Internet of Things Laboratory

Assignment 1

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1. What do you mean by Embedded Development boards?

Embedded boards are boards with processors, multiple integrated circuits, interfaces and other essential components assembled on them to serve a dedicated function. Embedded boards comprise of multiple technologies, including processors, core logic, networking, connectivity and multimedia components to provide functionality and performance for embedded system design applications. Systems in the electronic industry comprise of processing, software, storage and external interface components. In a system all of these sub components would work together to form one central processing system. Applications include Super Computing, Transport, Automotive, Industrial, Military and Audio/Video applications.

2. Different types of Embedded Development boards?

1. **Raspberry Pi 3 B+**

The Raspberry Pi development board is a small pocket-sized computer running the Raspbian operating system, which is a variant of Debian Linux.

2. **Qualcomm Snapdragon**

This is a single board computer (SBC) that uses the powerful Snapdragon processor from Qualcomm. It supports various interfaces like Wi-Fi, Bluetooth, and Global Positioning System (GPS). It is well suited for Internet of Things(Iot), medical, and robotic applications.

3. **Beagle Bone Black**

The BeagleBone Black uses a Texas Instruments (TI) Sitara processor running on ARM Cortex-A8 core. The system clock frequency is 1GHz, which supports various operating systems like Windows, Linux, Android, QNX, Embedded CE, and ThreadX.

4. **Panda Board**

The PandaBoard is a low-power, low-cost development board based on TI's OMAP4460 (Open media application platform). This board supports operating systems like Windows, Linux, Window CE, Palm OS, and Symbian.

5. **Intel Galileo Gen 2**

The Galileo development board comes from Intel and features an Intel Quark SoC X1000 processor. It is designed using Pentium technology. The advantage of this board is it is compatible with shields for the Arduino Uno R3.

6. **Arduino Mega 2560**

Arduino is an open source hardware and software platform family with thousands of active users and contributors. It is one of the best platforms for making electronic projects. If you are a beginner, you can quickly develop applications with less effort than with other platforms.

7. **Banana Pi M2+**

The Banana Pi M2+ is a portable SBC that supports various interfaces like Bluetooth, Wi-Fi, and Ethernet. It offers great computing performance with its quad-core ARM Cortex-A7 processor running at 1.2GHz.

8. **CubieBoard6**

CubieBoard6 is an SBC that runs operating systems like Linux. It also supports the Android OS. The Cubie is empowered with a quad core Cortex-A9 processor. The board can also be powered using a LiPo (lithium polymer) battery.

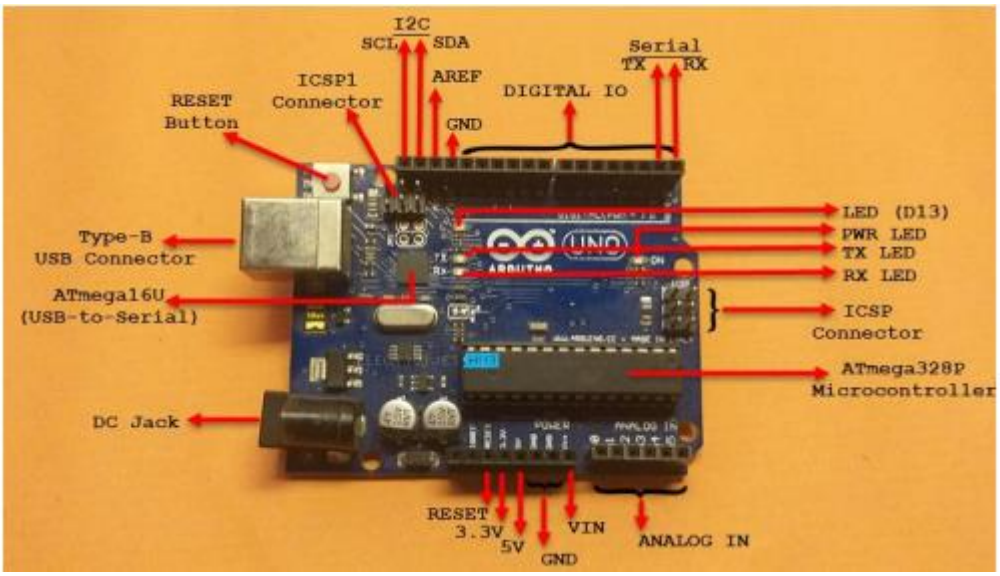
9. **Odroid-C2**

The ODROID-C2 is a 64-bit quad-core (SBC) that is suitable for applications like multimedia, gaming, and consumer electronics. It can also work as a standalone computer with available open source software packages.

10. **HummingBoard Gate**

Based on an NXP quad-core processor, this SBC comes with an integrated mikroBUS socket that is suitable for MikroElektronika development boards and external peripheral modules.The HummingBoard Gate supports 2GB of DDR3 RAM and is useful for building modular projects and providing proof-of-concept.

3. Detailed information on Arduino board- Layout (diagram), features and specifications.



Features:

1. 16 MHz crystal oscillator

2. Operating voltage is 5 V and it can be achieved by using a USB port or by using an external adaptor.

3. An external micro SD card is supported

4. This board comes with a built-in feature of voltage regulation i.e. when the device is connected to other external devices it keeps voltage under control thus preventing the board from damage.

5. Easy USB interface i.e. simply plug your external device with this port and your device is ready to use. 16 MHz clock makes it fast enough for most of the applications.

6. Onboard LED for easy and fast debugging of our code

7. Micro SD cards can be used if the functionality or nature of our project goes complex to make our board store more information.

Specifications:

Microcontroller: ATmega328P

Operating Voltage: 5V

Input Voltage (recommended): 7-12V

Input Voltage (limits): 6-20V

Analog Input Pins: 6(A0 to A5)

Digital I/O Pins: 14 (of which 6 provide PWM output)

DC Current per I/O Pin: 40 mA

DC Current for 3.3V Pin: 50 mA

Flash Memory: 32 KB (ATmega328) of which 0.5 KB used by bootloader

SRAM: 2 KB (ATmega328)

EEPROM: 1 KB (ATmega328)

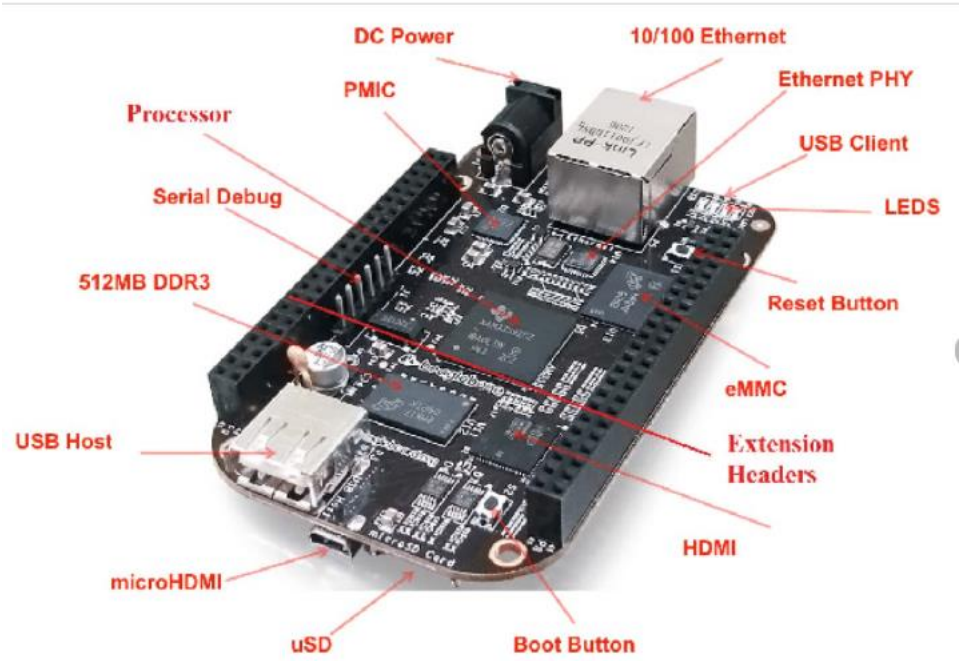
Frequency(Clock Speed): 16 MHz

Applications of **the Arduino board-**

- Weighing Machines
- Traffic Light Countdown
- Timer Parking Lot Counter
- Systems embedded in devices
- Automating the House
- Automation in the Industrial Sector
- Emergency Light for Railways

4. Detail information on Beagle Bone Black.

The Beagle Bone Black is low-power open-source single-board computer developed by Texas Instruments in cooperation with the Newark element 14 and Digi-Key.



Beaglebone Black Microcontroller specifications are as follows-

1. Processor: Processor being the heart of Beaglebone board manages all sorts of controls and operations. Beaglebone processor is based on ARM Cortex A8/A15 Processor technology running at various clock speeds like 720 MHz, 1GHz, and 1.5GHz.

2. RAM: Depending on various generation models, Beaglebone boards are equipped with 128/256/512/2048 MB RAM.

3. DC Power Jack: Beaglebone requires 5V and 500 mA of DC power to operate. Along with DC power jack, 2.1 mm barrel jack connector will be required to power the board. Beaglebone facilitates over voltage protection chip upto 12V.

4. Ethernet Port: Beaglebone has onboard 10/100 standard RJ45 Ethernet Port supporting all sorts of networking protocols along with Wi-Fi connection sharing.

5. Reset Button: Reset Button reboots the board. It provides logic 1 or 0 to trigger the processor. Functioning similarly like Reset Button on computer/smartphones, it reboots the entire operating system and also provides backup from failure if lock up situation occurs.

6. USB Host: USB Host provides same features like USB port on normal computers/laptops. Beaglebone USB host ports enables users to connect various 3rd party peripherals like Keyboard, Mouse, Web Camera, Wi-Fi

adopters and external storage devices like pen drives, USB card readers and hard disk drives.

7. LEDs: Beaglebone board has LED located aside power connector to indicate power ON signal when power applied to board. Most of the boards are equipped with 4 LED's with following functionalities: LED0 will be ON when Board is up and running. LED 1 will indicates microSD card operations. LED 2 indicates Active CPU active situation. LED 3 indicates flash memory access.

8. Extension Headers: Beaglebone has 2 extension headers on left and right side which facilitates integration of various electronic components like LED's, Switch's, Sensors, and Modules etc. for developing various projects.

9. USB Client: USB Client port is basically used for connecting Beaglebone to computer and power would be provided via USB. When connected to computer, it appears like storage device.

10. MicroSD Card Slot/uSD: MicroSD card slot facilitates integration of microSD cards to store operating systems, applications and data. Taking Beaglebone black into consideration, where operating system is stored on onboard flash memory by default, any updates can be done via sd card slot only. Operating systems can be downloaded on Beaglebone website which can be written on SD card via Win32Disk Imager software.

11. microHDMI: microHDMI port does the work of connecting Beaglebone board to HDMI enabled Monitor/TV. It supports maximum resolution of 1280x1024 pixels.

12. Serial Debug: Serial Debug is used for serial communications to connect an FTDI TTL-232 cable or breakout board and enable text based terminal via USB.

13. eMMC/Onboard Flash Memory: Beaglebone (Black version) has operating system stored on eMMC/onboard flash memory to boot up the board without any SD card requirement.

14. Boot Button: Available only in Beaglebone black. Continuous hold of Boot Button instructs Beaglebone to boot from SD card attached on SD card slot rather than onboard flash memory.

15. PMIC (Power Management Integrated Circuit): PMIC module provides power backup solution to Beaglebone via connecting li-po batteries. These batteries will act as UPS for Beaglebone for providing backup to users over

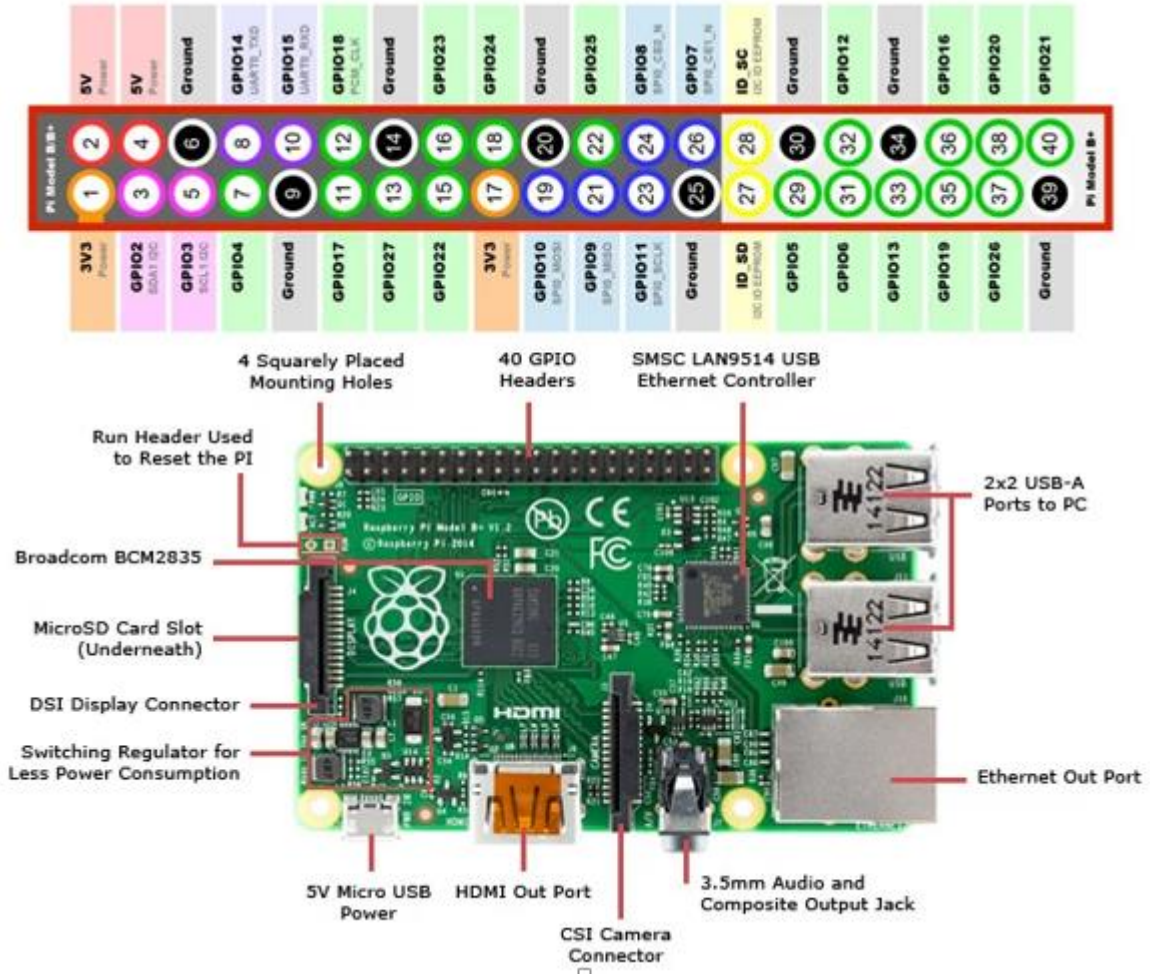
electricity failure to shut down the board or do necessary important work till batteries last long.

Applications of Beagle Bone Black

- Motor controllers
- Robotics
- It can work as a server in various IoT projects
- Monitoring and controlling units with the help of display cape
- AWS
- In several projects which are related to Bluetooth connectivity.
- Used by the developers in small network projects for designing and testing
- Used as a signal control unit in several industrial systems

5. Detail information on Raspberry-Pi-Layout, Features, specifications

Layout Diagram Of Raspberry-Pi



Raspberry Pi 4 specs

● SoC: Broadcom BCM2711B0 quad-core A72 (ARMv8-A) 64-bit @ 1.5GHz

● GPU: Broadcom VideoCore VI

● Networking: 2.4 GHz and 5 GHz 802.11b/g/n/ac wireless LAN

● RAM: 1GB, 2GB, or 4GB LPDDR4 SDRAM

● Bluetooth: Bluetooth 5.0, Bluetooth Low Energy (BLE)

● GPIO: 40-pin GPIO header, populated

● Storage: microSD

● Ports: 2 × micro-HDMI 2.0, 3.5 mm analogue audio-video jack, 2 × USB 2.0, 2 × USB 3.0, Gigabit Ethernet, Camera Serial Interface (CSI), Display Serial Interface (DSI)

● Dimensions: 88 mm × 58 mm × 19.5 mm, 46 g

1. Central Processing Unit (CPU)-Every computer has a Central Processing Unit, and so does the Raspberry Pi. It is the computer's brain and carries out instructions using logical and mathematical operations. Raspberry Pi makes use of the ARM11 series processor on its boards.

2. HDMI port-Raspberry Pi board has an HDMI or High Definition Multimedia Interface port that allows the device to have video options of the output from the computer displayed. An HDMI cable connects the Raspberry Pi to an HDTV. The supported versions include 1.3 and 1.3. It also comes with an RCA port for other display options.

3. Graphic Processing Unit (GPU)-This unit, GPU or Graphic Processing Unit, is another part of the Raspberry pi board. Its primary purpose is to hasten the speed of image calculations.

4. Memory (RAM)-Random Access Memory is a core part of a computer's processing system. It is where real-time information is stored for easy access. The initial Raspberry Pi had 256MB RAM. Over the years, developers gradually and significantly improved the size. Different Raspberry Pi models come with varying capacities. The model with the maximum capacity presently is the Raspberry Pi 4 with 8GB RAM space.

5. Ethernet port-The Ethernet port is a connectivity hardware feature available on B models of Raspberry Pi. The Ethernet port enables wired internet access to the minicomputer. Without it, software updates, web surfing, etc., would not be possible using the Raspberry Pi. The Ethernet port found on Raspberry

computers uses the RJ45 Ethernet jack. With this component, Raspberry Pi can connect to routers and other devices.

6. SD card slot-Like most other regular computers, Raspberry Pi must have some sort of storage device. However, unlike conventional PCs, it does not come with a hard drive, nor does it come with a memory card. The Raspberry Pi board has a Secure Digital card or SD card slot where users must insert SD cards for the computer to function. The SD card functions like a hard drive as it contains the operating system necessary for turning the system on. It also serves to store data.

7. General Purpose Input and Output (GPIO) pins-These are upward projecting pins in a cluster on one side of the board. The oldest models of the Raspberry Pi had 26 pins, but most have 40 GPIO pins. These pins are pretty sensitive and should be handled carefully. They are essential parts of the Raspberry Pi device as they add to its diverse applications. GPIO pins are used to interact with other electronic circuits. They can read and control the electric signals from other boards or devices based on how the user programs them.

8. LEDs-These are a group of five light-emitting diodes. They signal the user on the present status of the Raspberry Pi unit. Their function covers:

● PWR (Red): This functions solely to indicate power status. When the unit is on, it emits a red light and only goes off when the unit is switched off, or disconnected from the power source.

● ACT (Green): This flashes to indicate any form of SD card activity.

● LNK (Orange): LNK LED gives off an orange light to signify that active Ethernet connectivity has been established.

● 100 (Orange): This light comes on during Ethernet connection when the data speed reaches 100Mbps.

● FDX (Orange): FDX light also comes during Ethernet connection. It shows that the connection is a full-duplex.

9. USB ports-Universal service bus (USB) ports are a principal part of Raspberry Pi. They allow the computer to connect to a keyboard, mouse, hard drives, etc. The first model of Raspberry Pi had only two USB 2.0 ports. Subsequent models increased this number to four. Raspberry Pi 4 and Pi 400, much newer models, come with a mix of USB 2.0 and USB 3.0 ports.

10. Power source-Raspberry Pi has a power source connector that typically uses a 5V micro USB power cable. The amount of electricity any Raspberry Pi consumes depends on what it's used for and the number of peripheral hardware devices connected.

6. Briefly explain types of micro controllers.

PIC Microcontroller

PIC Stands for Peripheral Interface Controller is a kind of microcontroller components was used in the development of electronics, computer robotics, and similar devices. Even though the PIC was produced by Microchip technology and based on hardware computing architecture, here the code and data are placed in separate registers to increase the input and output. Pic has a built-in data memory, data bus and dedicated microprocessor for preparing all I/O purposes and methods.

ARM Microcontroller

ARM stands for Advanced RISC Machine. It's the most popular Microcontrollers Programming in the digital embedded system world, and most of the industries prefer only ARM microcontrollers since it consists of significant features to implement products with an excellent appearance. It is cost sensitive and high-performance device which has been used in a wide range of application such as Industrial Instrument control systems, wireless networking and sensors, and automotive body systems, etc.

8051 Microcontroller

Intel created 8051 microcontrollers in 1981. It is an 8 bit microcontroller. It's made with 40 pins DIP (Dual inline package), 4kb if ROM storage and 128 bytes of RAM storage, 2 16-bit timer. It consists of are four parallel 8-bit ports, which are programmable as well as addressable as per the specification.

AVR Microcontroller

AVR stands for Alf and Vegard's RISC Processor. It was the modified Harvard architecture machine, where program and data were stored in the separate physical memory system that appears in different address spaces, but having the ability to browse information things from program memory victimization particular directions. AVR isn't associate degree signifier and doesn't symbolize something specially.

MSP Microcontroller

MSP stands for Mixed Signal Processor. It’s the family from Texas Instruments. Built around a 16-bit CPU, the MSP is designed for low cost and respectively, low power dissipation embedded statements. It’s the controller's appearance is directly related to the 16-bit data bus, and seven addressing modes and the decreased instructions set, which allows a shorter, denser programming code for fast performance.

7. What is python language?

Python is a dynamic, interpreted (bytecode-compiled) language.

• There are no type declarations of variables, parameters, functions, or methods in source code.

• This makes the code short and flexible, and you lose the compile-time type checking of the source code.

• Python tracks the types of all values at runtime and flags code that does not make sense as it runs.

8. Syntax for python language to program embedded development board

Adafruit_BBIO

1.setup() 2.output() 3.input() 4.cleanup()

Time

1.sleep()

Import both the libraries in any application program

Using the Adafruit_BBIO library with the Beagle Bone Black (BBB) is fairly simple: To start, you'll want to import the library. There are two different options at this time to import.

The first one is for GPIO:

• import Adafruit_BBIO.GPIO as GPIO

• import Adafruit_BBIO.PWM as PWM

Example :

import Adafruit_BBIO.GPIO as GPIO

• GPIO.setup("P8_10", GPIO.OUT)

• GPIO.output("P8_10", GPIO.HIGH)

• GPIO.cleanup()

9. What do you mean by GPIO?

A general-purpose input/output (GPIO) is an uncommitted digital signal pin on an integrated circuit or electronic circuit board which may be used as an input or output, or both, and is controllable by software. GPIOs have no predefined purpose and are unused by default. If used, the purpose and behaviour of a GPIO is defined and implemented by the designer of higher assembly-level circuitry: the circuit board designer in the case of integrated circuit GPIOs, or system integrator in the case of board-level GPIOs. It's a standard interface used to connect microcontrollers to other electronic devices. For example, it can be used with sensors, diodes, displays, and System-on-Chip modules.

GPIO can be used in three modes:

• input

• output

• UART interface

GPIO input-This is the default setting, in which the linked device's GPIO is used by the beacon to accept input. You can picture a button that uses the beacon to broadcast its status (on/off). In this arrangement, the beacon will transmit the Estimote Telemetry packet containing the received data. The binary states of two GPIO pins are described here. To put it another way, the beacon will promote two 0/1 values.

GPIO output-When in output mode, beacon uses GPIO to provide data to the linked device. For instance, you could use a smartphone app to control a beacon to turn on or off an LED lamp. In this arrangement, the beacon will provide information to the linked device regarding the binary states of two pins.

UART

If you configure GPIO as an UART interface, you'll be able to define custom advertising packets for an Estimote Beacon. This feature will soon be enabled in the SDK.