensor outputs 10 mv voltage. E.g for 30 degrees it will give a voltage of 300 mv. We can sense this voltage using Arduino and convert it back to show the temperature.

LabAssignmentNo.	11
Title	WriteaprogramsoitdisplaysthetemperatureinFahrenheitas well as the maximum and minimum temperatures it has seen
Roll No.	
Class	SE
Dateof Completion	
Subject	InternetofThings Laboratory
AssessmentMarks	
Assessor'sSign	

ASSIGNMENTNo:11

Title: Writeaprogramsoitdisplaysthetemperatureinfahrenheitaswellasthemaximumand minimum temperatures it has seen

Problem Statement: Read the temperature sensor LM35 and show the values in Fahrenheit using Arduino.

Objective:

- ReadthetemperatureinFahrenheit

Theory:

Apparatus: Arduino Uno board,Micro-IoT sensor actuatorboard, Power adaptor.

Interface:Peripheral	ArduinoPin
LM35	A0

Procedure:
Step 1: Connect the Arduino board to the Micro-IoT Sensor board using the FRC cable provided with the board.
Step2: ConnectthePowersupplyadaptor and poweron thecircuit.
Step3: OpenArduinoIDEandcreate anewsketch(program)usingtheabovepins.
Step4: IntheArduino IDEgototools→PortandselecttheappropriateCOMport.

Step 5: In the Arduino IDEclick on theuploadbutton ( )to compile and download thecodeinto the Arduino UNO. When successfully downloaded the code will start running.

Step 6: Open the Serial Monitor in Arduino IDE Tools→Serial Monitor and observe the values of the temperature sensor.

Conclusion: The LM35 sensor is an analog sensor which outputs a voltage corresponding to the temperature. For every 1 degree the sensor outputs 10 mv voltage. E.g for 30 degrees it will give a voltage of 300 mv. We can sense this voltage using Arduino and convert it back to show the temperature.

LabAssignmentNo.	12
Title	Writeaprogramtoshowthetemperatureandshowsagraphof the recent measurements
Roll No.	
Class	SE
Dateof Completion	
Subject	InternetofThings Laboratory
AssessmentMarks	
Assessor'sSign	

ASSIGNMENTNo:12

Title: Writeaprogramto showthetemperatureand showsagraphoftherecent measurements

ProblemStatement: ReadthetemperaturesensorLM35andshowthevaluesonagraphusing Arduino.

Objective:

- Readthetemperatureandgeneratethe graph

Theory:

Apparatus: Arduino Uno board,Micro-IoT sensor actuatorboard, Power adaptor.
Interface:

SerialPlotterPeripheral	ArduinoPin
LM35	A0

Procedure:
Step 1: Connect the Arduino board to the Micro-IoT Sensor board using the FRC cable provided with the board.
Step2: ConnectthePowersupplyadaptor and poweron thecircuit.
Step3: OpenArduinoIDEandcreate anewsketch(program)usingtheabovepins.
Step4: IntheArduino IDEgototools→PortandselecttheappropriateCOMport.

Step 5: In the Arduino IDEclick on theuploadbutton ( )to compile and download thecodeinto the Arduino UNO. When successfully downloaded the code will start running.

Step 6: Open the Serial Monitor in Arduino IDE Tools→Serial Plotter and observe the graph of values from the temperature sensor.

Conclusion: When you output the values using ***serial.println()*** function and use the serial plotter the plotter will plot the graph of the values.

LabAssignmentNo.	13
Title	Writeaprogram usingpiezo element and useit to playa tuneafter someone knocks
Roll No.	
Class	SE
Dateof Completion	
Subject	InternetofThings Laboratory
AssessmentMarks	
Assessor'sSign	

ASSIGNMENTNo:13

Title: Write a program using piezo element and use it to play a tune after someone knocks

ProblemStatement: Detectaknock andplayatuneusingaPiezoelement,usingArduino. **Objective:**

- Interfacingofpiezoelement

Theory:

Apparatus: Arduino Uno board,Micro-IoT sensor actuatorboard, Power adaptor.

Interface:Peripheral	**ArduinoPin**
PiezoElement	A1

Procedure:
Step 1: Connect the Arduino board to the Micro-IoT Sensor board using the FRC cable provided with the board.
Step2: ConnectthePowersupplyadaptor and poweron thecircuit.
Step3: OpenArduinoIDEandcreate anewsketch(program)usingtheabovepins.
Step4: IntheArduino IDEgototools→PortandselecttheappropriateCOMport.

Step 5: In the Arduino IDEclick on theuploadbutton ( )to compile and download thecodeinto the Arduino UNO. When successfully downloaded the code will start running.
Step6: Tapon thepiezoelement andhearthetune.

Conclusion: You can use the Piezo element for both input sensing and output tone generation**.** In this experiment the user will tap the sensor and read the input values and once a certain threshold is passed can start generating a tone from the Piezo Element.

LabAssignmentNo.	14
Title	Understanding the connectivity of Raspberry-Pi /Beagle board circuit / Arduino with IR sensor. Write an application to detect obstacle and notify user using LEDs
Roll No.	
Class	SE
Dateof Completion	
Subject	InternetofThings Laboratory
AssessmentMarks	
Assessor'sSign	

ASSIGNMENTNo:14

Title: UnderstandingtheconnectivityofRaspberry-Pi/Beagleboardcircuit/ArduinowithIRsensor. Write an application to detect obstacle and notify user using LEDs

ProblemStatement: Detect obstacleusinga IRreceiverandindicate usinga LED,usingArduino.

Objective:

- UnderstandingtheconnectivityofRaspberry-Pi/Beagleboard circuit/ArduinowithIR sensor.
- Anapplicationto detectobstacleandnotifyuser using LEDs

Theory:

Apparatus: Arduino Uno board,Micro-IoT sensor actuatorboard, Power adaptor.
Interface:

Peripheral	ArduinoPin
IRReceiver	9
LED4	4

Procedure:
Step 1: Connect the Arduino board to the Micro-IoT Sensor board using the FRC cable provided with the board.
Step2: ConnectthePowersupplyadaptor and poweron thecircuit.
Step3: OpenArduinoIDEandcreate anewsketch(program)usingtheabovepins.
Step4: IntheArduino IDEgototools→PortandselecttheappropriateCOMport.

Step 5: In the Arduino IDEclick on theuploadbutton ( )to compile and download thecodeinto the Arduino UNO. When successfully downloaded the code will start running.
Step6: Putanobstacle(paper,finger)betweenthe IRtransmitterandreceiverandobserveLED4.

Conclusion: When an obstacle is inserted in between the IR transmitter and Receiver the state of the LED is changed.

LabAssignmentNo.	15
Title	Writeanapplicationtocontroltheoperationofhardwaresimulated traffic signals.
Roll No.	
Class	SE
Dateof Completion	
Subject	InternetofThings Laboratory
AssessmentMarks	
Assessor'sSign	

ASSIGNMENTNo:15

Title: Writeanapplicationtocontroltheoperationofhardwaresimulatedtrafficsignals.

ProblemStatement: ToimplementthesimulationofaTrafficSignalusingRaspberryPi hardware.

Objective:

- Controltrafficsignals

Theory:

Apparatus: RaspberryPi,Micro-IoT TrafficSimulation Board,Power adaptor.
Interface:

DeviceDetails	PinsRpi(Arduino)
NorthGreen	GPIO6(A2)
EastGreen	GPIO7(0)
South Green	GPIO8(10)
WestGreen	GPIO9(12)
NorthAmber	GPIO10(11)
EastAmber	GPIO12(5)
South Amber	GPIO11(13)
West Amber	GPIO16(9)
NorthRed	GPIO17(A1)
EastRed	GPIO18(6)
South Red	GPIO5(A3)
West Red	GPIO4(A0)

Procedure:
Step1: Connect theRaspberryPi board to the Micro-IoTSensor boardusing theFRC cableprovided with the board.
Step2: ConnectthePowersupplyadaptor and poweron thecircuit.
Step3: Openaterminalandcreate anewpythonprogram usingtheabovepins.
Step4: Runtheprogrampythonprogram.
Step5:checkthetraffic simulation.

Conclusion: Theprogramsimulatestheworkingof atrafficsignal.

LabAssignmentNo.	16
Title	Develop a Real time application like smart home with following requirements: When the user enters into the house the required appliances like fan, light should be switched ON. Appliances should also get controlled remotely by a suitable web interface. Theobjectiveofthisapplicationisthatstudentsshouldconstruct completeSmartapplicationsingroups
Roll No.	
Class	SE
Dateof Completion	
Subject	InternetofThings Laboratory
AssessmentMarks	
Assessor'sSign	

ASSIGNMENTNo:16

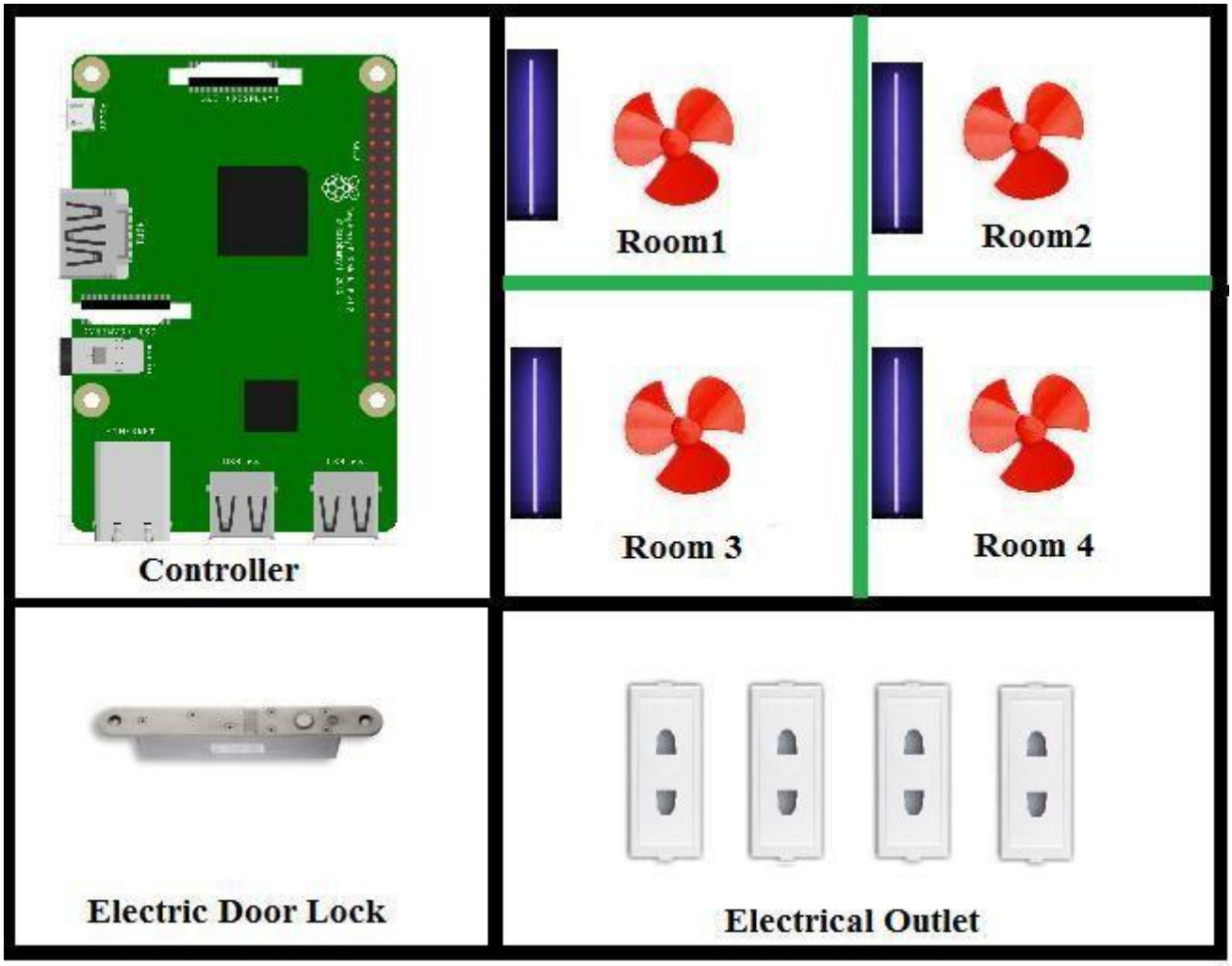
Title: Develop a Real time application like smart home with following requirements: When the user enters into the house the required appliances like fan, light should be switched ON. Appliances should alsogetcontrolled remotelybyasuitableweb interface.Theobjectiveofthisapplicationisthatstudents should construct complete Smart applications in groups

ProblemStatement: Tocontrol theHomeAppliances usingawebpage.

Objective:

- Controllinghome appliances

Theory:



Apparatus:RaspberryPi,relays,powersupply.
Procedure:
Step1:ConnecttheRaspberryPi boardtotheMicro-IoTSensor board.

Step2:UnderstandtheconnectionsfortheMicro-IoTSensorboardandRaspberryPiboard. Step 3:
Connect the Raspberry Pi setup and write the program for interfacing relays.
Step4:Sendthefilestothe **/var/www/html/HomeAutomation**directory.
Step5:openthebrowseronanyotherPCandconnecttotheIPaddressofRaspberryPi:**e.g.**
//http:192.168.1.100/HomeAutomation.
The webpage will take instructions from the user and pass it on to the PHP page which will in-turn run shell commands to switch the Home Appliances.

InterfacingDetails:

Peripherals	**RaspberryPiPin**
Buzzer(Alarm)	GPIO6
Relay1- DoorLatch	GPIO7
Relay2-Light	GPIO12
Relay3-Fan	GPIO16

Conclusion: Thusyou cancontroltheHomeAppliancesusingawebpage.