Global Academy of Technology

Department Of Electronics and Communication Engineering

REPORT ON ARDUINO WORKSHOP

Name of the workshop: Arduino 2020

Venue: Global Academy of Technology

Dates: 21 January 2020 – 24 January 2020

Total Participants: 11

Duration: 4 Days

Organized by: Gokul Sai R (1GA17EC041).
Gowrav S (1GA17EC042).

Mentored by: Ramya K V

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Nikhil S
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ACKNOWLEDGEMENT

We **Gokul Sai R** and **Gowrav S** are thankful to **Mrs. Ramya K V** Madam to guide us in hosting this workshop and also help us to learn many things about teaching, class controlling during the workshop and also how to organise an event.

We the students of BE V semester, Department of E&C Engineering, would like to express our heartier gratitude to all, who have extended their valuable support and have been immensely helpful during the completion of our Project.

I would like to thank **Dr.H.S. MANJUNATH**, Head of the Department of E&C Engineering for the encouragement and support.

I would also like to thank **Dr. N. RANAPRATAP REDDY**, Principal, Global Academy of Technology and the management of Global Academy of Technology for providing us all the infrastructural facilities.

Last but not the least, I extend my gratitude to the non-teaching staff in giving technical support and facilitating a lab for conducting the workshop my fellow mates who have been of constant support directly or indirectly.

ABSTRACT

We the students of Global Academy of Technology conducted a workshop on Arduino UNO, following are the detailed planned programme on four days. Students of 3rd Sem ECE and 5th Sem MEC attended the programme very enthusiastically and their thirst towards knowledge increased day by day.

CONTENT

INTRODUCTION

- Arduino is an open-source prototyping platform used for building electronics projects. It consists of both a physical PCB (programmable circuit board) and a software, or IDE (Integrated Development Environment) that runs on your computer, where you can write and upload the computer code to the physical board.
- Arduino was born at the Ivrea Interaction Design Institute as an easy tool for fast prototyping. Initially, it was aimed at students without a background in electronics and programming, but now, it is considered to be a great tool for people of all skill levels. The Arduino hardware and software was designed for artists, designers, hobbyists, hackers, newbies, and anyone interested in creating interactive objects or environments.
- The Arduino board started adapting to the new needs and challenges, differentiating it from simple 8-bit boards to products for IoT applications, wearable, 3D printing, and embedded environments. Arduino can interact with buttons, LEDs, motors, speakers, GPS units, cameras, the internet, and even your smart-phone or your TV.

OBJECTIVES

Our prime objective was to share our knowledge to our fellow juniors and Arduino enthusiasts, as this platform creates a sack full of opportunities to the ones learning and understanding the concepts of Arduino Uno.

This platform makes Engineers to prototype any idea into a smaller working model of the project making them understand the flaws and also on how to improvise on their product creating a level of confidence on their idea

Making them learn about Arduino would bring them close to learn embedded C programming, which is now a booming subject in the fourth coming future, this also gives a head start to Machine learning and artificial intelligence

We also wanted to remove their fear towards coding and make it being user friendly and purportedly help in the problems that they are facing while coding and also making them understand that hardware components and software (programming) goes hand in hand making them appreciate the usage of the components to a certain application to where it is been used in our day to day lives and how to prototype these into simpler projects using Arduino and also making them in pace with the advancement in the technology.

OUR BENEFITS TO CONDUCTING THE WORKSHOP

Conducting a workshop gives us a platform to enhance our leadership qualities and our ability to plan and organise an event

This has also improved our communication skills and our ability to understand what and where the errors could occur and how to rectify it in a convincing manner

Since we conducted workshop on Arduino we were able to perfect to what we have learnt and also new ideas were given out by the students and so there was efficient interaction with them

WORKSHOP DAY ONE:

The first day of the workshop was mostly towards the theoretical part of Arduino its development towards the community and the benefits of this open-source platform

Why did we choose Arduino?

- It can be programmed with C++ language.
- Arduino Uno uses a different USB chip which makes installation of the Arduino software lot easier.
- Has higher speeds of communication with the computer.
- Comes equipped with the ATmega328 Microcontroller, which has more memory.
- The processor can be easily replaced if damaged.
- Can supply more current on its 3.3V supply.
- Arduino is open-source electronics prototyping platform.
- It is flexible, easy-to-use hardware and software.
- Kids can use this to make interactive objects quickly and easily for their school projects.
- It will enhance their thinking and analytic skill set.
- Libraries to do Everything
- Low Cost

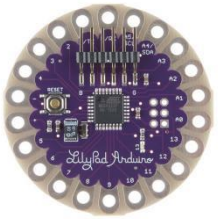
Arduino board is an interface to a microcontroller **ATmega328**

Types of Arduino Boards:

Arduino UNO

Arduino LEONARDO

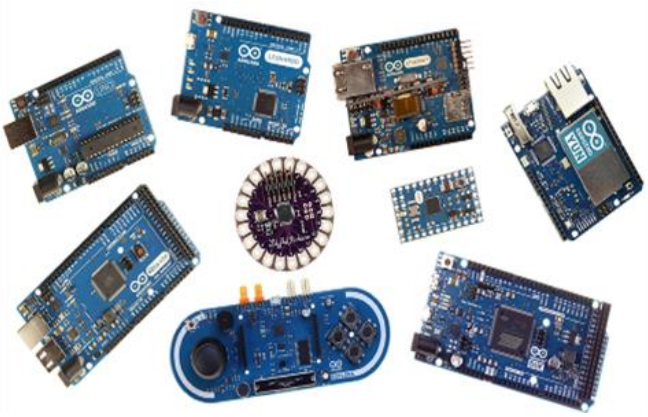
Arduino NANO



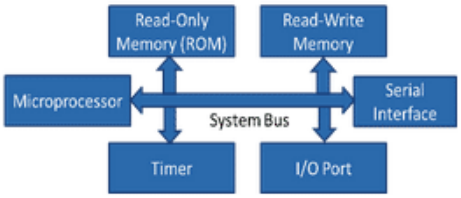
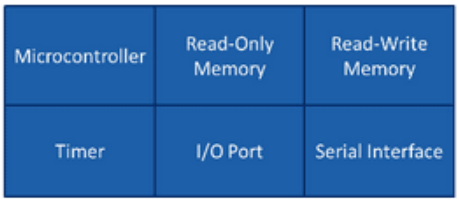
Arduino LILY

Arduino MEGA

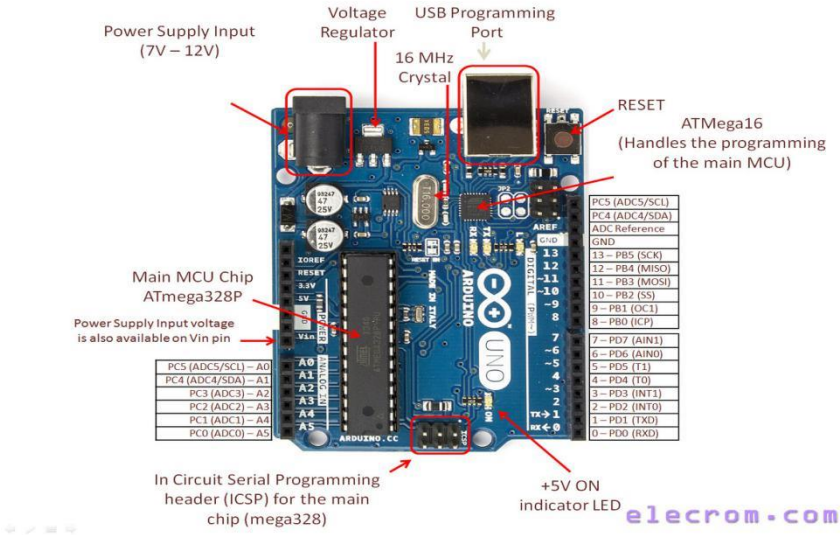
Other Boards:



Difference between a microprocessor and a microcontroller

Microprocessor	Micro Controller
	
Microprocessor is heart of Computer system.	Micro Controller is a heart of embedded system.
It is just a processor. Memory and I/O components have to be connected externally	Micro controller has external processor along with internal memory and i/O components
Since memory and I/O has to be connected externally, the circuit becomes large.	Since memory and I/O are present internally, the circuit is small.
Cannot be used in compact systems and hence inefficient	Can be used in compact systems and hence it is an efficient technique
Cost of the entire system increases	Cost of the entire system is low
Due to external components, the entire power consumption is high. Hence it is not suitable to used with devices running on stored power like batteries.	Since external components are low, total power consumption is less and can be used with devices running on stored power like batteries.
Most of the microprocessors do not have power saving features.	Most of the micro controllers have power saving modes like idle mode and power saving mode. This helps to reduce power consumption even further.
Since memory and I/O components are all external, each instruction will need external operation, hence it is relatively slower.	Since components are internal, most of the operations are internal instruction, hence speed is fast.
Microprocessor have less number of registers, hence more operations are memory based.	Micro controller have more number of registers, hence the programs are easier to write.
Microprocessors are based on von Neumann model/architecture where program and data are stored in same memory module	Micro controllers are based on Harvard architecture where program memory and Data memory are separate
Mainly used in personal computers	Used mainly in washing machine, MP3 players

Identifying the components on Arduino UNO:



Voltage regulator: regulates the voltage to 5 V from 9V-12V supply

16Mhz crystal: generates clock pulse at a frequency of 16Mhz

USB programming port:USB meaning universal-serial-bus, there is an on board chip which converts USB logic to TTL logic (5V logic) as the microcontroller communicates and only understands TTL logic, this is to load the programs to the microcontroller or to read the data from the microcontroller, the data is transmitted serially one byte of data at each rising edge of the clock

Reset Button:this button is internally connected to the reset of the MCU which resets the operation from the initial stage

Atmega 328p Microcontroller: this is the MCU used on Arduino to perform operations onto the interfaced devices or setting up of commands to follow certain operation

Input And Output Ports:there are three types of ports they are:

1}analog pins
2}digital pins
3}PWM(Pulse Width Modulation) pins

Analog pins: these pins can be programmed as only inputs and can read a range of values from the interfaced

Sensors, transducers etc. There are 6 analog pins on each of which on board ADC(**A**nalog to **D**igital **C**onvertor)

ADC: converts analog voltage value with reference voltage of 5V by default to an equivalent decimal value

0-5V in analog is converted to 0-1023 in digital.

With 10-bit resolution is embedded so the range is 0-1023 in decimal

Pins {A0,A1,A2,A3,A4,A5}

Digital pins: these pins are Boolean logic pins they can be programmed as Input or an output a logic HIGH(5V) or a

Logic LOW(0V) these pins are used to enable or disable a module or to interface a push button to the

Arduino

Pins {0,1,2,4,6,7,8,12,13}

PWM pins: these pins are special purpose pins which can be programmed like digital pins as Boolean input/output

Pins and also write analog values to interfaced servo motor,steppar motor,actuators etc,there are 5 PWM

Pins on each of which on board DAC(**D**igital to **A**nalog **C**onvertor)

DAC: converts decimal value with reference voltage of 5V by default to an equivalent analog voltage value

0-255 in digital is converted to 0-5V in analog

With 8 –bit resolution is embedded so the rang is 0-255 in decimal.

Pins {3,5,9,10,11}

PWM working principle:

Analog value=(Duty cycle) x (reference voltage) in Volts.

Digital value=(Duty cycle) x (decimal range maximum of DAC) in decimal.

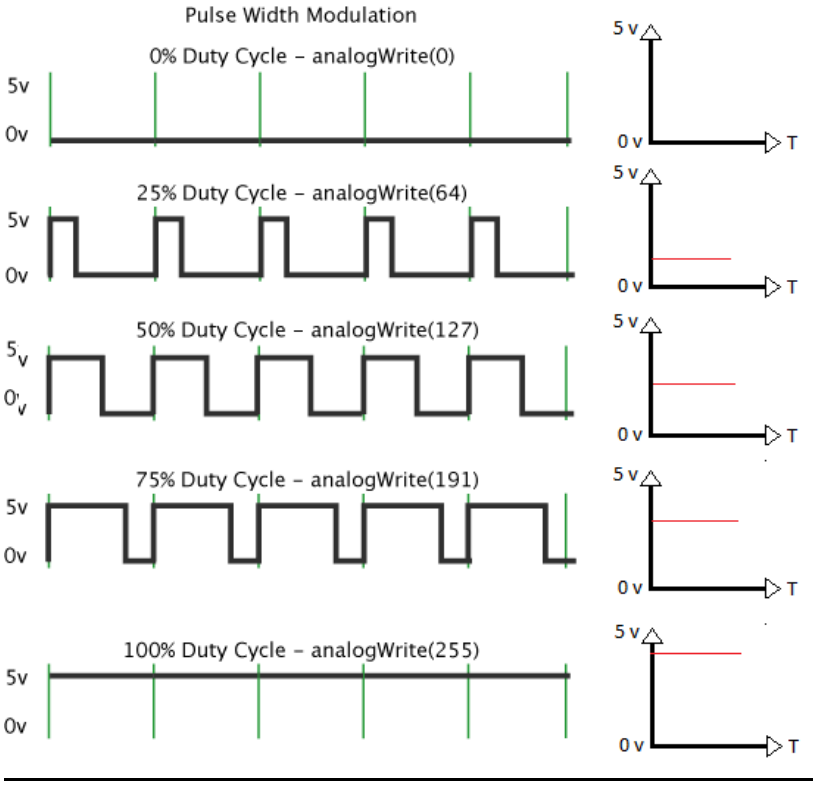
If a signal of 50% duty cycle has to be generated DAC reference being 5V by default

Analog value=(Duty cycle) x (reference voltage) in Volts

= 50% x 5V= 2.5Volts

Digital value=(Duty cycle) x (decimal range maximum of DAC) in decimal

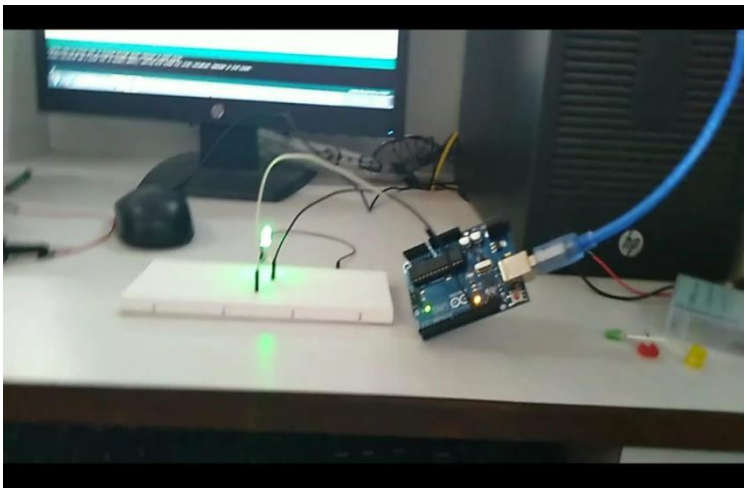
=50% x 255= 128.



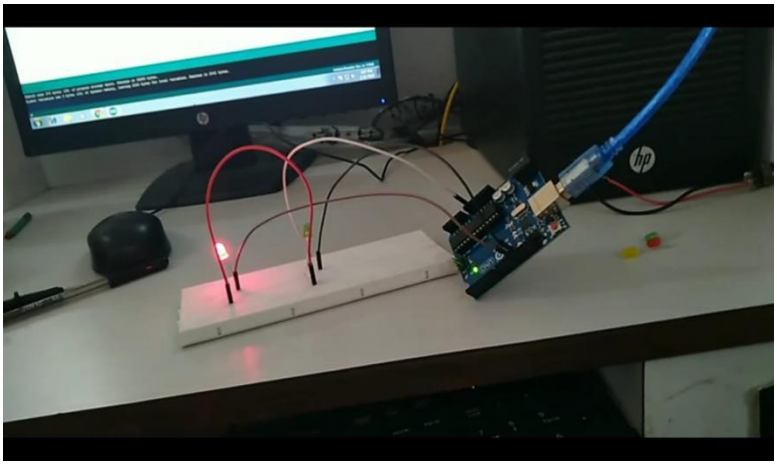
the above image gives a visual understanding of the PWM pins.

An introduction to Arduino IDE and explanation to the basic outline of the code:

the next session was started with a simple code on blinking an LED ON and OFF with a desired value of delay



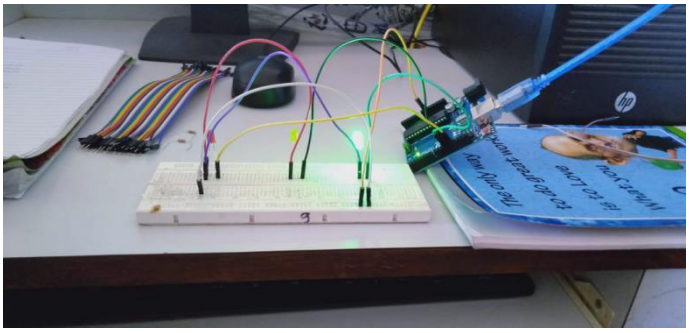
We gave a task of blinking two led with their state of led being compliment to each other, from this they will learn the code flow and how the instructions on the IDE typed would be executed and also understand the usage of digitalRead, digitalWrite instructions.



After which a task was given to the students to work it out in home and report it on the second day

TASK-1

Prototype a one-way traffic with Red light on for 5 seconds next with yellow light on for 2 seconds and then green light on for 7 seconds which repeats in the loop



Course Outcome:

Internal working of arduino uno,features of arduino and the effective usage of the input output ports.

WORKSHOP DAY TWO

The next day a brief discussion on yesterday's task was done, the students were able to analyse the syntactical errors that they have made and they were able to appreciate the code created by them and understand the flow of data,

They also understood how to manipulate the delay function and the usage of digitalWrite and were able to implement the concepts learnt into their code.

We did a brush up on the C- programming explaining about the conditional and looping statements also about
Function handling

Conditional statements:

1} if else conditional statement :

```
If (expression )
  {
      Statement.1;
      Statement.2;
   .
   .
   .
      Statement.n;
   }
else
  {
      Statement.1;
      Statement.2;
   .
   .
   .
      Statement.n;
   }
```

2} else-if-ladder conditional statements:

```
If (expression1 )
        {
            Statement.1;
            Statement.2;
         .
         .
         .
            Statement.n;
          }
else if (expression2 )
        {
            Statement.1;
            Statement.2;
         .
         .
         .
            Statement.n;
          }
else if (expression 3)
        {
            Statement.1;
            Statement.2;
         .
         .
         .
            Statement.n;
          }
.
.
.
else
        {
            Statement.1;
            Statement.2;
         .
         .
```

```
        .
            Statement.n;
        }
```

3} Switch case conditional statement:

```
 switch(variable_input)
{
case var_i/p1:statement1;
                statement2;
break;
case var_i/p1:statement3;
                statement4;
break;
case var_i/p1:statement5;
                statement6;
break;
.
.
.
default:statement_n;
}
```

LOOPING STATEMENTS:

1} while loop :

```
    while(expression)
        {
            Statement.1;
            Statement.2;
            .
            .
            .
            Statement.n;
                }
```

2} do-while loop:

```
        do  {
```

```
    Statement.1;
    Statement.2;
  .
  .
  .
    Statement.n;
}while(expression)
```

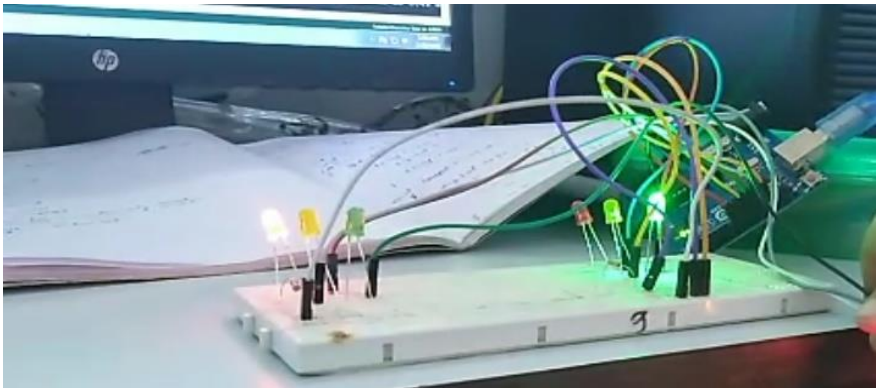
3} for loop:

```
for(initialization ;condition ;increment/decrement)
    {
        Statement.1;
        Statement.2;
      .
      .
      .
        Statement.n;
    }
```

TASK-2

A task was given for students such that they had to prototype a 2-way traffic system

from this task the students will be able to control 6 different LEDs and they were able to efficiently handle **delay** function and **digitalWrite** function effectively.



TASK-3

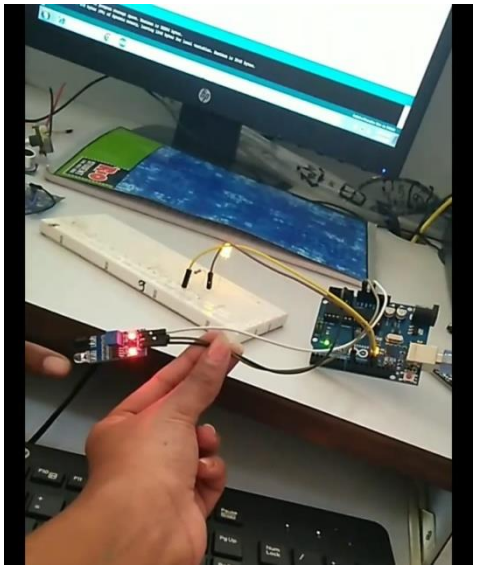
2-way traffic using if else conditional statements, from this concept they were able to fill the void between C-programming and arduino programming.

Introduction to sensors:

A **Sensor** is a device that detects and responds to some type of input from the physical environment. The specific input could be light, heat, motion, moisture, pressure, or any one of a great number of other environmental phenomena.

We taught them usage of datasheet and how to extract the required data from the datasheet.
We explained about 4 different types of sensors.

1. I-R (InfraRed) sensor.
   This sensor outputs a logic low when an obstacle is detected, a program was demonstrated wherein the program control was done through arduino, the LED would turn on when an obstacle is placed in front of sensor.



2. UltraSonic distance sensor:
   In this sensor a measure of distance can be calculated depending on how far the obstacle is placed for which the distance is measured based on the time taken for the reflected ultrasonic wave which is emitted by generating pulse signal in trigger pin and receiving in eco pin using pulseIn function until which the time elapsed will be calculated
   We know,

$$\text{Velocity} = \frac{\text{displacement}}{\text{time}}$$

   we know the velocity of sound is 342 m/sec.

arduino has a built in function to check the time elapsed called the millis() function which returns the time

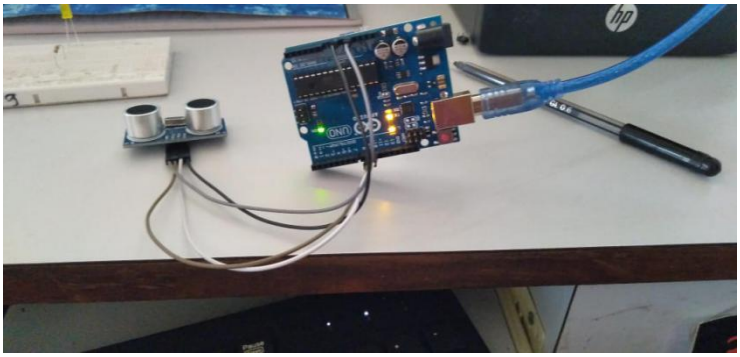
ellapsed in milli-seconds

so the velocity of sound should be converted to cm/sec

hence,velocity of sound=0.0342 cm/sec

Displacement =velocity * time

= 0.0342 * time elapsed.



At the end of the day a task was given out to them to work in their house

TASK-4

Prototype a traffic light intruder detector and halt the signal making all the signal go Red

Course Outcome:

Usage of C-programming basics to Arduino platform and usage of intruder detection sensors like ultrasonic sensor and an IR-sensor and its application in our day to day life.

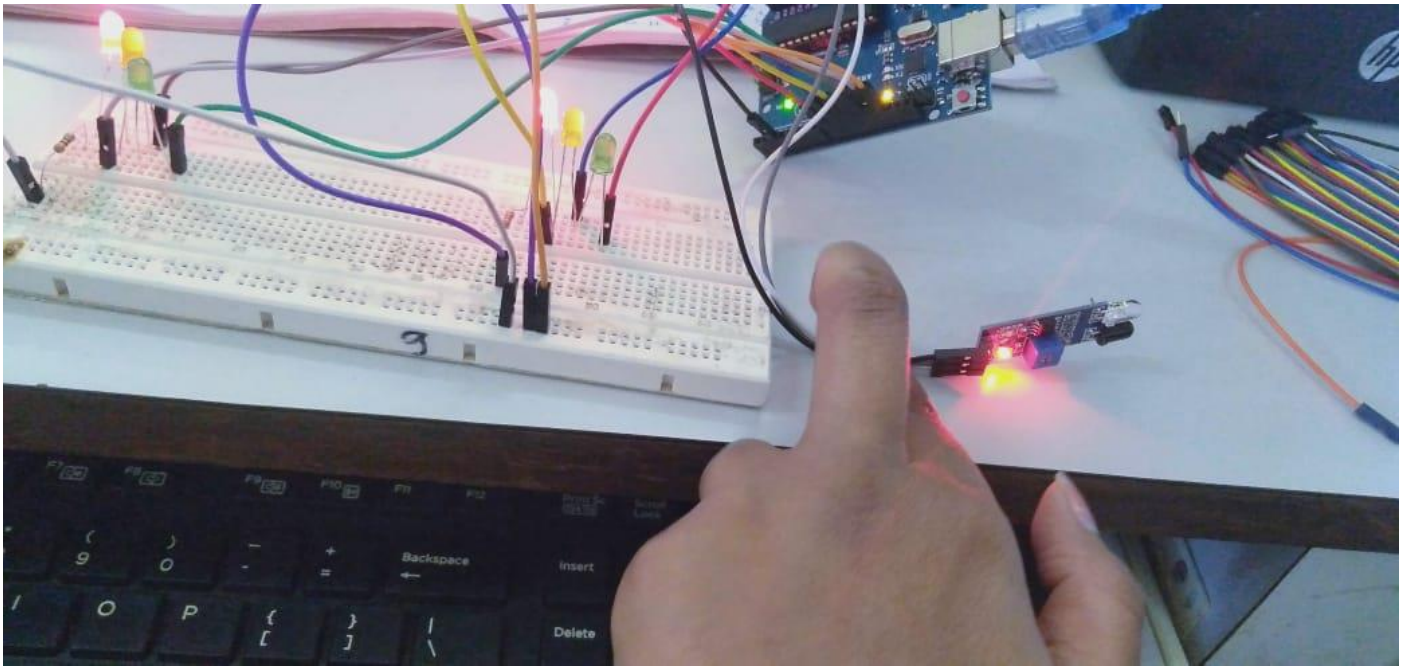
WORKSHOP DAY THREE

The next day a brief discussion was done on the task given to the students,they were able to apply the logic essentially but the module was not giving the desired output,they used the concept of functions dividing the whole processes into two different subroutines one For normal working of the traffic light and the other for what operation to do when there is an intruder

From this error they were able to analyze how the program is processed and how the instructions are read by arduino

To overcome this error **Interrupt** concept was introduced
We taught them how to manipulate the ISR (Interrupt Service Routine) and usage of the built in interrupt pins INT0 and INT1 which are pin number 2 and on the uno board, from this concept the traffic light goes to hault condition when there is an interrupt and serves the interrupted operation.

A function AttachToInterruptPin(*pin_no,function_name,at_what_state*)
From this concept we created a link between what they will study about interrupts in Microcontroller (VTU curriculum subject) towards its practical approach.

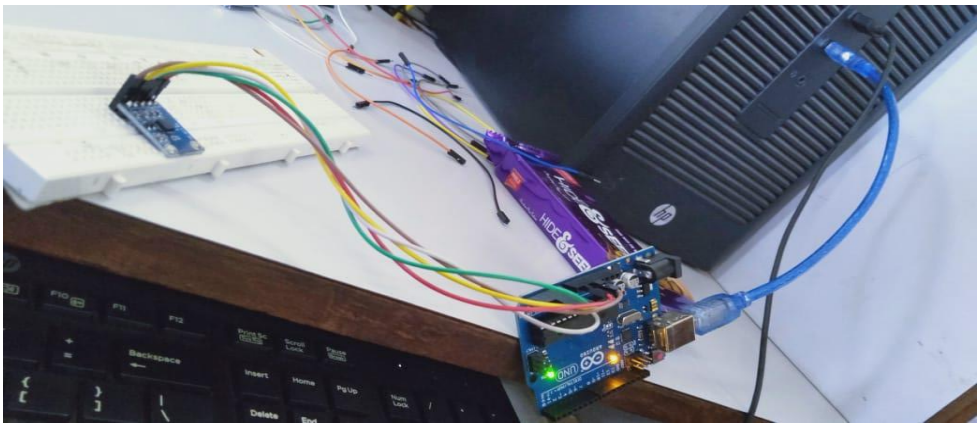


The next we continued with sensors

3) Accelerometer:

An **accelerometer** is an electromechanical device used to measure acceleration forces. Such forces may be static, like the continuous force of gravity or, as is the case with many mobile devices, dynamic to sense movement or vibrations.

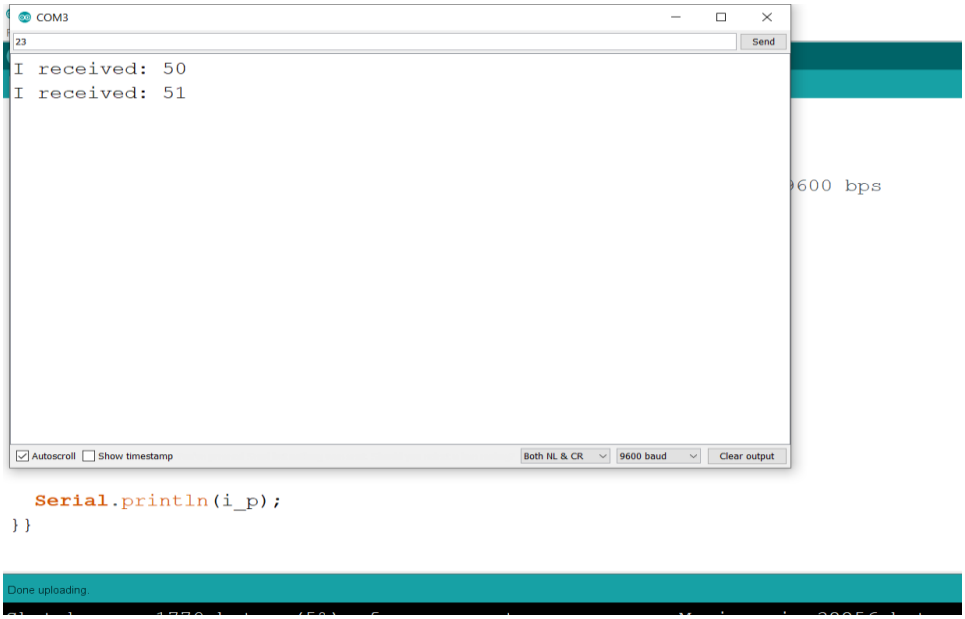
From which we made them understand the usage of accelerometer as a motion sensor and so
we gave them a head start to them in creating a motion sensor car or a balancing robot to their project arsenel in the future.



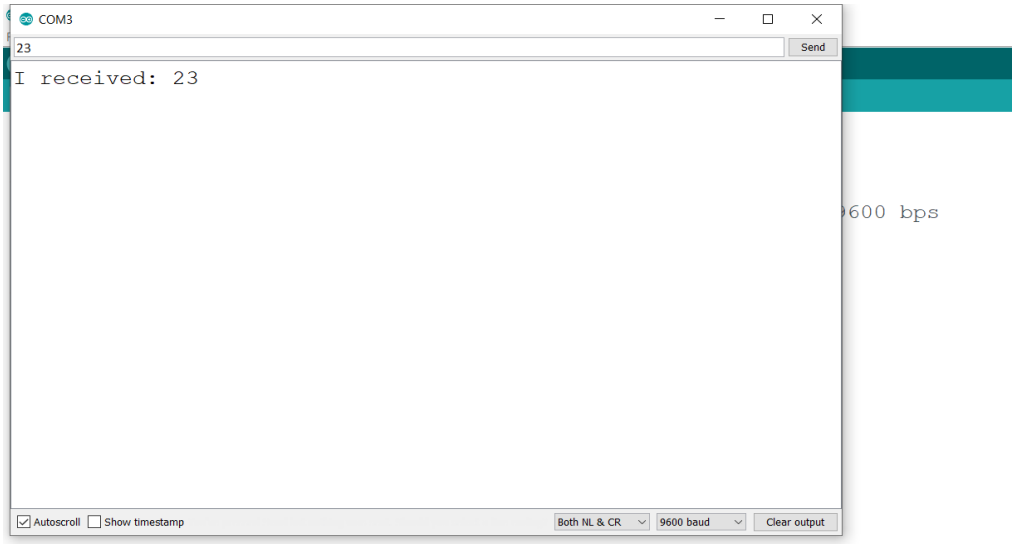
4) DHT 11 Temperature Humidity Sensor:

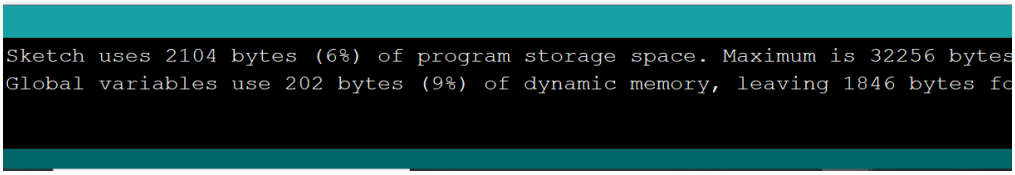
This sensor is used to measure the temperature and humidity of the environment Which will be displayed on the serial monitor, for this a standard code from Adafruit library was used to demonstrate the working of the sensor.

The next what was taught is about the serial monitor,which is used to check the operation of the modules connected to the UNO board.
They were taught how to read data from the keyboard and use this to do required operation on this data,
A function called Serial.read(); is used to read the data from the keyboard, but the problem was any data read from the keyboard were read as characters and the output displayed being its individual characters with its ASCII equivalent values,so instead of Serial.read() function a function called Serial.ParseInt() was used this function has the capacity to revert the integer values back to user typed integer form.
To read a string or a character Serial.readString() function was demonstrated.



above image is of the serial monitor when Serial.read() is used,it can be observed that ASCII equivalent of each digit is displayed





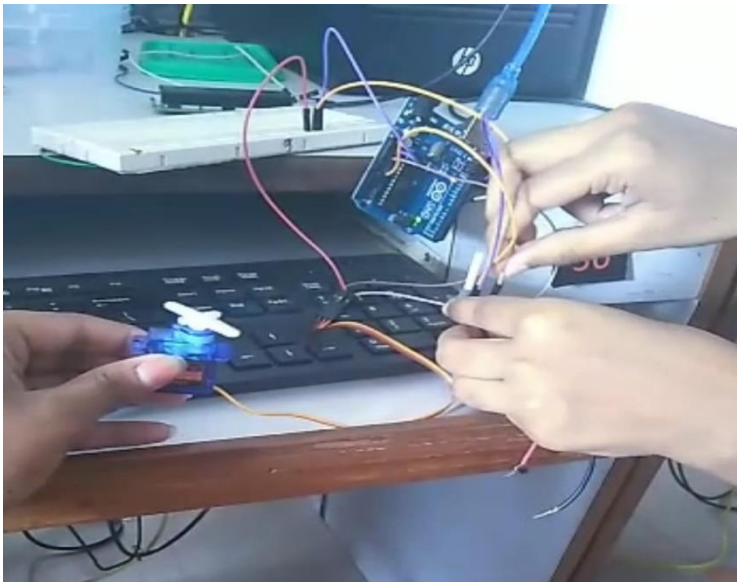
This is when parseInt() function is used,the integer which is taken as input is displayed onto the serial monitor

Servo motors and steppar motors

A **servo motor** is an electrical device which can push or rotate an object with great precision,with its range varying from 0^0-180^0.

A **steppar motor** is an electrical device which can push or rotate an object with great precision,with its range varying from 0^0-360^0.

We also emphasized on the difference between them and the limitations of both and its application
Since servo motor is cost friendly compared to steppar motor,for this workshop servo motor was used
A program was demonstrated on how to change the degree of rotation of the servo using for loop and also controlling servo using potentiometer.



At the end of the day we gave them two tasks

TASK-5
Enter the angle in serial monitor to rotate the servo to that particular angle.

TASK-6
Automatic Door opener- when there is some obstacle the servo gate should turn 90 degree or open, else remain closed

Course Outcome:
Usage of motion sensor and a temperature humidity sensor,how serial data can be taken as an input from the user and how to use a servo motor.

WORKSHOP DAY FOUR

LCD (Liquid Crystal Display)

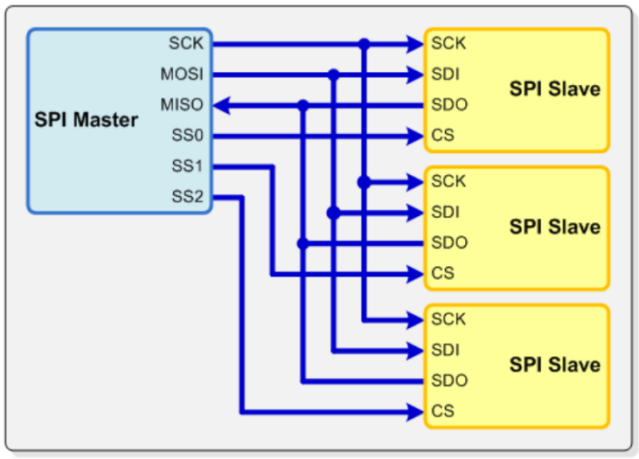
The final day of the workshop we started with LCD (**L**iquid **C**rystal **D**isplay).we explained its internal set up
Along with a code to display “Hello World ” on the display screen,we made them understand how LCD in having
2x16 as in 2 rows and 16 columns each element could display one character and each element is a matrix of 5x3
Liquid crystals which are exited when a supply is given to it.

And gave them a task

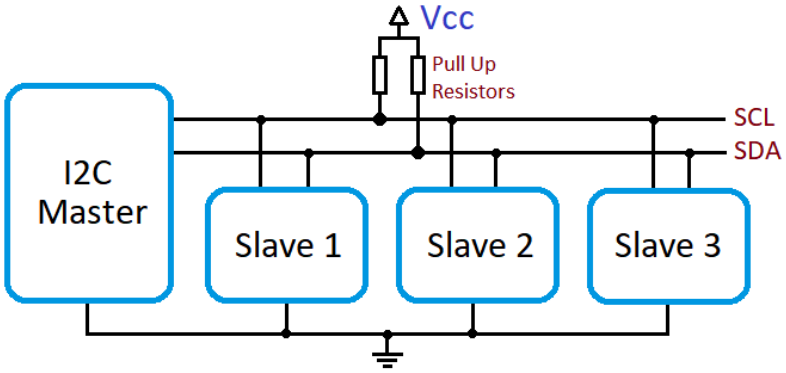
TASK-7
Display the distance values calculated by the Ultrasonic distance sensor on to the LCD display

Protocols that are supported by Arduino

1) I2C (**I**nter **I**ntegrated **C**ircuits) protocol
2) SPI (Serial Pheripheral Interface) protocol
Since SPI is easier to understand we decided to teach I2C as it requires more of understanding the concept



Visualization of SPI protocol



Visualization of I2C protocol

We emphasized on how I2C protocol is an important aspect to know while being an electronics engineer.
I2C protocol was first developed by a company named **PHILIPS**,this protocol played a major role in manufacture of many automated electronic products like TV,washing machine,microwave oven etc even till now.
We demonstrated a arduino code to show the same and learn and understand the concepts behind I2C and apply the same while coding. This protocol becomes necessary when there are more number of sensors or more number of modules that are to be interfaced to overcome this I2C protocol is employed.

Bluetooth :

At the end of the workshop we taught them how to wirelessly transmit or receive data using two Bluetooth modules,
The two Bluetooth modules must be configured in Master-Slave configuration by making the module enter into AT mode (**AT**tension mode) there are a set of AT commands which we taught them along with what operation it does.

AT-to check whether it is working or not
AT+ROLE?-to check whether the Bluetooth is in slave or master mode
AT+ADDR?-To get the address of the Bluetooth module
AT+CMODE=0-to fixate the Bluetooth module connection to one address
AT+BIND=.....-for the master to connect to the slave when it is inputted with the slave address

After pairing the two Bluetooth modules we demonstrated how to to transmit data from one module to the other wirelessly

We gave them a task based on this

TASK-8

Control the motion of a servo motor wirelessly using a variable potentiometer

At the end of the day we gave them another task to work at home

TASK-9

Display the ultrasonic sensor data wirelessly onto an LCD

Course Outcome:

The use of LCD in displaying data,understanding the concepts behind I2C protocol and how to make a working project wireless.

Citation

www.jeremyblum.com introduction regarding the UNO board,usage of basic built in functions covered in the first two days of the workshop

www.arduino.cc -Serial monitor related concepts were directly taken from their official website

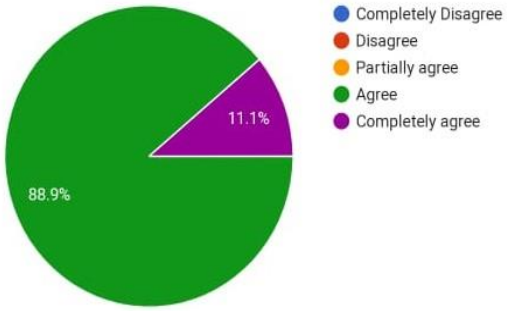
www.dronebotworkshop.com -he concepts regarding I2C protocol and on how to implement in on Arduino

www.howtomechatronics.com - Bluetooth to Bluetooth wireless transmission

PARTICIPANTS REVIEW

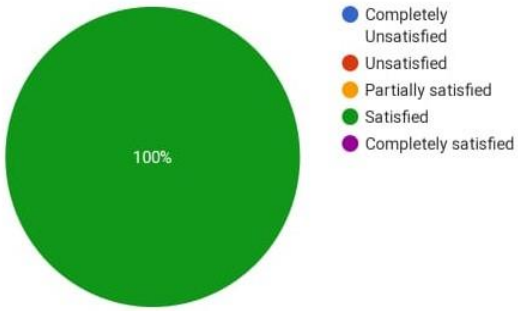
1. Were the topics explained informative and useful?

9 responses



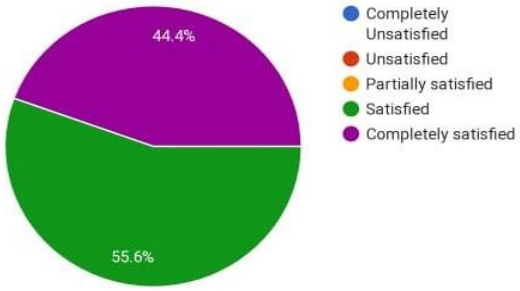
2. How was the explanation regarding the concept pertaining to Arduino?

9 responses



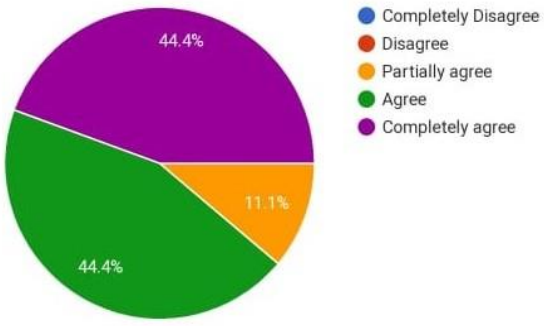
3. Were the trainers able to clear the doubt and approachable?

9 responses



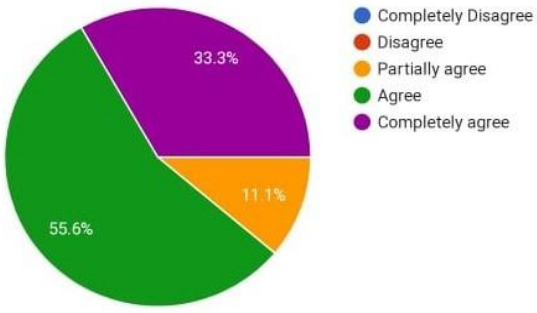
4. Individual attention or time given to clear your doubts regarding the problem faced while coding

9 responses



5. Was the workshop helpful to you learn about Arduino and help you develop a project on your own?

9 responses



Fill it with your thoughts and and if any remarks or improvements do mention.

9 responses

It was good

It was good and helpful

It was good

It was very informative. More information and examples were required for Bluetooth.

Informative workshop

More topics were needed

Time management

It was a good session and if they thought the applications of the topic it would help more.

Thank you