

G. Pulla Reddy Engineering College (Autonomous): Kurnool
Department of Electrical & Electronics Engineering
M.Tech EEE – I Semester (Scheme: 2022)
MICROCONTROLLERS AND EMBEDDED SYSTEMS LABORATORY (MES (P))

I Semester : Automation and Robotics					Scheme : 2022			
Course Code	Category	Hours/Week			Credits	Maximum Marks		
EE856	Professional Core	L	T	P	C	Continuous Internal Assessment	End Exam	Total
		0	0	3				
					End Exam Duration: 3 Hrs			
Course Outcomes : At the end of the course the student will be able to								
CO1: Apply embedded C programming method for MSP 430 microcontroller using Code Composer Studio.								
CO2: Understand configuration of GPIO, serial ports, ADC and DAC for MSP430 microcontroller.								
CO3: Understand interfacing of sensors, actuators with ESP32, NodeMCU and Raspberry PI.								
List of Experiments								
Note : At least 8 of the following experiments shall be conducted								
1. Configure GPIO ports of MSP430 to drive a DC Motor.								
2. Configure GPIO ports of MSP430 to drive a stepper Motor.								
3. Configure GPIO ports of MSP430 to generate variable duty cycle PWM. (Without and with timer)								
4. On/Off control of DC Motor using temperature and humidity sensor and ESP32.								
5. Display the PIR sensor values on serial monitor using ESP32.								
6. On/Off control of DC Motor using IR sensor and NODEMCU. ultrasonic sensor								
7. Interface 16X2 LCD to NodeMCU and display the given input string.								
8. Display the PIR sensor values on serial monitor using NODEMCU.								
9. On/Off control of DC Motor using ultrasonic sensor and Raspberry pi.								
10. Object detection system by using a PIR sensor, buzzer and Raspberry PI.								

Prepared by:
 B.Amarnath Naidu
 Assistant Professor

Approved by:
 Dr. K. Sri Gowri
 HOD, EEE Dept

Page 1 of 1
 Revision No.:0

TITLE: Introduction to NodeMCU ,ESP32 ,Raspberry Pi and Sensors

GPREC/DEEE/EXPT-MES (P)-INTRODUCTION

Date: 08/08/2022

1.NODEMCU:

The NodeMCU development board has a total of 30 pins, which can be divided into two main categories: power and input/output (I/O) pins. Here is a brief description of each pin:

i.Power Pins:

- **VIN:** This pin is used to supply power to the board. It can accept voltages between 5V and 12V.
- **GND:** These pins are connected to ground and can be used to complete electrical circuits.

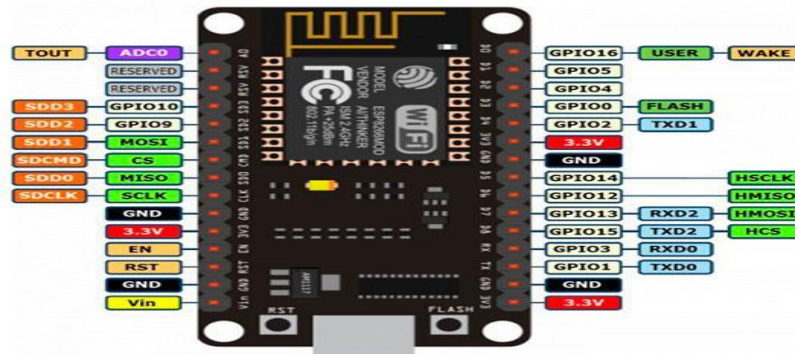
ii.Input/Output (I/O) Pins:

- **D0-D8:** These pins are digital I/O pins that can be used for both input and output. They are also capable of generating PWM signals.
- **A0:** This is an analog input pin that can be used to read analog signals from sensors.
- **TXD0 and RXD0:** These pins are used for serial communication.
- **SDA and SCL:** These pins are used for I2C communication.

TITLE: Introduction to NodeMCU ,ESP32 ,Rasberry Pi and Sensors

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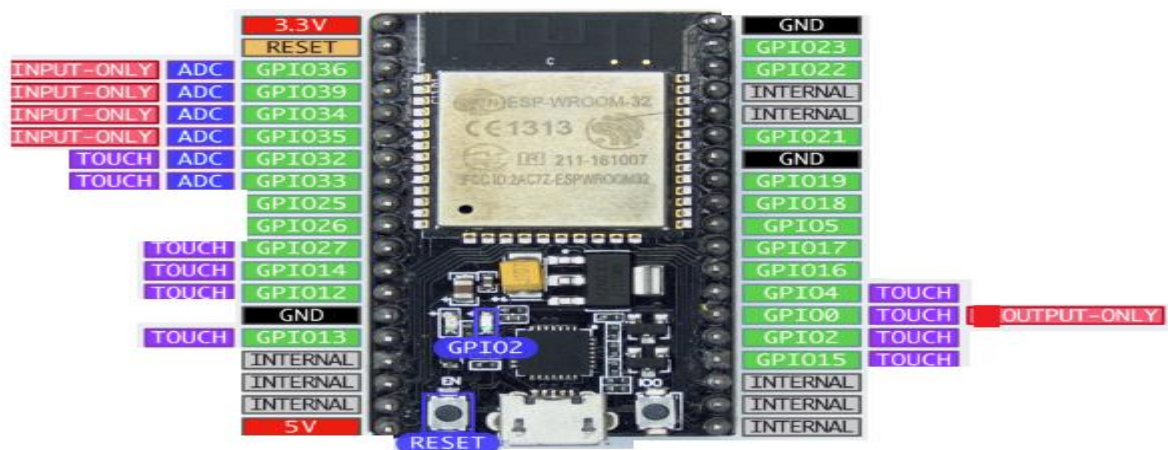
Date: 08/08/2022



NODEMCU

2.ESP32:

The NodeMCU ESP32 board (in some cases also known as ESP32-DevkitC) is fully supported by ESPHome. select ESP32 when the ESPHome wizard asks for type of platform and **nodemcu-32s** as the board type.



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Date: 08/08/2022

1. GPIO0 is used to determine the boot mode on startup. It should therefore not be pulled LOW on startup to avoid booting into flash mode. You can, however, still use this as an output pin.
2. GPIO34-GPIO39 can not be used as outputs (even though GPIO stands for “general purpose input output”).
3. GPIO32-GPIO39: These pins can be used with the Analog To Digital Sensor to measure voltages.
4. GPIO2: This pin is connected to the blue LED on the board as seen in the picture above. It also supports the touch pad binary sensor as do the other pins marked touch in the above image.
5. 5V is connected to the 5V rail from the USB bus and can be used to power the board. Note that the UART chip is directly connected to this rail and you therefore cannot supply other voltages into this pin.

3. RASBERRY PI:

The Raspberry Pi is a small, affordable, single-board computer that can be used for a wide range of projects. It has a number of pins that can be used to connect various sensors, modules, and peripherals to the board. Here is a brief overview of the Raspberry Pi pin descriptions:

1. **Power Pins:** The Raspberry Pi has two power pins: 5V and 3.3V. The 5V pin can be used to power external devices that require 5V, while the 3.3V pin can be used to power sensors and other low-power devices.
2. **Ground Pins:** There are a number of ground pins on the Raspberry Pi board. These pins are used to complete the circuit and provide a common reference point for all connected devices.

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Date: 08/08/2022



Alternate Function					Alternate Function
	3.3V PWR	1		2	5V PWR
I2C1 SDA	GPIO 2	3		4	5V PWR
I2C1 SCL	GPIO 3	5		6	GND
	GPIO 4	7		8	UART0 TX
	GND	9		10	UART0 RX
	GPIO 17	11		12	GPIO 18
	GPIO 27	13		14	GND
	GPIO 22	15		16	GPIO 23
	3.3V PWR	17		18	GPIO 24
SPI0 MOSI	GPIO 10	19		20	GND
SPI0 MISO	GPIO 9	21		22	GPIO 25
SPI0 SCLK	GPIO 11	23		24	GPIO 8
	GND	25		26	GPIO 7
	Reserved	27		28	Reserved
	GPIO 5	29		30	GND
	GPIO 6	31		32	GPIO 12
	GPIO 13	33		34	GND
SPI1 MISO	GPIO 19	35		36	GPIO 16
	GPIO 26	37		38	GPIO 20
	GND	39		40	GPIO 21
					SPI0 CS0
					SPI0 CS1
					SPI1 CS0
					SPI1 MOSI
					SPI1 SCLK

3. **GPIO Pins:** The GPIO (General Purpose Input/Output) pins are used to connect various sensors and modules to the Raspberry Pi. These pins can be configured as either input or output pins, depending on the needs of the project.
4. **UART Pins:** The Raspberry Pi has two UART (Universal Asynchronous Receiver/Transmitter) pins that can be used to communicate with other devices using the serial protocol.
5. **I2C Pins:** The I2C (Inter-Integrated Circuit) pins are used to connect sensors and other devices using the I2C protocol. The Raspberry Pi has two I2C pins: SDA (data) and SCL (clock).
6. **SPI Pins:** The SPI (Serial Peripheral Interface) pins are used to connect sensors and other devices using the SPI protocol. The Raspberry Pi has two SPI pins: MOSI (Master Out Slave In) and MISO (Master In Slave Out).

TITLE: Introduction to NodeMCU ,ESP32 ,Raspberry Pi and Sensors

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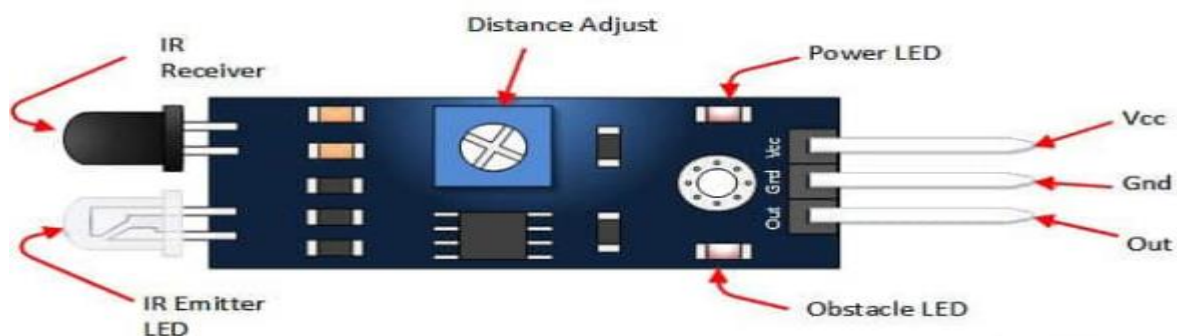
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7. **PWM Pins:** The PWM (Pulse Width Modulation) pins are used to control the brightness of LEDs and the speed of motors.
8. **Camera Connector:** The Raspberry Pi has a dedicated camera connector that can be used to connect a Raspberry Pi Camera Module.
9. **Display Connector:** The Raspberry Pi has a dedicated display connector that can be used to connect a Raspberry Pi Display Module.

4.IR SENSOR:

The pin configuration or pin description of an IR sensor may vary depending on the specific type and manufacturer of the sensor. However, here is a general pin description of an IR sensor:

1. **VCC or VDD:** This pin is used to supply power to the sensor. It is usually connected to a 5V DC power source.
2. **GND:** This pin is used to connect the sensor to the ground or negative terminal of the power source.
3. **OUT or SIGNAL:** This pin is the output pin of the sensor. It is used to send a signal to the microcontroller or other electronic devices based on the detection of infrared radiation. The signal can be either analog or digital, depending on the type of sensor.
4. **NC (Not Connected):** This pin is not used and remains unconnected.



TITLE: Introduction to NodeMCU ,ESP32 ,Rasberry Pi and Sensors

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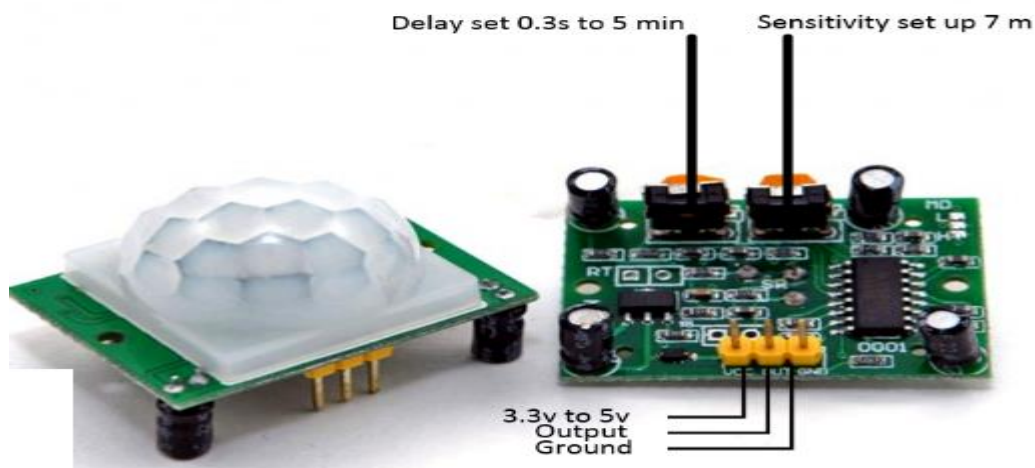
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5.PIR SENSOR:

A PIR (Passive Infrared) sensor typically has three pins:

1. VCC (or +): This pin is used to supply power to the sensor. It is usually connected to a 5V power source.
2. GND (or -): This pin is the ground or negative terminal of the sensor. It should be connected to the ground of the circuit.
3. OUT (or Signal): This pin is used to output the detection signal. When the sensor detects motion or changes in the infrared radiation in its field of view, it sends a signal to this pin. The signal can be either a digital signal (high or low) or an analog signal (varying voltage level), depending on the sensor's configuration.

It is important to check the datasheet of the specific PIR sensor you are using to ensure the correct pinout and proper usage.



6.Temperature and Humidity Sensor:

The DHT sensor is a popular type of digital temperature and humidity sensor used in various applications. The sensor usually has four pins:

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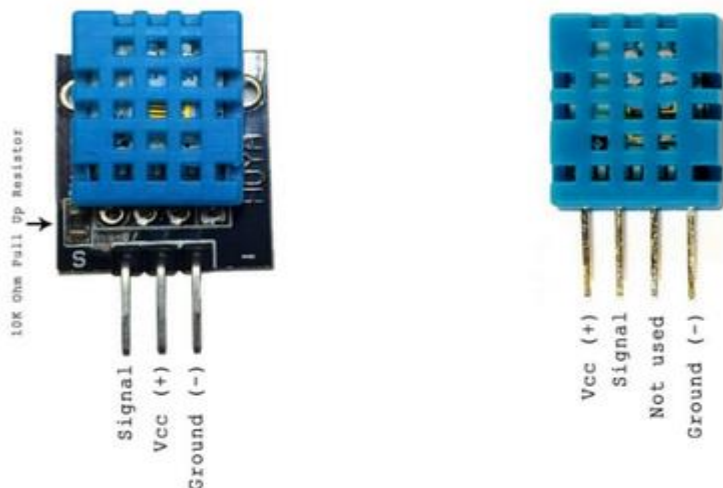
GPREC/DEEE/EXPT-MES (P)-INTRODUCTION

Date: 08/08/2022

1. VCC (or +): This pin is used to supply power to the sensor. It is usually connected to a 3.3V or 5V power source.
2. GND (or -): This pin is the ground or negative terminal of the sensor. It should be connected to the ground of the circuit.
3. DATA: This pin is used to transfer digital data from the sensor to the microcontroller. It is usually connected to a digital input/output (I/O) pin of the microcontroller.
4. NC (or Not Connected): This pin is not used and can be left unconnected.

The DHT sensor outputs digital data that includes the temperature and humidity values in a specific format. The data is transmitted through the data pin in a serial format that can be read by the microcontroller using a specific protocol.

It is important to note that different versions of the DHT sensor may have slightly different pinouts or communication protocols. Therefore, it is important to check the datasheet of the specific DHT sensor you are using to ensure the correct pinout and proper usage.



TITLE: Introduction to NodeMCU ,ESP32 ,Rasberry Pi and Sensors

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7.ULTRASONIC SENSOR:

An ultrasonic sensor is a device that can measure the distance to an object by emitting high-frequency sound waves and detecting the time it takes for the sound waves to bounce back. The sensor typically has four pins:

1. VCC (or +): This pin is used to supply power to the sensor. It is usually connected to a 5V power source.
2. GND (or -): This pin is the ground or negative terminal of the sensor. It should be connected to the ground of the circuit.
3. TRIG: This pin is used to trigger the ultrasonic pulse. When this pin receives a high signal, the sensor emits a pulse.
4. ECHO: This pin is used to receive the echo signal that is generated when the ultrasonic pulse bounces back from an object. The time it takes for the pulse to return can be used to calculate the distance to the object.

The TRIG and ECHO pins usually operate on 5V logic levels, so it is important to use appropriate level-shifting circuitry if connecting the sensor to a microcontroller that operates on lower voltage levels.

It is important to check the datasheet of the specific ultrasonic sensor you are using to ensure the correct pinout and proper usage.



TITLE: Introduction to NodeMCU ,ESP32 ,Rasberry Pi and Sensors

GPREC/DEEE/EXPT-MES (P)-INTRODUCTION

Date: 08/08/2022

8.ARDUINO IDE:

The Arduino IDE is an open-source software, which is used to write and upload code to the Arduino boards. The IDE application is suitable for different operating systems such as Windows, Mac OS X, and Linux. It supports the programming languages C and C++. Here, IDE stands for Integrated Development Environment.

The program or code written in the Arduino IDE is often called as sketching. We need to connect the Genuino and Arduino board with the IDE to upload the sketch written in the Arduino IDE software.

TITLE: Configure GPIO ports of MSP430 to drive a DC Motor

GPREC/DEEE/EXPT-MES (P)-1

Date: 08/08/2022

OBJECTIVE:

Configure GPIO ports of MSP430 to drive a DC Motor

APPARATUS:

1. MSP 430 launch pad.
2. L293D –DC motor interface board
3. USB Cable.
4. PC (Core i3, 4GB RAM, 500GB HDD).
5. IDE CSS V 6.0.0 software.

ALGORITHM:

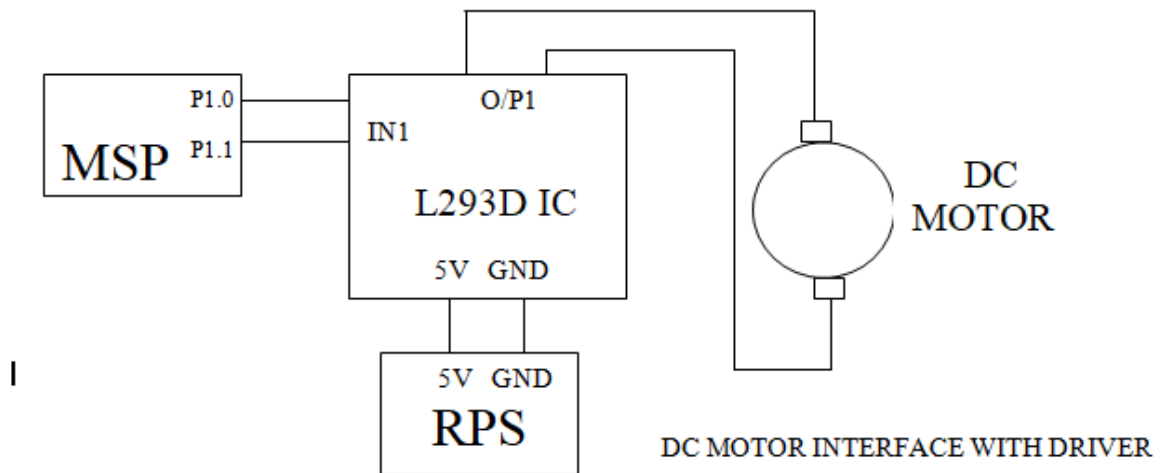
1. Open new project in CCS.
2. Configure MSP430g2553 board.
3. Initialize variable.
4. Stop watch dog timer.
5. Initialize ports for selective operation.
6. Use condition to drive DC motor – use PWM method
7. Compile the program.
8. Copy above program in to MSP430 and verify that DC motor interfacing is working properly and the motor is running.

TITLE: Configure the GPIO ports of MSP430 for driving a DC Motor in forward and reverse direction.

GPREC/DEEE/EXPT-MC (P)-1

Date: 08/08/2022

CONNECTION DIAGRAM:



RESULT:

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TITLE Configure GPIO ports of MSP430 to drive a stepper Motor.

GPREC/DEEE/EXPT-MES (P)-2

Date: 08/08/2022

OBJECTIVE:

Configure GPIO ports of MSP430 to drive a stepper Motor.

APPARATUS:

1. MSP 430 launch pad.
2. ULN2803 –Stepper motor interface board
3. USB Cable.
4. PC (Core i3, 4GB RAM, 500GB HDD).
5. IDE CSS V 6.0.0 software.

ALGORITHM:

1. Open new project in CCS.
2. Configure MSP430g2553 board.
3. Initialize variable.
4. Stop watch dog timer.
5. Initialize ports for selective operation.
6. Use condition to drive stepper motor
7. Compile the program.
8. Copy above program in to MSP430 and verify that stepper motor interfacing is Working properly and the motor is running.

TITLE: Configure GPIO ports of MSP430 to drive a stepper Motor.

GPREC/DEEE/EXPT-MES (P)-2

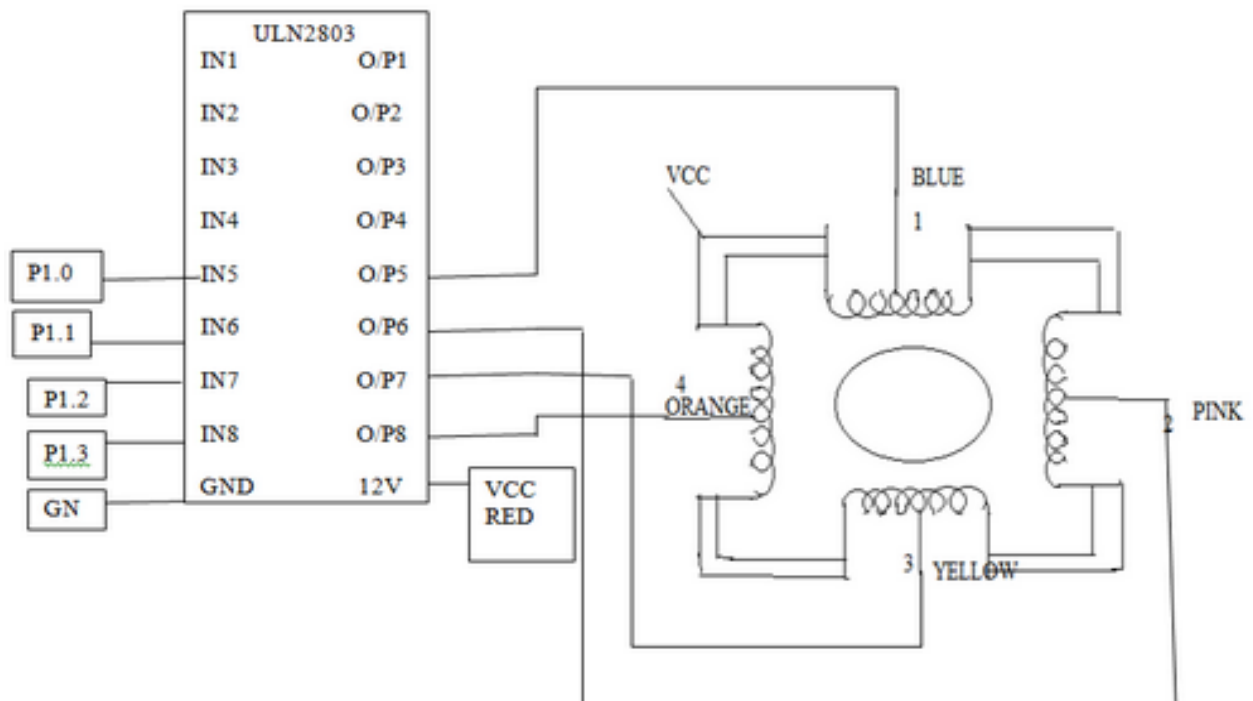
Date: 08/08 /2022

CIRCUIT DIAGRAM:-

Connections for the stepper motor (Using launch pad and interface board)

From msp430 pins (p1.0, p1.1, p1.2, p1.3) to ULN drive (IN5,IN6,IN7,IN8) and provide a 12V and GND connection to ULN drive. From the ULN drive connect motor1 terminals (OP5,OP6,OP7,OP8) to the connections of stepper motor with color sequence as OP5-BLUE, OP6-PINK, OP7-YELLOW, OP8-ORANGE, Common PIN-RED.

At the interface terminals (ULN2803) of the kit the following connections are to be made



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TITLE: Configure GPIO ports of MSP430 to generate variable duty cycle PWM. (Without and with timer)

GPREC/DEEE/EXPT-MES (P)-3

Date: 08/08/2022

OBJECTIVE:

Configure GPIO ports of MSP430 to generate variable duty cycle PWM. (Without and with timer)

APPARATUS:

1. MSP 430 launch pad
2. USB Cable.
3. PC (Core i3, 4GB RAM, 500GB HDD).
4. IDE CSS V 6.0.0 software.

ALGORITHM:

1. Open new project in CSS.
2. Configure MSP430G2553 board.
3. Initialize variable.
4. Stop watch dog timer.
5. Initialize ports for selective operation.
6. Use condition to generate PWM duty cycle (with timer use CCR and without timer).
7. Compile the program.
8. Copy above program in to MSP430 and verify the output at pin 1.0 in DSO.

RESULT:

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Page 1 of 1
Revision No.:0

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MICROCONTROLLERS AND EMBEDDED SYSTEMS LABORATORY (MES (P))

TITLE: On/Off control of DC Motor using temperature and humidity sensor and ESP32.

GPREC/DEEE/EXPT-MES (P)-4

Date: 08/08/2022

OBJECTIVE:

On/Off control of DC Motor using temperature and humidity sensor and ESP32.

APPARATUS:

1. ESP32
2. Temperature and Humidity Sensor.
3. DC motor
4. L293D

ALGORITHM:

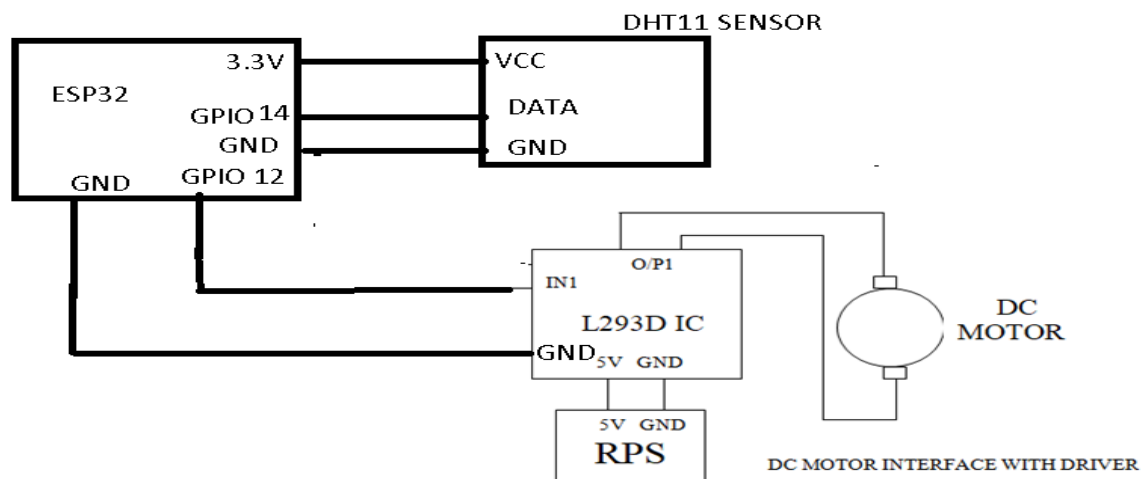
1. In the `setup()` function, we initialize the serial communication, the DHT sensor, and set the motor pin as an output pin.
2. In the `loop()` function,
 - a. read the temperature and humidity values from the DHT sensor, print them to the serial monitor, and then
 - b. use an **if** statement to turn on the motor if the temperature is higher than 25C or humidity is higher than 60%, and turn it off otherwise.
 - c. add a delay of 2 seconds to avoid rapid switching of the motor.

TITLE: On/Off control of DC Motor using temperature and humidity sensor and ESP32.

GPREC/DEEE/EXPT-MES (P)-4

Date: 08/08/2022

CIRCUIT DIAGRAM:-



RESULT:

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MICROCONTROLLERS AND EMBEDDED SYSTEMS LABORATORY (MES (P))

TITLE: Display the PIR sensor values on serial monitor using ESP32.

GPREC/DEEE/EXPT-MES (P)-5

Date: 08/08/2022

OBJECTIVE:

Display the PIR sensor values on serial monitor using ESP32.

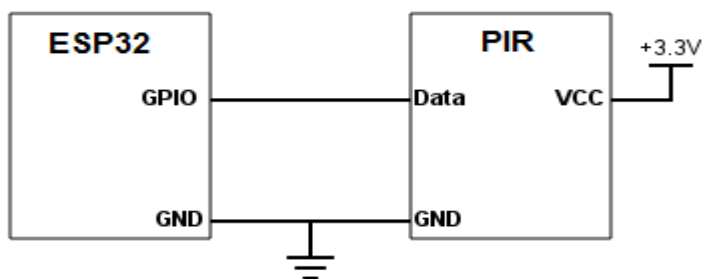
APPARATUS:

1. ESP32
2. PIR sensor
3. Jumper wires

ALGORITHM:

1. In the setup() function, we start serial communication at a baud rate of 9600 and configure the PIR sensor pin as an input.
2. In the loop() function, read the value from the PIR sensor using the digitalRead() function and store it in a variable called pirValue
3. Then print the value to the serial monitor using the **Serial.println()** function.
4. Add a short delay of 100 milliseconds using the **delay()** function to give some time for the PIR sensor to detect motion before repeating the process

CIRCUIT DIAGRAM:-



RESULT:

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Page 1 of 1
Revision No.:0

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MICROCONTROLLERS AND EMBEDDED SYSTEMS LABORATORY (MES (P))

TITLE: On/Off control of DC Motor using IR sensor and NODEMCU.

GPREC/DEEE/EXPT-MES (P)-6

Date: 08/08/2022

OBJECTIVE:

On/Off control of DC Motor using IR sensor and NODEMCU.

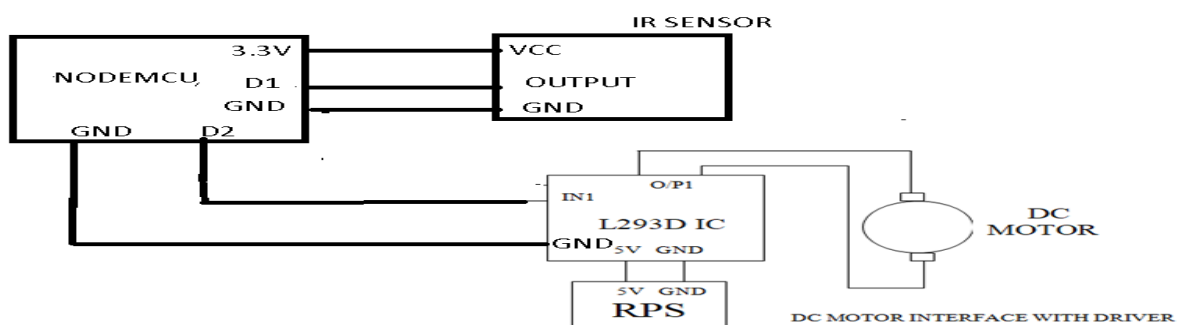
APPARATUS:

1. NODEMCU.
2. IR sensor
3. USB Cable.
4. DC MOTOR
5. L293D driver circuit

ALGORITHM:

1. Define the digital input and output pins for the IR sensor and DC motor, respectively
2. Define the threshold value for the IR sensor output.
3. Set the pinMode for the IR sensor and DC motor pins
4. In the loop() function, read the output of the IR sensor using digitalRead() and compare it to the threshold value

CONNECTION DIAGRAM:



RESULT:

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TITLE: Interface 16X2 LCD to NodeMCU and display the given input string.

GPREC/DEEE/EXPT-MES (P)- 7

Date: 08/08/2022

OBJECTIVE:

Interface 16X2 LCD with NodeMCU and display the given input string

APPARATUS:

1. NodeMCU .
2. 16X2 LCD.
3. JUMPER WIRES
4. I2C module

ALGORITHM:

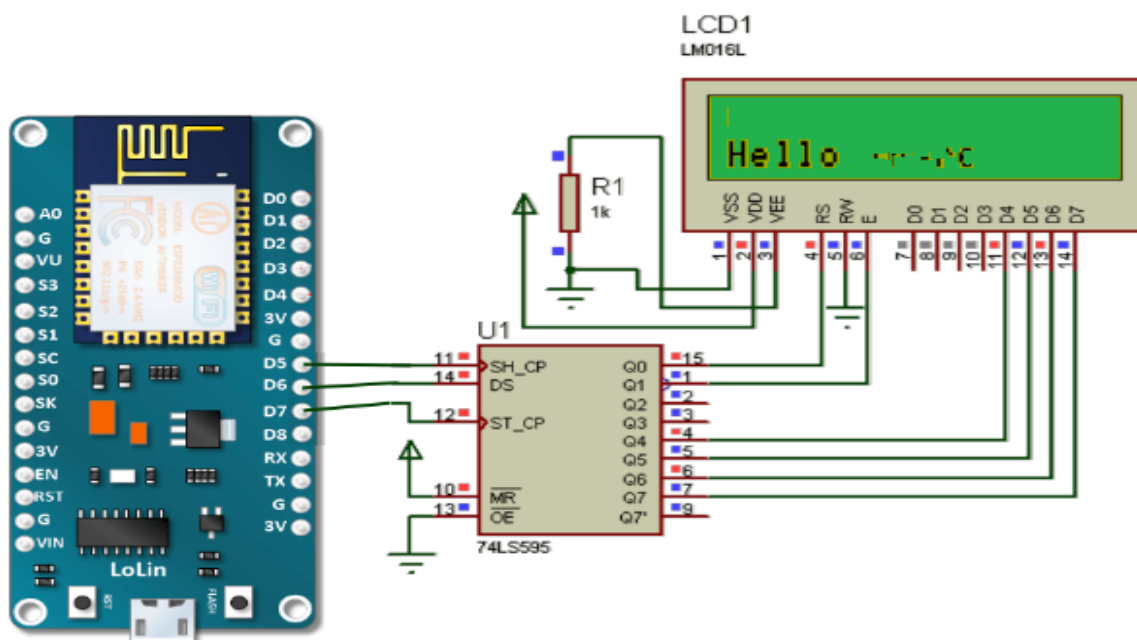
1. Include Liquid crystal display.
2. Creat liquid crystal object with the appropriate pin numbers.
3. Initialize the LCD in the setup()function.
4. In the loop() function, display the input string on the LCD using the print() function
- 5.A delay of 1 second is applied using delay function to repeat the process.

TITLE: Interface 16X2 LCD to NodeMCU and display the given input string.

GPREC/DEEE/EXPT-MES (P)- 7

Date: 08/08/2022

CIRCUIT DIAGRAM:-



RESULT:

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TITLE: . Display the PIR sensor values on serial monitor using NODEMCU

GPREC/DEEE/EXPT-MES (P)-8

Date: 08/08/2022

OBJECTIVE:

Display the PIR sensor values on serial monitor using NODEMCU

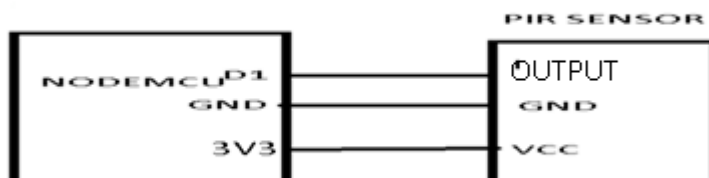
APPARATUS:

1. NodeMCU board
2. PIR sensor
3. Jumper wires

ALGORITHM:

1. Define the PIR pin.
2. Initialize the serial monitor.
3. Set the PIR pin as input.
4. Read the PIR sensor output .
5. Print the sensor output to the serial monitor.
6. Add a delay for 500 milliseconds .

CONNECTION DIAGRAM:



RESULT:

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Page 1 of 1
Revision No.:0

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TITLE: On/Off control of DC Motor using ultrasonic sensor and Rasberry pi.	Date: 08/08/2022
GPREC/DEEE/EXPT-MES (P)-9	

OBJECTIVE:

On/Off control of DC Motor using ultrasonic sensor and Rasberry pi.

APPARATUS:

1. Rasberry pi
2. DC motor
3. Ultrasonic sensor.

ALGORITHM:

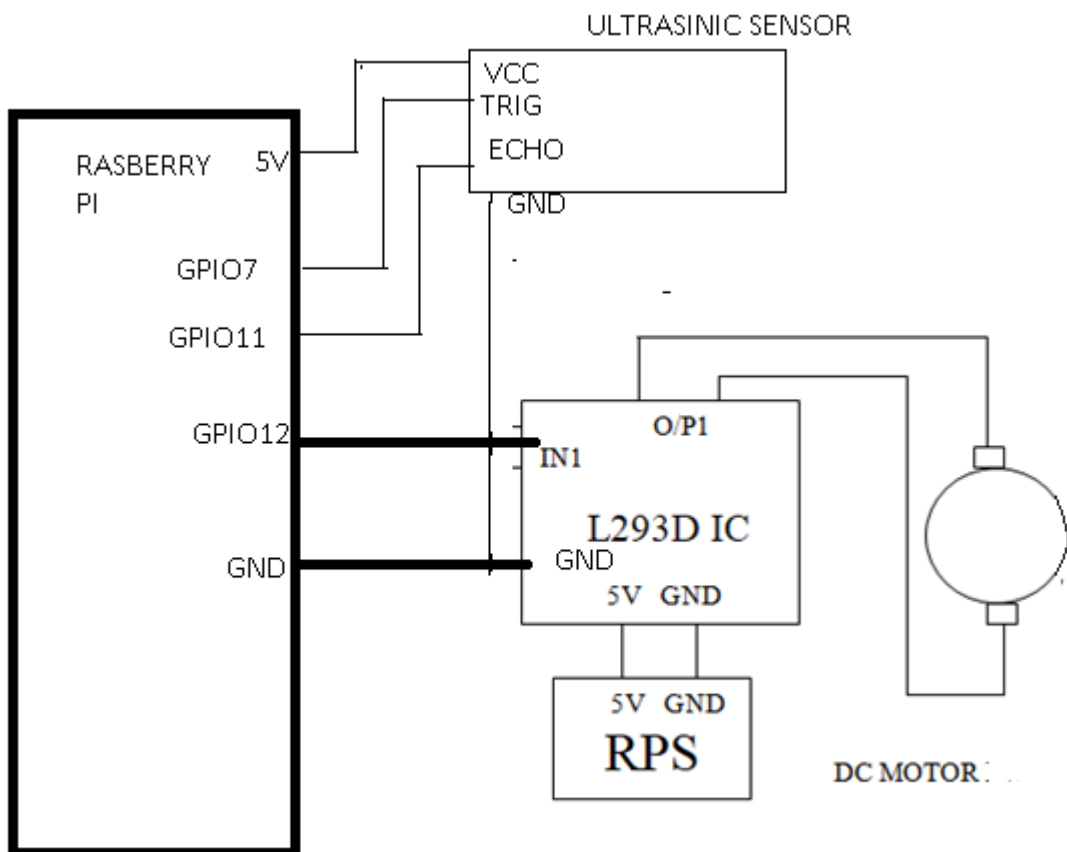
1. Connect the ultrasonic sensor and the DC motor to the Raspberry Pi according to their respective datasheets and the GPIO pins.
2. Set up the ultrasonic sensor to measure the distance between the sensor and the object in front of it.
3. Define a threshold distance, which is the distance between the ultrasonic sensor and the object at which you want the motor to turn on or off.
4. Write a program in your preferred programming language that will read the distance from the ultrasonic sensor and compare it to the threshold distance.
5. If the distance is greater than the threshold distance, turn the motor off.
6. If the distance is less than or equal to the threshold distance, turn the motor on.
7. Repeat the distance measurement and motor control loop continuously.

TITLE: On/Off control of DC Motor using ultrasonic sensor and Raspberry pi.

GPREC/DEEE/EXPT-MES (P)-9

Date: 08/08/2022

CONNECTION DIAGRAM:



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TITLE: Object detection system by using a PIR sensor, buzzer and Rasberry PI.

GPREC/DEEE/EXPT-MES (P)-10

Date: 08/08/2022

OBJECTIVE:

Object detection system by using a PIR sensor, buzzer and Rasberry PI.

APPARATUS:

APPARATUS:

1. Rasberry pi
2. Buzzer
3. PIR sensor.

ALGORITHM:

1. Connect the PIR sensor and the buzzer to the Raspberry Pi according to their respective datasheets and the GPIO pins.
2. Set up the PIR sensor to detect motion in its field of view.
3. Write a program in your preferred programming language that will read the signal from the PIR sensor and control the buzzer accordingly.
4. Define a threshold duration for which the buzzer will sound when motion is detected.
5. Set up a loop that will continuously read the PIR sensor's output and trigger the buzzer if motion is detected.
6. If motion is detected for a duration greater than the threshold, sound the buzzer.
7. Repeat the motion detection loop continuously.

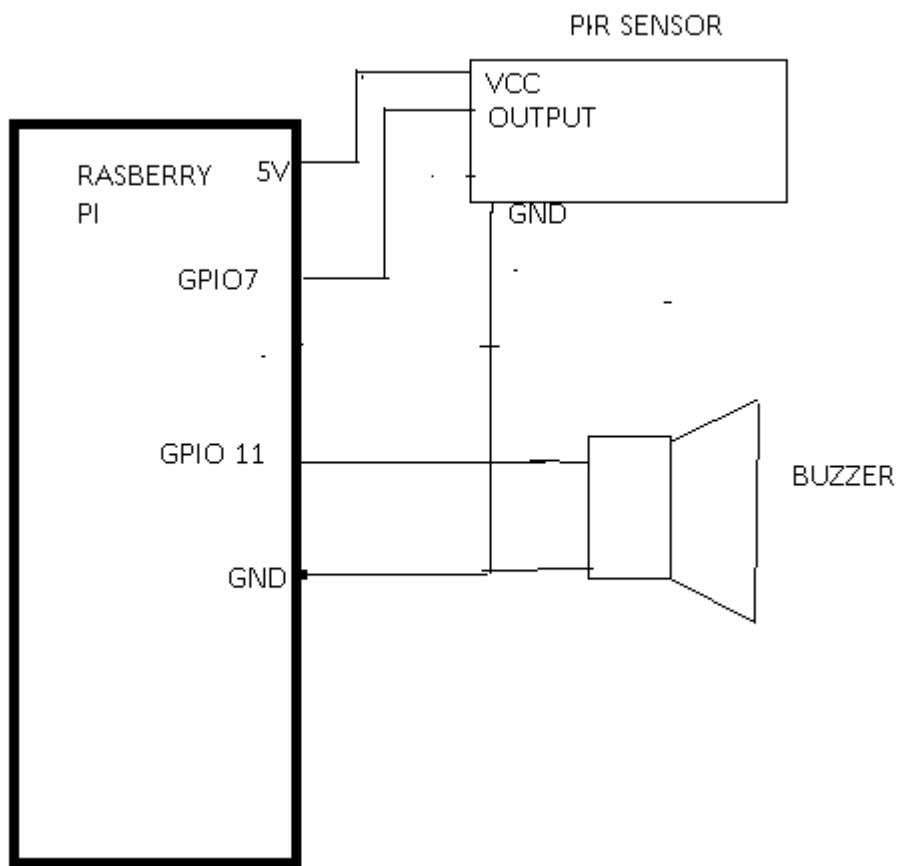
G. Pulla Reddy Engineering College (Autonomous): Kurnool
Department of Electrical & Electronics Engineering
M.Tech EEE – I Semester (Scheme: 2022)
MICROCONTROLLERS AND EMBEDDED SYSTEMS LABORATORY (MES (P))

TITLE: . Object detection system by using a PIR sensor, buzzer and Raspberry PI.

GPREC/DEEE/EXPT-MES (P)-10

Date: 08/08/2022

CIRCUIT DIAGRAM:-



RESULT: