CS 321 : Computer Peripherals and Interfacing Lab

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Group No - *10*
Project - *Smart Classroom*
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Contents

1. Introduction

In this project we try to provide a hardware based solution to some of the common classroom problems like proxies marked by student . In this project we came up with a cheaper and more precise solution for attendance which not only marks attendance but also identifies proxies . We also tried to automate classroom controls like light and fan control for power conservation during class .

2. Hardware Modules

2. 1 Sensors

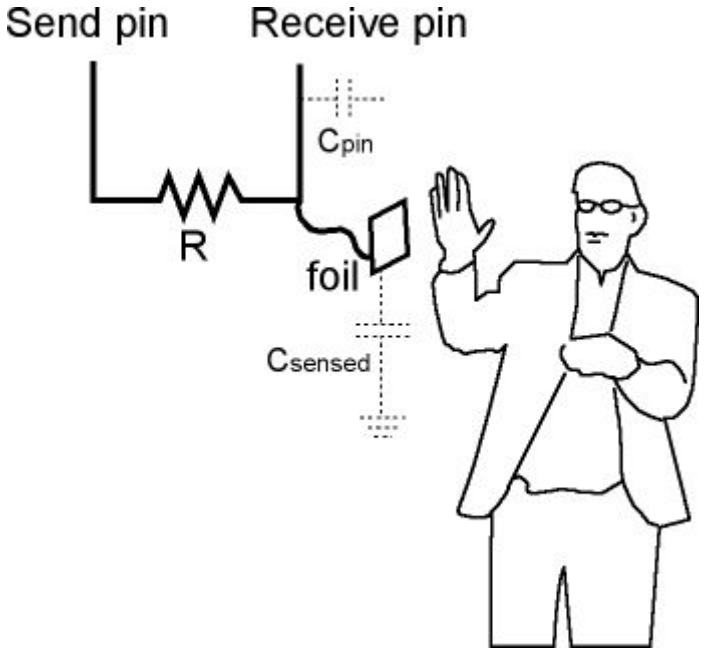
2.1.1 Capacitive Sensor

(A) *Why Used*

Capacitive sensor generally used to detect and measure proximity , position and displacement and force. In our project, we used capacitive sensing to detect and measure proximity and to measure force. Firstly ,we used capacitive sensing for turning on blackboard leds as proximity sensor because we want blackboard lights on as soon as professor going to write on board. Secondly , we used capacitive sensing as force sensing device to measure force on bench and as soon as force over bench goes above particular specified value , we toggled seat occupancy data to occupied. The capacitiveSensor always used with arduino and properly insulated aluminium metal foil and large 1 mega ohm resistance.

(B) Working

The capacitiveSensor method toggles a microcontroller *send* pin to a new state and then waits for the *receive* pin to change to the same state as the send pin. A variable is incremented inside a *while* loop to time the receive pins state change. The method then reports the variable's value, which is in arbitrary units.



The physical setup includes a medium to high value (100 kilo ohm - 50 megohm) resistor between the send pin and the receive (sensor) pin. The receive pin is the sensor terminal. A wire connected to this pin with a piece of foil at the end makes a good sensor. For many applications, a more useful range of values is obtained if the sensor is covered with paper, plastic, or another insulating material, so that users do not actually touch the metal foil. Research has shown that a small capacitor (100 pF) or so from sensor pin to ground improves stability and repeatability.

When the send pin changes state, it will eventually change the state of the receive pin. The delay between the send pin changing and the receive pin changing is determined by an RC time constant, defined by R * C, where R is the value of the resistor and C is the capacitance at the receive pin, plus any other capacitance (e.g. human body interaction) present at the sensor (receive) pin. Adding small capacitor (20 - 400 pF) in parallel with the body capacitance, is highly desirable too, as it stabilizes the sensed readings.

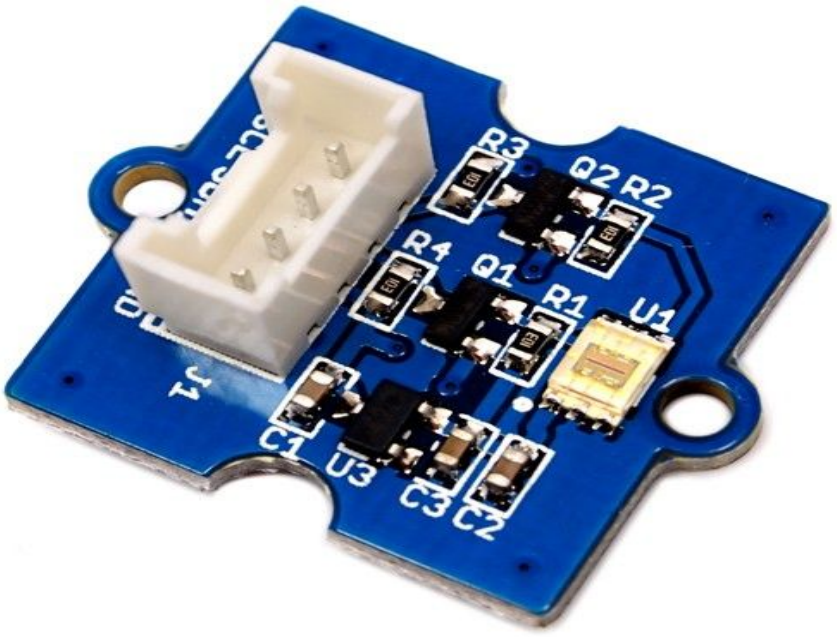
2.1.2 Digit Light Sensor

(A) Why used

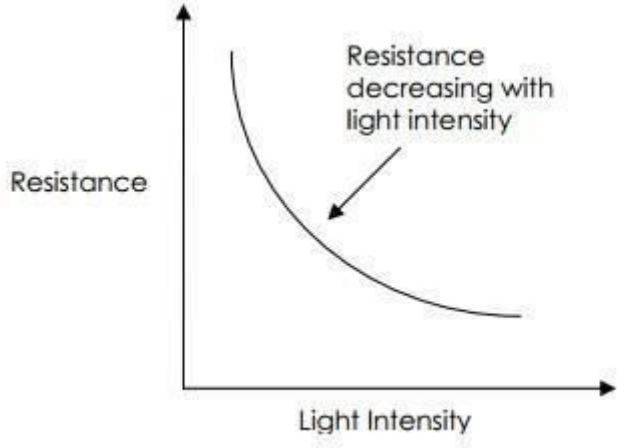
We have used this sensor to detect if there is sufficient amount of light in the classroom or not. If there is no light and someone occupying seat in class, then we sense it using this sensor and turn on the light of classroom. Whether anyone occupying seat in class or not is confirmed by seat occupancy data which we received from arduino.

(B) Working

This module is based on the I2C light-to-digital converter TSL2561 to transform light intensity to a digital signal. Different from traditional analog light sensor as this digital module features a selectable light spectrum range due to its dual light sensitive diodes: infrared and full spectrum.



Digital light sensor



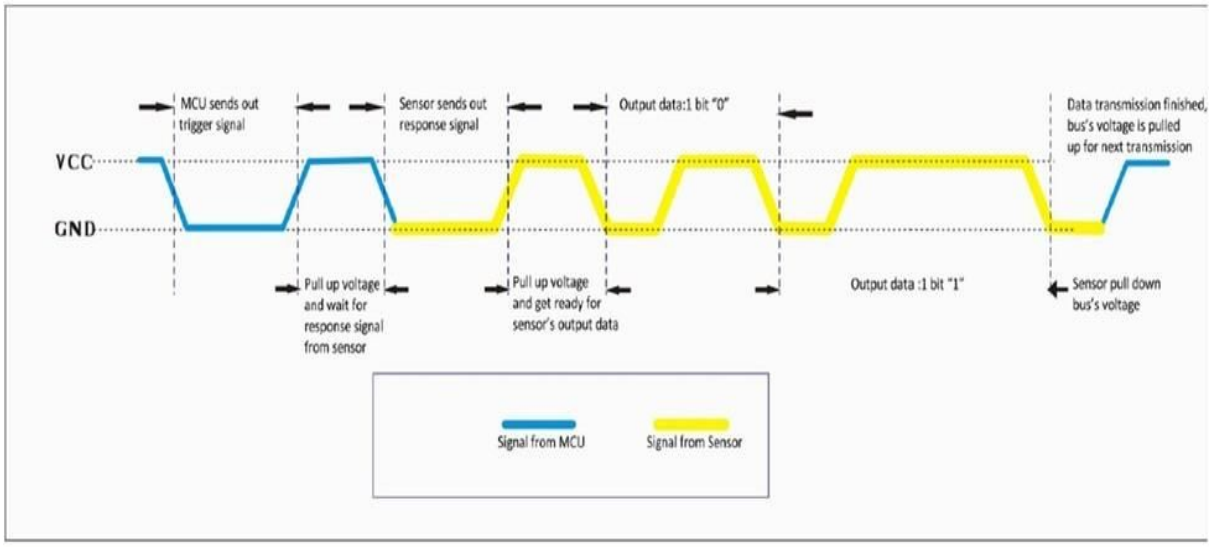
Light intensity vs Resistance for digital light sensor

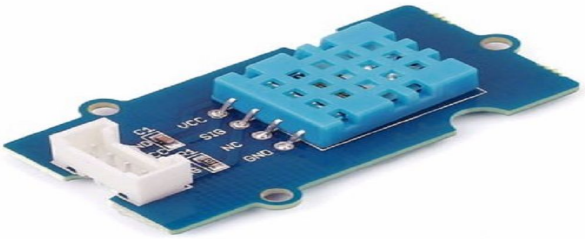
2.1.3 Temperature & Humidity Sensor

(A) Why Used

Temperature & Humidity Sensor is used to detect temperature of Classroom. Speed of fan in classroom is controlled by temperature sensor data and seat occupancy data. Fan will be on in case if someone occupying seat in classroom and its speed is controlled with help of temperature sensor data and transistors. Reason for controlling speed of fan is someone may not want fan on in winters.

(B) Working





2.2 RFID Reader

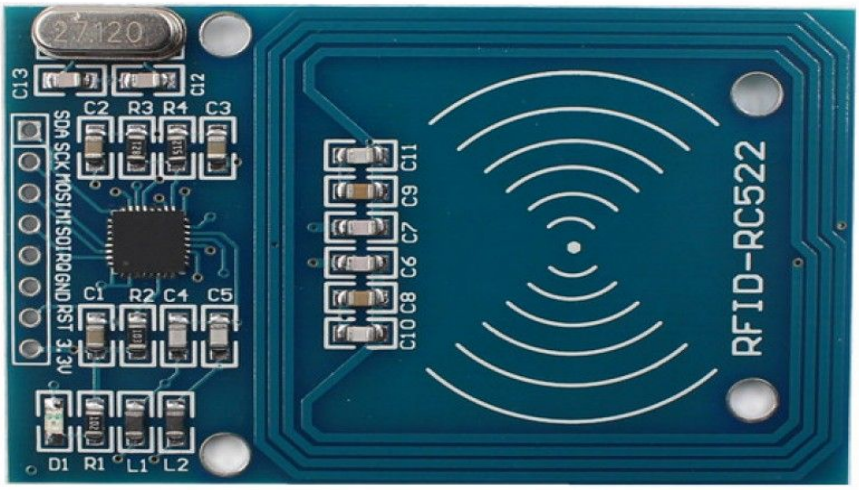
(A) Why Used

It is used with the arduino module to read RFID tag of students Id card. With this RFID tag information , we find out who the student is and with its respective seat occupancy data we find out whether that student took his seat or not , if yes for how much time.With all above information , we mark student as present , absent , involved in proxies and exit in mid class.

(B) What it is

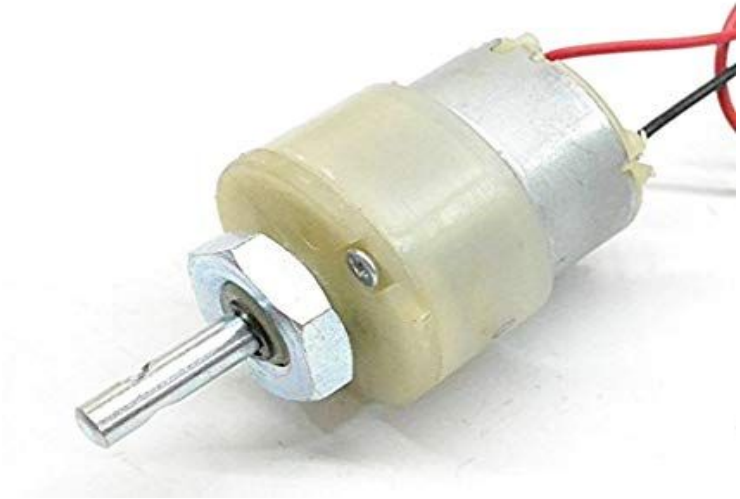
A radio frequency identification reader (RFID reader) is a device used to gather information from an RFID tag, which is used to track individual objects. Radio waves are used to transfer data from the tag to a reader.

RFID is a technology similar in theory to bar codes. However, the RFID tag does not have to be scanned directly, nor does it require line-of-sight to a reader. The RFID tag it must be within the range of an RFID reader, which ranges from 3 to 300 feet, in order to be read. RFID technology allows several items to be quickly scanned and enables fast identification of a particular product, even when it is surrounded by several other items.



2.3 DC Motor

We used DC motor as a DC Fan. And we are controlling DC Motor Speed according temperature of classroom.



2.4 WiFi Module

(A) Why Used

It is used with the raspberry board to connect the board to the other arduino boards which could send the collected data(RFID and capacitive sensor) and the end of the class.

(B) What it is

The WiFi Module is a self contained SOC with integrated TCP/IP protocol stack that can give any microcontroller access to your WiFi network. The module is capable of either hosting an application or offloading all Wi-Fi networking functions from another application processor.

2.5 Microcontroller

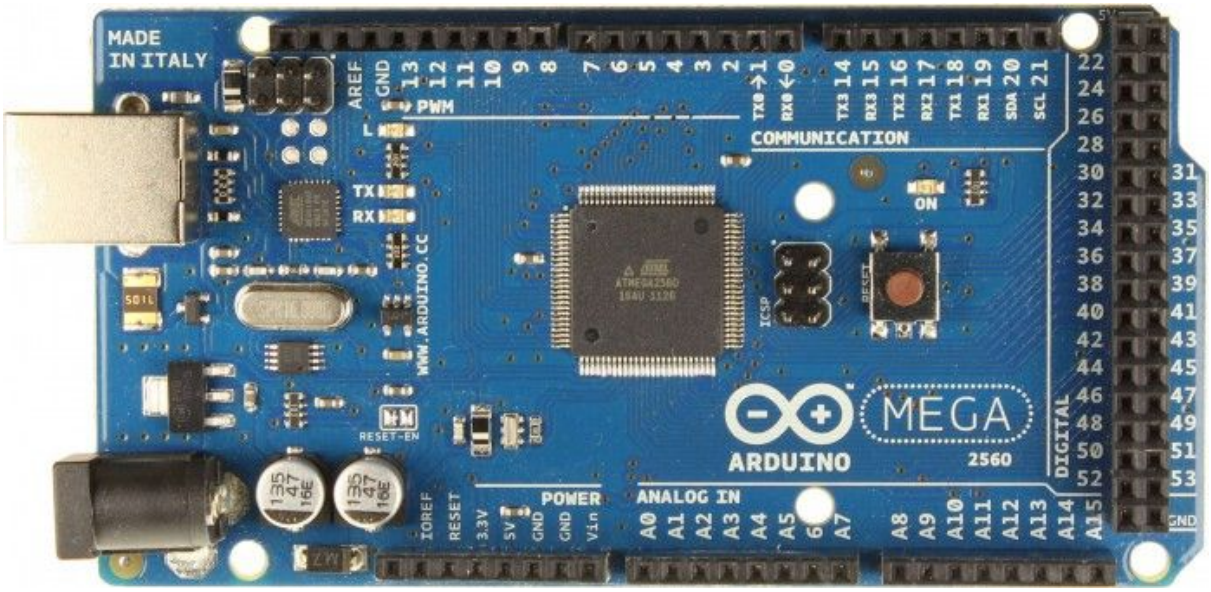
2.5.1 Arduino board (mega 2560)

(A) Why Used

Arduino board is used to control Capacitive sensor and RFID reader. Capacitive sensor is fixed over every seat and read seat occupancy data of that seat and read id card details of that student using RFID Reader for entire class interval.

(B) What it is

The Mega 2560 is a microcontroller board based on the ATmega2560. It has 54 digital input/output pins (of which 15 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button.



2.5.2 Raspberry Pi

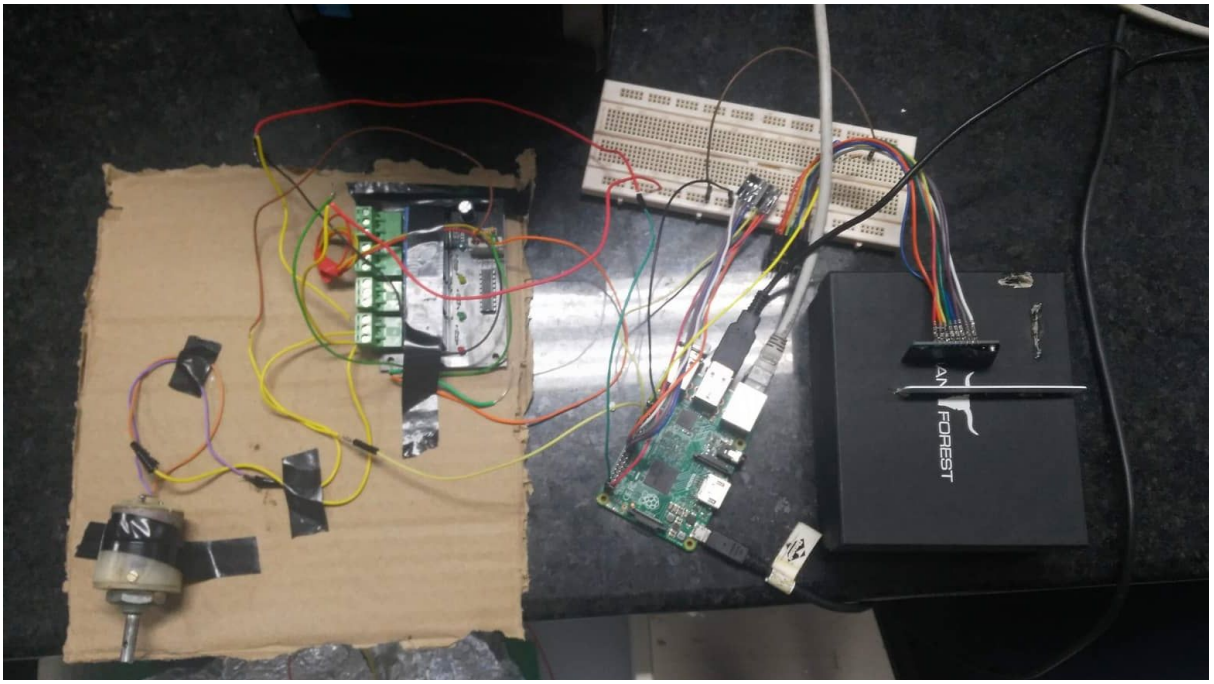
(A) Why Used

It is used as centralized control module in classroom, also it is used to control light sensor, temperature & humidity sensor. All students attendance status is collected in a csv format and then stored in centralized pc. Light control using digital light sensor and fan speed control is done by raspberry pi.

(B) What it is

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 learn how to program in languages like Scratch and Python.

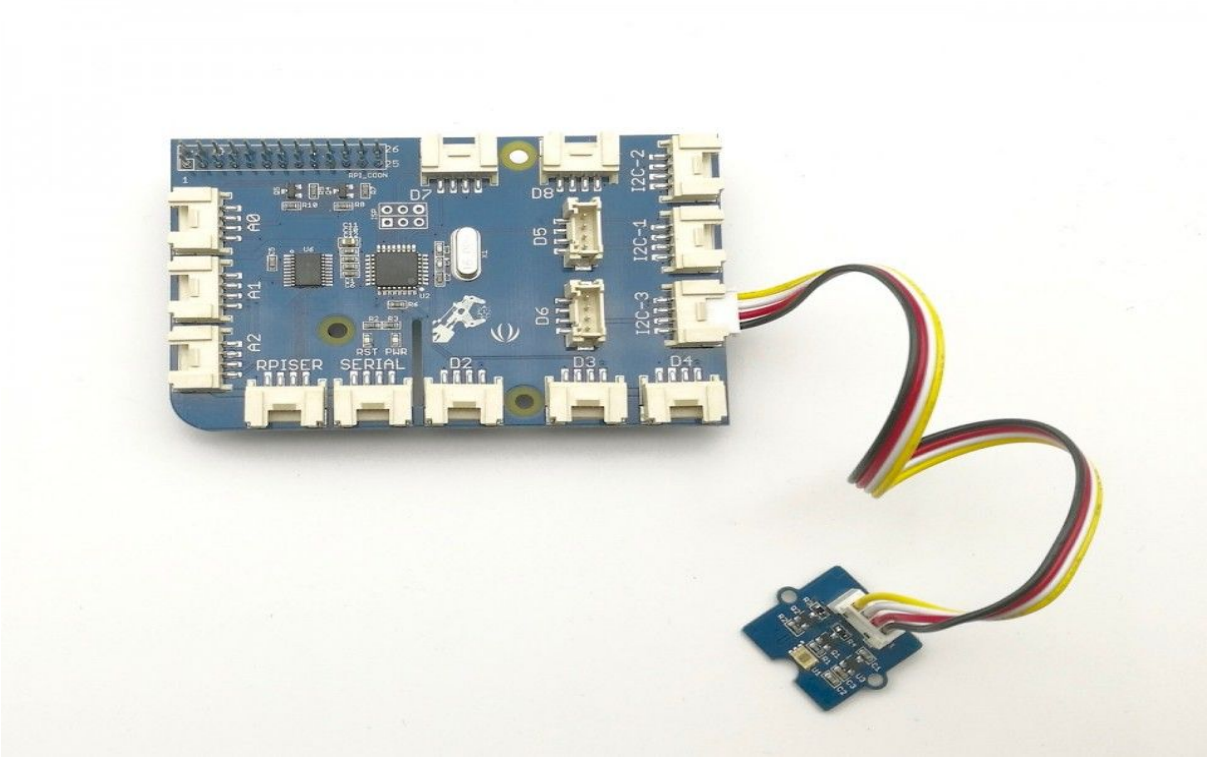
3. Setup



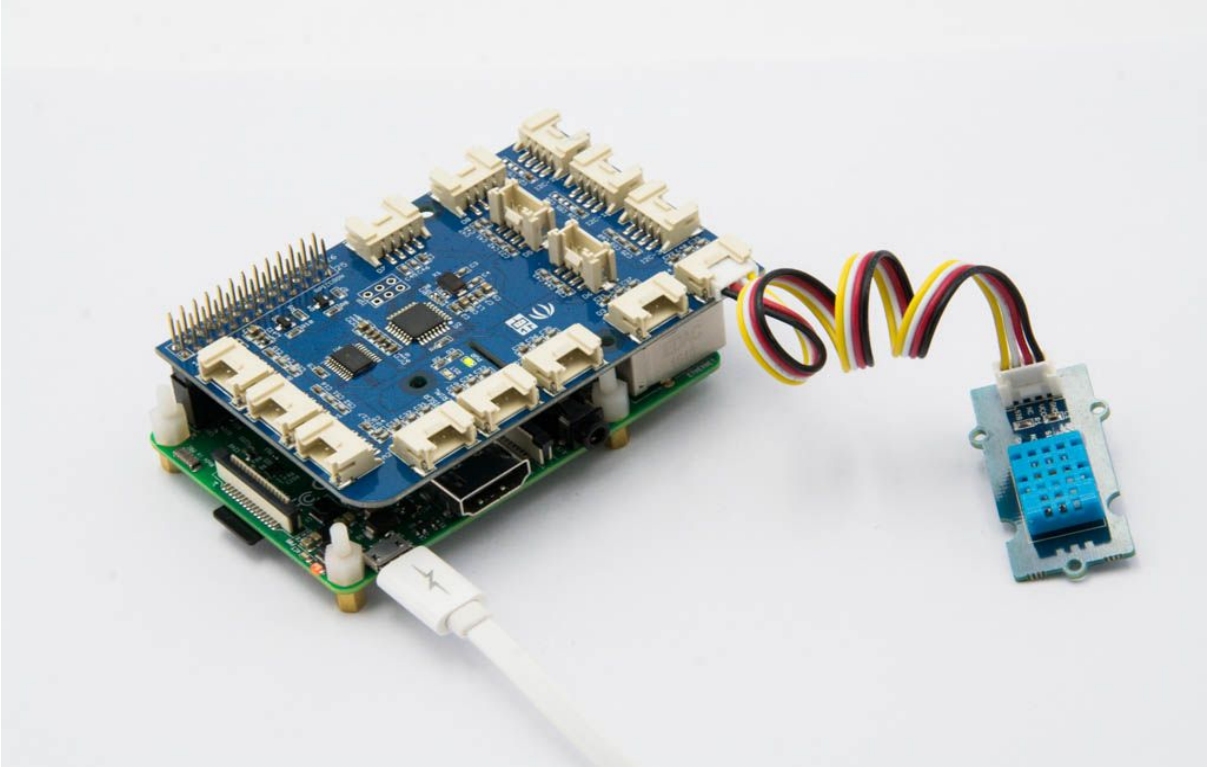
In the complete setup of smart classroom , we fixed one arduino on each seat and one centralized raspberry pi. One side of big cardboard box act as blackboard of classroom and a box is fixed on every seat where student will insert his id card and along with it , on every seat capacitive sensor fixed so as to check the seat occupancy status.
RFID card reader and capacitive resistor sensor is connected to arduino and arduino is connected to raspberry pi using wifi. Fan and light of classroom is connected to raspberry pi. Raspberry pi controls speed of fan and light on-off using temperature and digital light sensor respectively. lights above blackboard controlled using capacitive sensor where it act as proximity sensor. In this setup, arduino continuously publish seat occupancy data using mqtt. In the end of the class , class attendance is published over attendance topic.

4. Circuit Diagram

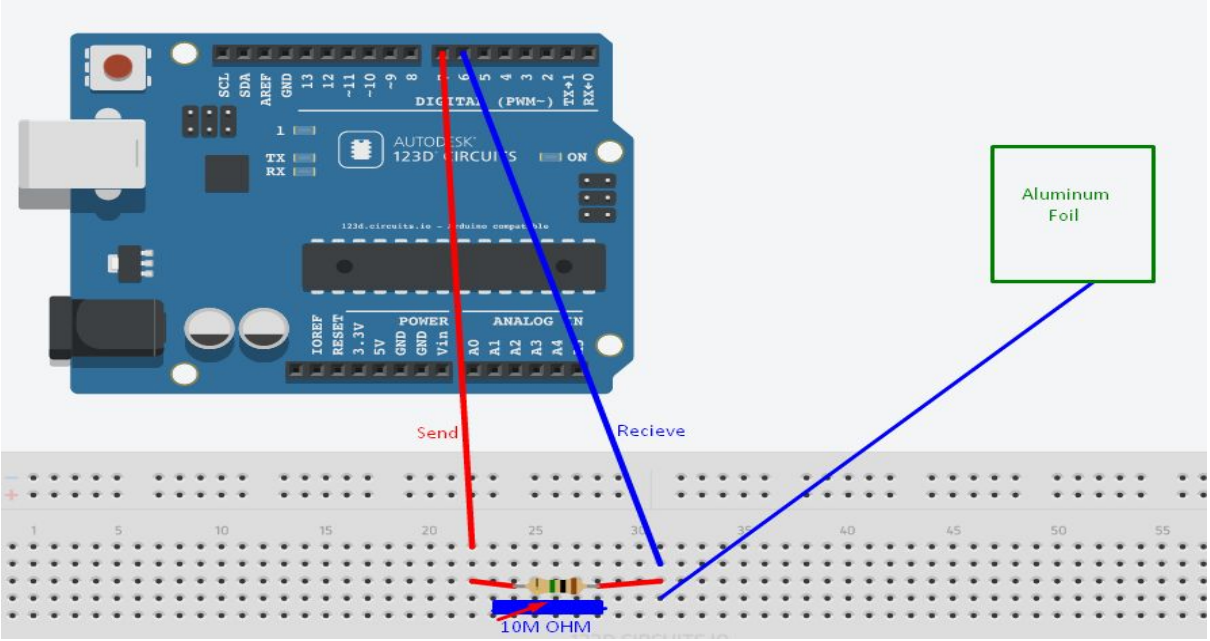
4.1 Raspberry Pi and light sensor connection



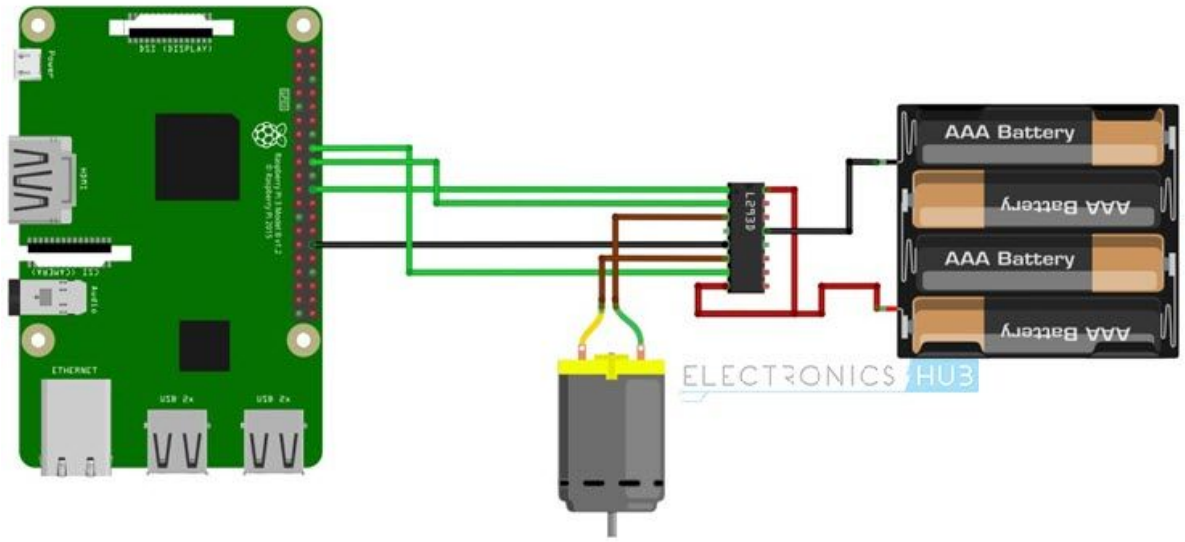
4.2 Raspberry Pi - Temperature sensor connection



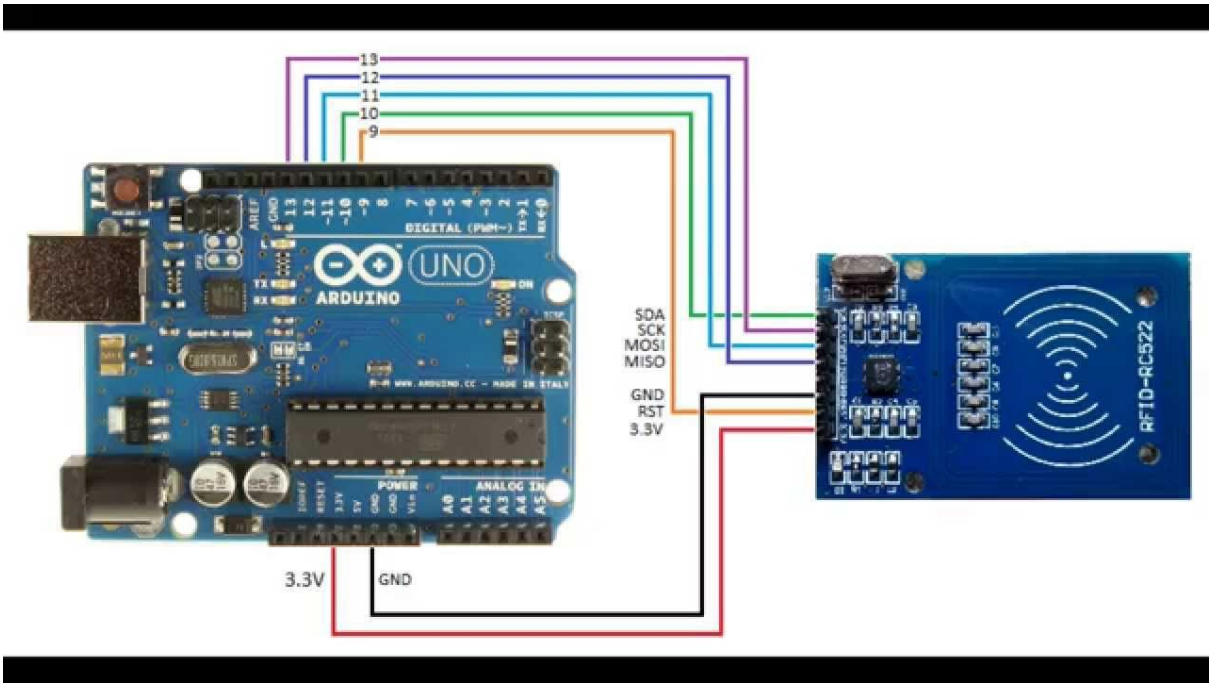
4.3 Arduino - Capacitive sensor connection



4.3 Raspberry Pi - Fan(Dc Motor) connection



4.4 Arduino - RFID Reader connection



5. Salient Features

1) Attendance and proxy detection – Using the RFID and seat occupancy data obtained from the capacitive sensor we can mark the attendance of the student accordingly . If the data is valid the student will be marked present . If the RFID data is not valid we can detect proxy and if the seat occupancy data is not sufficient we can detect exit in mid class . Thus we are able to detect all the proxies and also the id of the student marking the proxies .

(2) Exit in mid class – we are recording the RFID and seat occupancy data for the entire class duration.If the data obtained is not sufficient , will indicate that either the student was not present for the entire class duration and from this data we can detect exit in mid class .

(3) Automatic light and Fan control – we are controlling the light and fan using seat occupancy status . we are continuously getting the seat occupancy data from the capacitive sensor and publishing the data using mqtt which is used by the light and fan control . whenever the seat is occupied light and fan will be turned on .

(4) Blackboard lights control - we are using the capacitive sensor as a proximity sensor to detect if the professor is near the blackboard or writing on it .Then the blackboard lights will be turned on for some time and turned off if the blackboard is inactive .

(5) Seat occupancy status – We have the seat occupancy status obtained from the capacitive sensor continuously .This data can be used to detect which seats are occupied and which are not .

6. Advantages Over other Method

1) Using a face detection or fingerprint scanner for attendance are prone to proxies because the students can easily mark their attendance and leave class . But using our system the attendance is marked only if the student is present in the class for entire time and if any student tries to mark proxies it will be identified using the RFID sensor data . We are also able to identify if the student is marking its attendance and leaving mid class.

2) It is extremely cheap as it requires only a RFID sensor and capacitive sensor which does not requires any cost .

3) Thus,the attendance system used in our project is cheaper and more accurate than the existing systems used for attendance .

4) The use of capacitive sensor to detect the seat occupancy is used to control the lights in the classroom. Capacitive sensors require no cost at all as opposed to the PIR , IR or ultrasonic sensors which are generally used for automatic light control . Thus at no cost at all we are able to control the lights in the classroom .