TinkerCAD- A Virtual Platform for Home Automation Applications

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ABSTRACT

In this paper proposes an effective platform for implementation of home automation processes. The home automation activities are versatile depends upon the user interest and requirement where portable devices like sensors and actuators are used as a user interface. The devices can communicate among individual components over an internet gateway by means of ZigBee WIFI protocols. The power and data transmission capabilities are limited to small ranges. In academic laboratories students face connection hassle in executing the automation processes, leads to loss of components due to misconnection and complexity in circuit debugging. The effective solution to realize various automation applications through AUTODESK TINKERCAD. The paper consists of demonstrative views of executing home automation applications in keypad-based door unlocking with IR based appliances control, home appliances over voltage circuit protection, the home interior appliances through motion, ambient light and temperature, and concludes with an application of garage car parking lot. The component connection, the programming logics, has been discussed and results are demonstrated using the recorded step by step video links for individual applications.

Keywords: TinkerCAD, IIOT, Arduino UNO, PIR (passive infrared)

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1 Introduction

The term automation is tossed in late 70's. home automation now a days are practical in present age and are getting more progressively famous and less expensive with more individuals used. Home automation is a control system that permits home to run automated services. They will be customized by client for specific events. The hypothesis behind home automation is that certain things we do all the times on routine basis should be automated. Life of an individual gets easier when they control the home with google Alexa where we just command the device to operate the appliance whenever one desire. The Figure 1 depicts the scenario of home automation

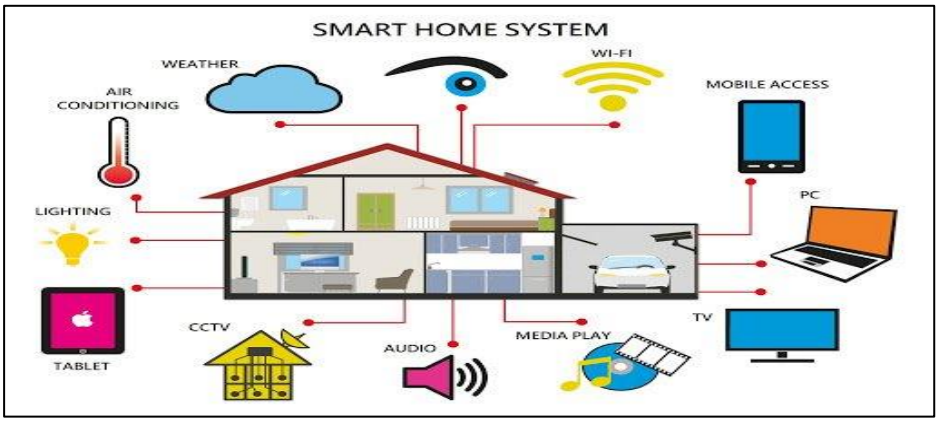

Figure-1 home automation system

In a typical home the number of appliances one uses with a frequency of more than ten over a day. It requires lot of individual attentions to initiate the events. Automation of these components with a flexible user interface saves effective utilization of individual time with an added advantage of energy saving. The prioritized devices to have a automated on and off with respect to proximity changes and climatic conditions and interrupted power scenarios are light intensity controls security door alarm system and parking system, weather control appliances, timer based control of home appliances, power and energy estimation etc.., to interconnect the devices with user an embedded architecture is needed with a added facilities of wireless connectivity, memory storage and remote access. The details of wide applications of home automation is portrayed in figure 2.

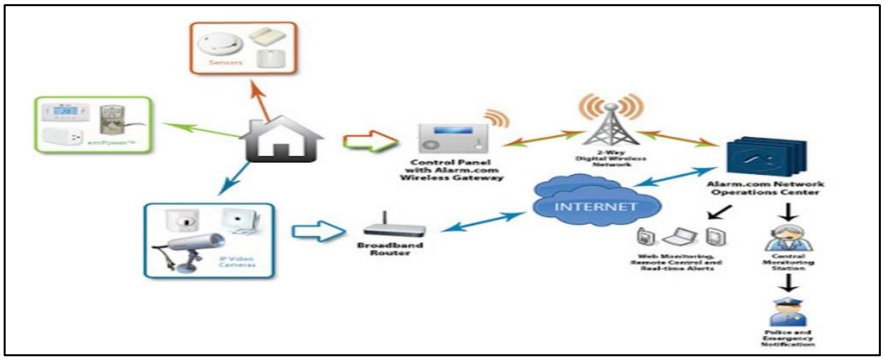

Figure-2 applications of home automation

1.1 Virtual platform TinkerCAD

TinkerCAD is a free, easy-to-use app for 3D design, electronics, and coding. It's used by teachers, kids, hobbyists, and designers to imagine, design, and make anything. TinkerCAD is a great tool to start 3d modelling. It simplifies the process of 3d design. It is easy to use and compatible with 3d printers. TinkerCAD has another feature of designing circuits with available components in it. It has integrated some custom circuit components (called Circuit Assemblies) into the TinkerCAD editor, it allows LEDs, coin-cell batteries, switches and even a vibrating motor into design. It offers print or display some data, we are having LCD's, seven segment display and multimeter for metering. The literature provides the scope and extension of

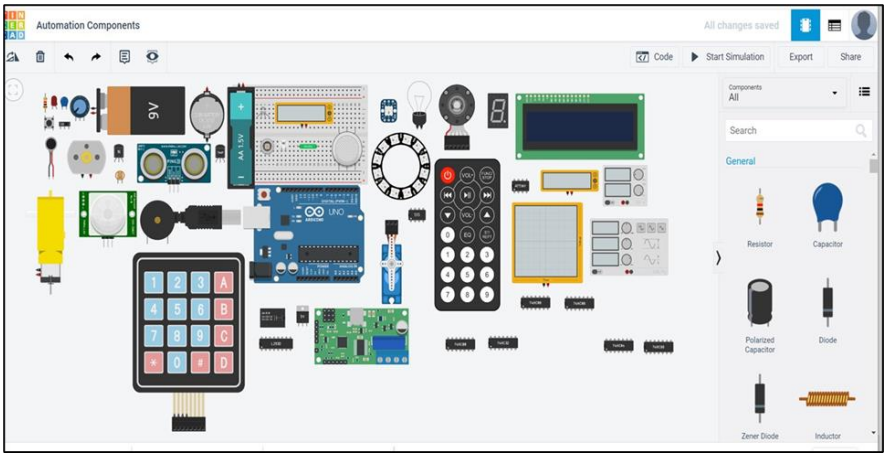

Figure-3 components in TinkerCAD

The virtual platform offers components like Arduino UNO which is a micro controller able to read the data and perform certain operation, 16*2 LCD display, LM393 for voltage comparison,

servo motor, 4X4 matrix keypad, piezo buzzer, SPDT switch, DC motor, push button, IR sensor, LM35 for detection of temperature, Ultrasonic sensor, PIR sensor, ambient light sensor. The figure 3 shows the various components available in TinkerCAD platform. The TinkerCAD has simulation available with block and code as well. Block code is something which you can use existing or create a block and place it in accordingly code will be generated and been simulated. Code simulation something which you write text code for execution.Using this virtual platform, the multilevel automation processes are modeled, designed and simulated. The steps of component integration, programming logic and the analysis is discussed in detail with selected automation applications.

2. Literature review

Home automation applications are vast and user specific. In this paper application used in smart homes , a keypad-based door unlocking system is simulated in which will provide security to things at homes, schools and offices. The security system contains a 4X4 keypad input unit for entering the Personal Identification Number (PIN) and a display unit in form of Liquid Crystal Display (LCD) for visual display of information. It also contains a servo motor that serves as a switching for locking and unlocking the door and a programmed Arduino that processes the input information and take appropriate action. When a user enters a PIN into the security system installed at any entrance, the system captures the PIN and compares it with the stored PINs for a match. If the captured PIN matches with the stored PIN door open is displayed on the LCD and the door opens otherwise, wrong password is displayed on the LCD and the door remains closed. The second home automation process isover voltage protection of the home appliances. The over voltage is inevitable due to generation and transmission limitations of electrical power. The isolation relay circuit helps the connected appliance to get isolated with the supply when high voltage scenarios arises. Third application selected for simulation demonstration is IR remote based home applications in which the control of applications like bulb and fans using IR remote. When button in IR remote is pressed it will generate a hexadecimal number which is received by IR receiver and sends the data to Arduino and accordingly control the bulb and fans which are present in particular range.

The last application is Managing parking space is one of the challenges that cities and towns have to face. On average, car drivers spend about 100 hours per year hunting for a parking space. For this reason, automation has innovative Parking Solutions for the traffic management needs. Improved occupancy and profitability of multi-story car parks and parking lots, reduced traffic loads and environmental impact, more attractive cities with a higher quality of life. In this automation we will going to display the available car need to be parked and when the parking lot is full. It will show no space is left. If the car passes through the exit point again it will show the available cars need to be parked.

3.Virtual Home Automation applications

3.1 Home appliances control and door unlocking system

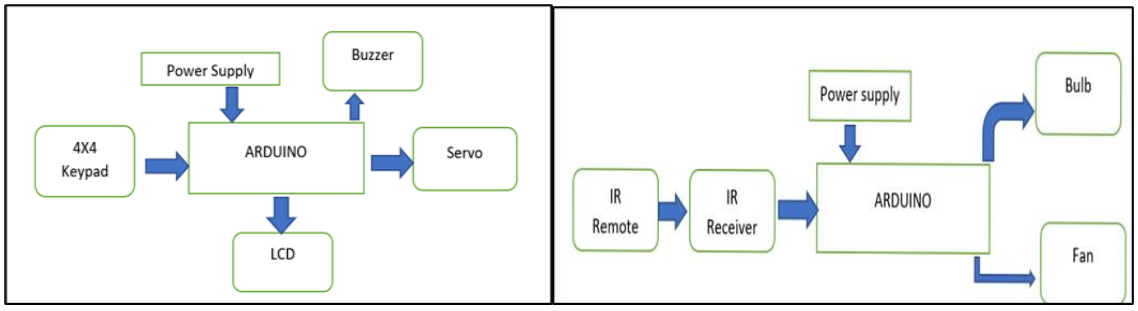

Figure-4 Block diagram for keypad security system and IR remote control home appliances

The components used in this application are tabulated and quantity of each component is mentioned. The list is figure 6 generated by tinkerCAD circuit platform

Name	Quantity	Component
KEYPAD1	1	Keypad 4x4
SERVO1	1	Micro Servo
PIEZO1	1	Piezo
U1 U5	2	Arduino Uno R3
U2	1	LCD 16 x 2
Rpot1	1	250 kΩ, Potentiometer
R1	1	220 Ω Resistor
R2	1	1 kΩ Resistor
U3	1	IR sensor
L1	1	Light bulb
M2	1	DC Motor

Figure-6 List of components used in this application

3.1.1 Methodology:

The working and logic of this simulation is simple to understand and execute. Initially unlock the door by using keypad with right PIN and displaying the state of door and entered PIN is right or wrong. Whenever wrong password is pressed piezo buzzer is placed to indicate as wrong PIN entered. After unlocking the door, we use IR remote as to control home applications in home by pressing the buttons of IR remote and control them.

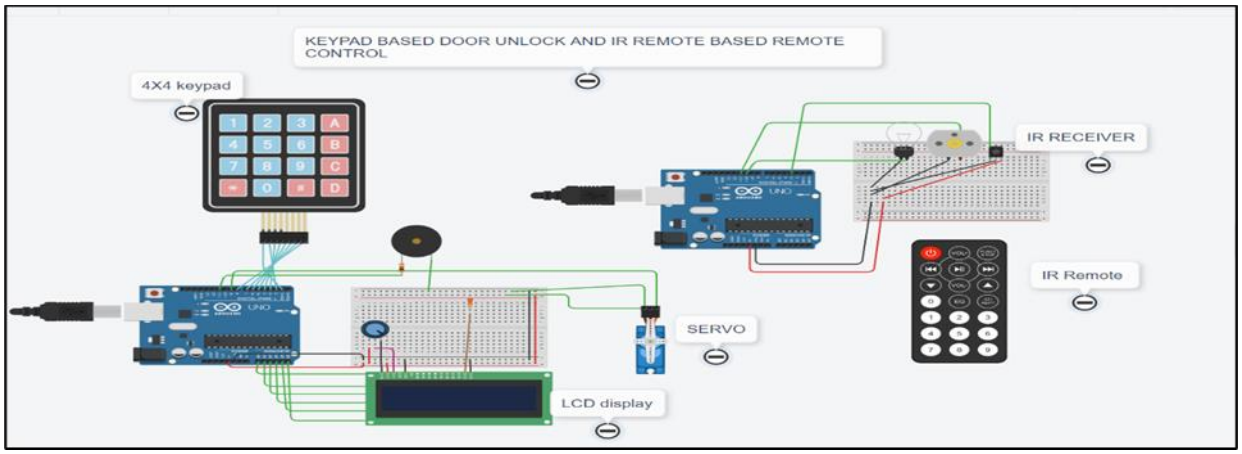

Figure-5 simulation model in TinkerCAD

3.1.2 Process case studies:

The outputs are shown to represent action done in this door unlocking automation. The starting of simulation, entering password, correct password door open servo rotates LCD displays action, # for closing of door, when wrong password is entered, IR remote control of bulb and motor and turning off bulb and motor using IR remote.

Initial stagein figure-6 run the simulation then welcome note of the simulation in LCD is displayed. The servo will come to its initial state of close of door when simulation starts then LCD will display enter password.In figure-7 After entering right password, the door will open is seen on LCD and servo will rotate as indication, while entering wrong PIN then wrong password will displayed on LCD. Figure-8 After unlocking the door, you can enter inside and can access the home applications by using IR remote. when 1 button of IR remote is pressed then bulb will glow and Motor rotate for button 2

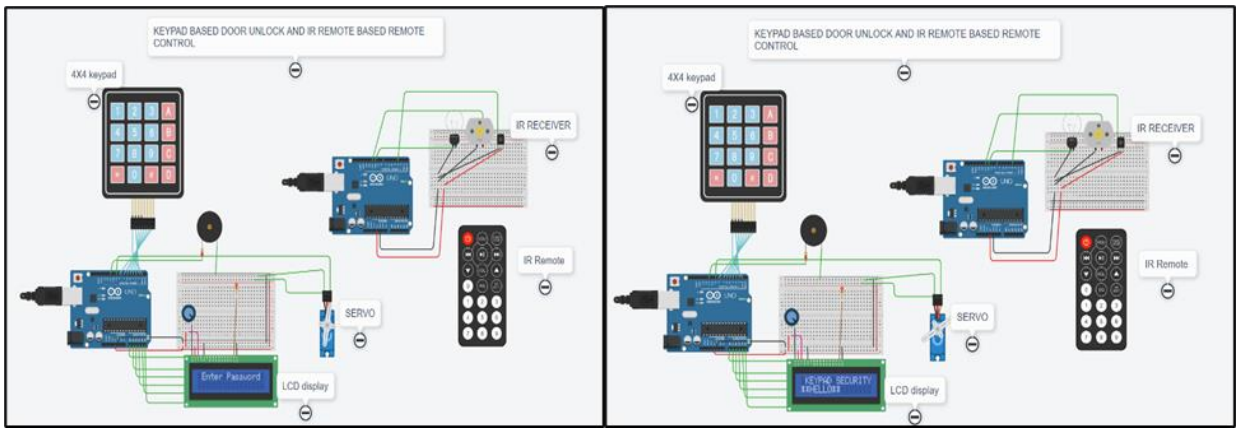

Figure-6 initial state of automation process

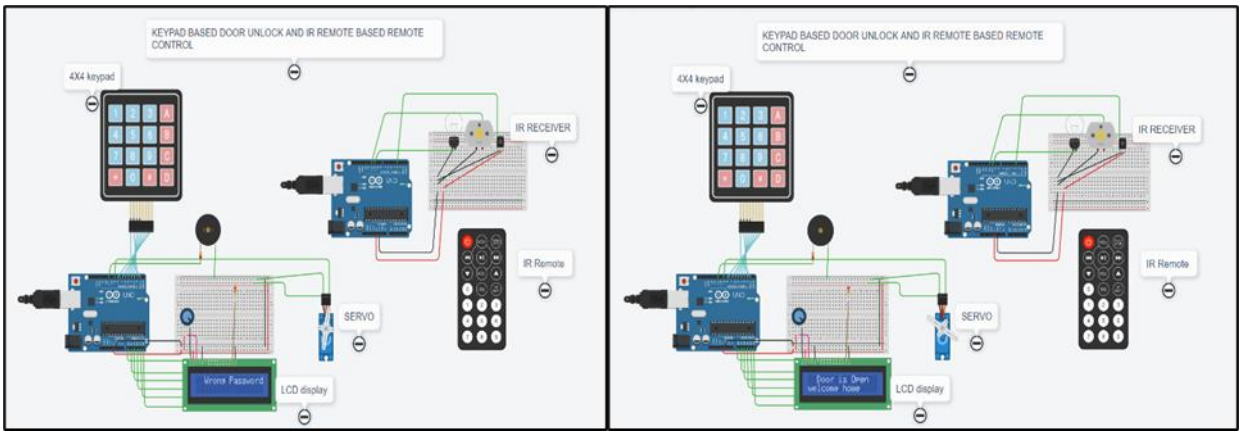

Figure-7After entering right password door opening displaying in LCD

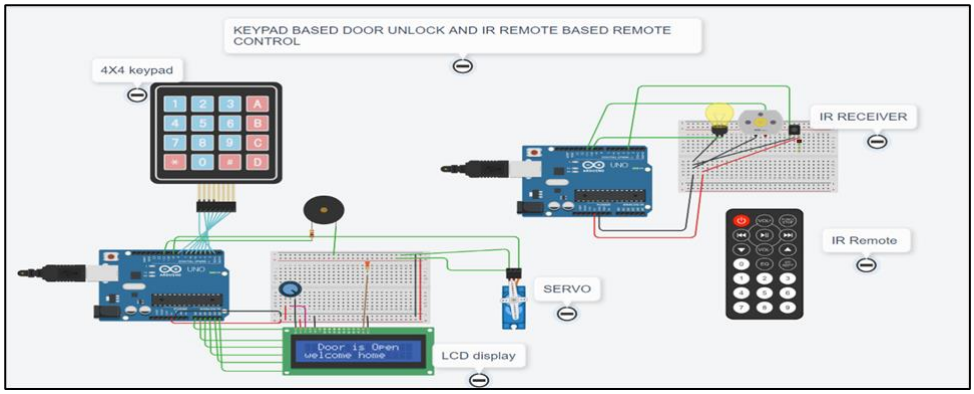

Figure-8 bulb and motor on when IR remote button pressed

Primary step is to enter password by using 4X4 keypad after entering right password LCD will display door open and servo will rotate to indication of door opening. When to close door # is pressed, entering a wrong password will make buzzer activate. In order to control the home appliances IR remote buttons are pressed to on and off bulb, motor. The recorded simulation step are available for reference.
https://www.youtube.com/watch?v=cTe3xJ1d-FI

3.2 Circuit protection using microcontroller

3.2.1 Methodology:

In this automation application a circuit is designed for protection of equipment on over voltages present in a particular room. A lm393 is an integrated circuit for voltage comparison is used to compare voltages of preset and actuating value. If any deviations are found in supply voltage, when actuating value is greater than preset value then accordingly signal will be sent to

Arduino and an indication will be seen at the circuit.

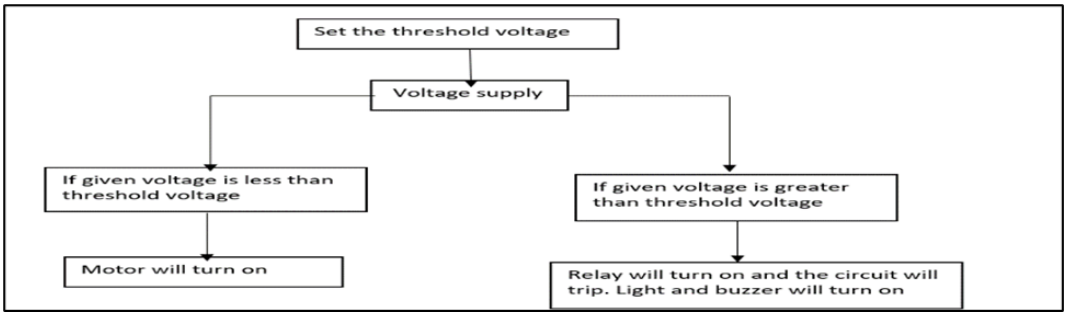

Figure-9 Sequence of steps for over voltage protection

The components used in the application of circuit protection are mentioned with used quantity of components

Name	Quantity	Component
R1	1	Resistor
K2, K3, K4, K5	4	Relay SPDT
U5	1	Arduino Uno R3
U6	1	LCD 16 x 2
L7	1	LM393
P8,P9,P10	3	Power supply
PE11	1	Piezo buzzer
L12	1	LED

Figure-16 list of components

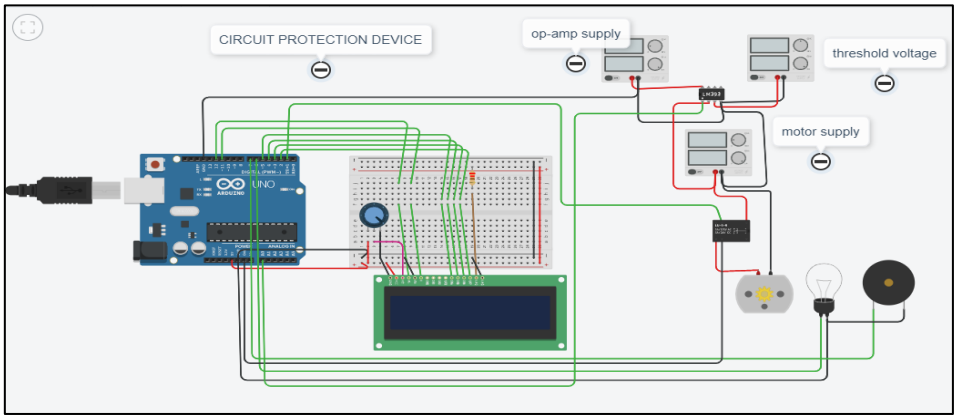

Figure-10 circuit modelling in TinkerCAD

In home when the given supply voltage is higher than the preset value then damage may occur to equipment. So, here this automated circuit protection circuit will let you know the voltage variations as to protect the equipment from higher voltages. When the supply is greater than the preset voltage then relay will trip and circuit will open. If supply is less than preset voltage the motor will work without any deviation. This automated circuit protection circuit will be used in any place where over voltage protection is required.

3.2.2 Process case studies:

When the given voltage is less than threshold voltage. The motor will turn on as it is safer to operate below the preset value.when the given

voltage is greater than threshold voltage.
In LCD high voltage will displayed and buzzer will blow for indication.

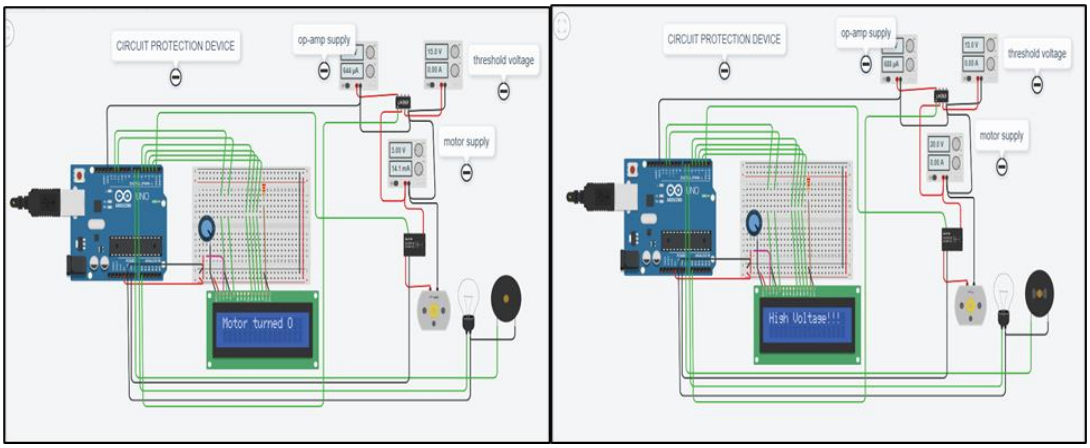

Figure-11 when voltage is less and for voltage high

This application is for detection of over voltage for given input voltage. For that a lm393 integrated circuit of voltage comparator is used. Initially a preset value is set in comparator to compare with input voltage if actuating voltage is greater than preset voltage then relay will operate, high voltage will be seen in LCD and buzzer is blowen as indication. When actuating voltage is less than preset voltage then motor will rotate as indication of motor on is shown in LCD. The process steps over the tinker platform are recorded and made available in the following link.
https://www.youtube.com/watch?v=1CG_jJBaDO8&feature=youtu.be

3.3 Home interior appliances control

3.3.1 Methodology:

In this application, typical home automation, few automated circuits are simulated. Ultrasonic, PIR, ambient, LM35sensors are taken as inputs for detection of motion, intensity of light and sensing temperature respectively. The ultrasonic sensor is used to sense the motion and when person is detected the signals are send to Arduino through sensor then it accordingly actuates the actuator and the door opens, status of door is displayed in LCD. PIR sensor detects the motion and sends the signal to Arduino to led to turn on till the interruption goes off. The state (whether OFF or ON) of LED is displayed in LCD. When temperature is high or low of certain selected value then sensor detects temperature and it sends signals to Arduino to dc motor(fan) acts according to temperature in room. The temperature (whether high or low) is displayed in LCD. When light intensity is less or high of certain selected value it sends signal to Arduino to bulb and bulb acts based on intensity in room.

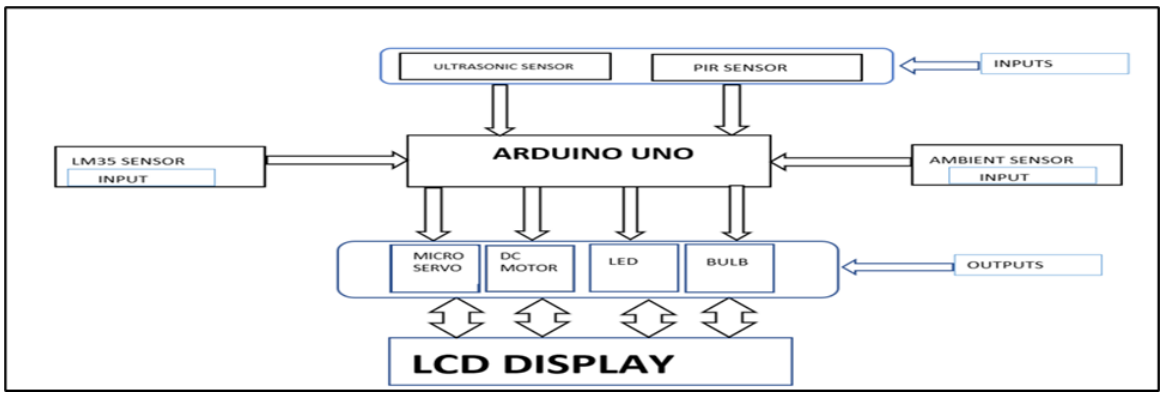

Figure-12 Block diagram for home interior automation

The list of components used in this application are tabulated with quantity of components are mentioned

Name	Quantity	Component
U1	1	Arduino Uno R3
U2	1	LCD 16 x 2
Rpot1	1	250 kΩ Potentiometer
SERVO1	1	Micro Servo
PING1	1	Ultrasonic Distance Sensor
PIR1	1	PIR Sensor
U3	1	Temperature Sensor [TMP36]
Q1	1	Ambient Light Sensor [Phototransistor]
L1	1	Light bulb
D1	1	Red LED
R1, R2, R3, R4	4	1 kΩ Resistor
U4	1	H-bridge Motor Driver
M1	1	DC Motor

Figure-13 Table of components with quantities used

The logic and simulation of this application are taking signals from sensors and actuating the actuators present like home interior appliances. Initially ultrasonic is used to open the door when any movement observed in range of it then door will open, PIR is to control LED depends on motion, lm35 is used to actuate the fan depending on temperature, finally ambient used to control intensity of light.

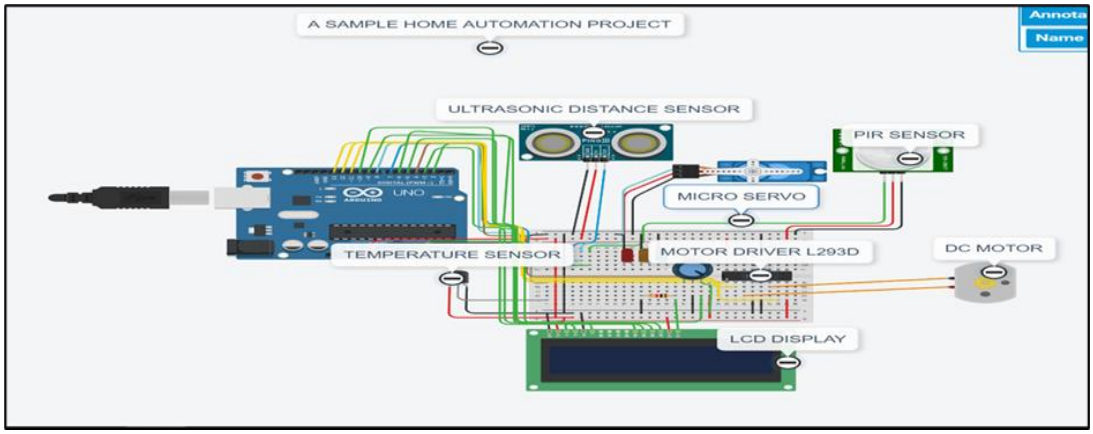

Figure-14TinkerCAD simulation model of Home interior appliances control

3.3.2Process of case studies

Figure-15 shows the process activity,When the distances between the object and ultrasonic sensor is less than 20 cm then Arduino sends the signal to Micro Servo and door open is displayed in LCD.When PIR sensor detects the motion then Arduino sends the signal to led to turn on till the interruption in the PIR Sensor goes low accordingly the state of led will be shown in LCD.when LM35 sensor detects high temperature then DC motor (FAN) will be on an indication of temperature is shown on LCD.

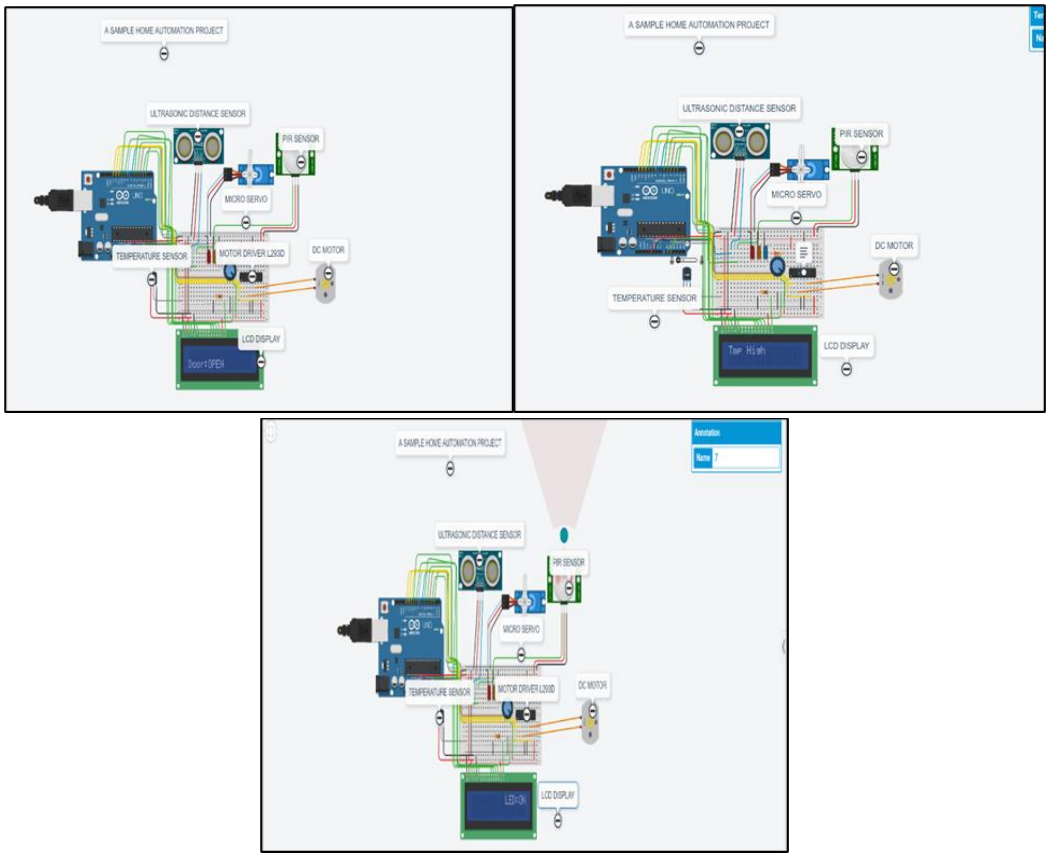

Figure-15simulation's explaining the working of sensors

Initially when ultrasonic sensor detects any movement in its range the door will open as an indication servo will rotate and displayed in LCD, LED is controlled on the motions of PIR, motor will be turned depending on lm35 temperature sensor, finally ambient light sensor is to control intensity of bulb. All these actions are done in interior of home as an applications of home automation. The simulation modelling and steps were recorded and uploaded in the below link.

https://www.youtube.com/watch?v=1DwecwqhpJc&feature=youtu.be

3.4 Automated Car parking system

3.4.1 Methodology:

In this circuit we have two push button which acts as entry point and exit point. If we will press the push button the servo motor will rotate it means it allows the car to enter the parking lot. If the parking lot is full it will show no space lest. At that time if we will push the push button the servo motor will not rotate it means it will not allow the car to get inside the parking lot. To vacate the parking lot, we have to push the exit push button. If all the car left the parking lot it will show space left for available car.

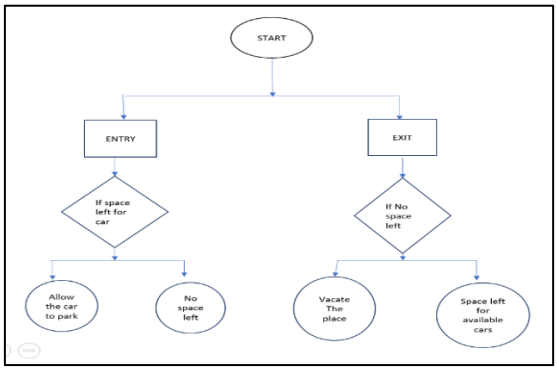

Figure-16 flow chart of garage car parking lot

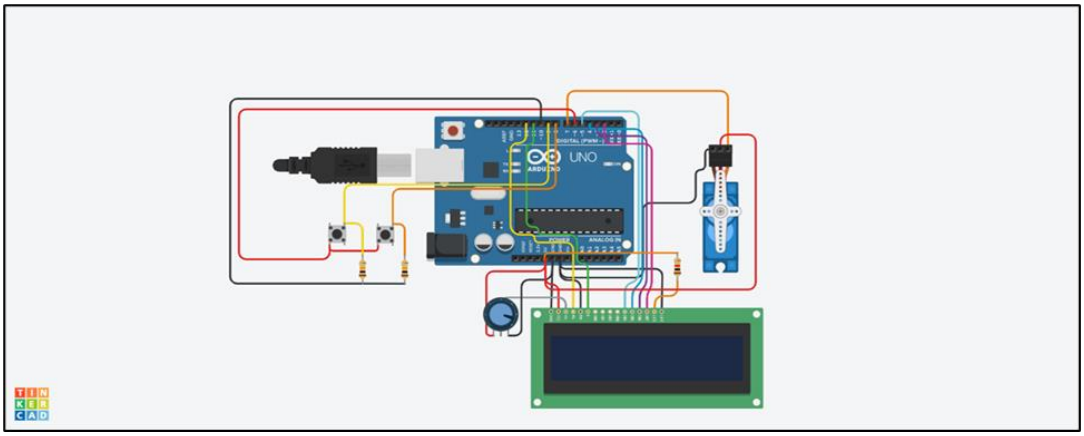

Figure-17TinkerCAD simulation circuit

3.4.2 Process of case studies:

From the figure-18 shows Initially LCD will print space left for 7 cars and when car enters the count decreases. Figure-19 is When all the cars are parked it will show No space left, when cars left from parking lot it displays the remaining space

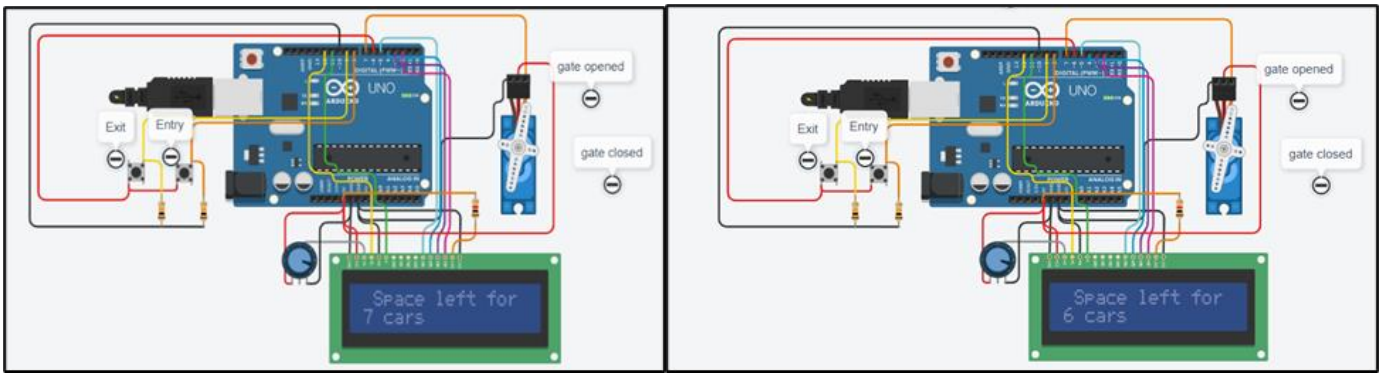

Figure-18 showing the space left for car

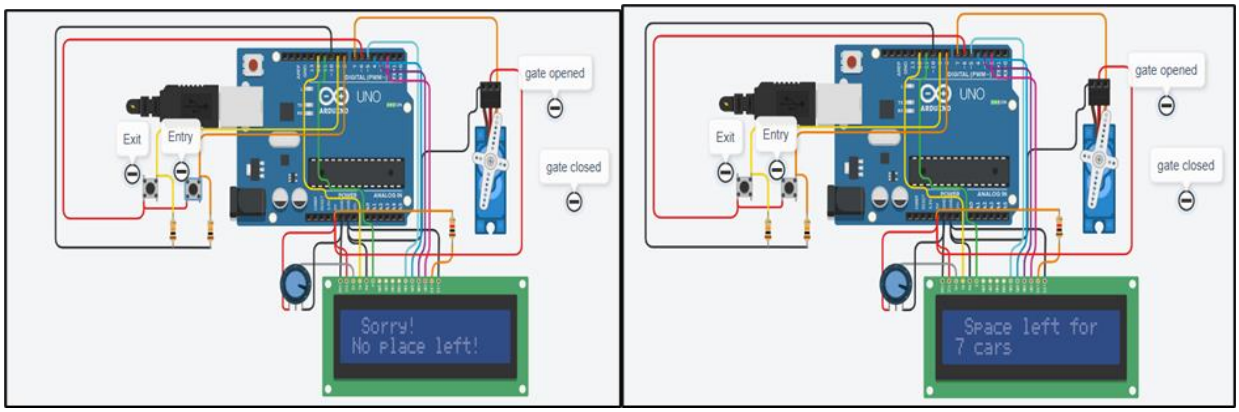

Figure-19 after filling all spaces

This garage parking lot automation process is easy for implementation. A two pushbuttons are taken as incoming and outgoing cars once car is entered into lot then place available will be decreased as an indication it mentioned in LCD. Likewise, when car is leaved from parking lot then space available will be increased. This application can be implemented in places where heavy cars are parked to avoid misplacement of cars in lot.

https://www.youtube.com/watch?v=5xTh78LZGI0

4. Virtual platform challenges and future scope

At present the tinker platform provides simulation of electrical, electronics, Boolean components and Arduino, ATTINY as programable modules. It provides ease in understanding the characteristics of components, power supply and display devices. The additional simulation features are more useful in terms of debugging and short-circuit scenarios. In addition to the present features the TinkerCAD could extend IOT simulation capabilities for the scope of releasing more automation applications. During the process of simulation faced some issues while integrating two Arduinos and using some motor control driver boards during simulation of our work.

5. Conclusion

The virtual platform for simulation of automation processes has been introduced and discussed the challenges user experiences during the simulation process. In this paper four home automation activities are demonstrated using the simulation results. In security system servo movement is controlled over input keypad secret PIN and alarm mechanism is adopted for wrong entry, fan and bulb controls are operated with IR remote, in second application the home appliance over voltage protection is demonstrated with buzzer indication. In third application the home interior automation processes like ultrasonic door opening, PIR motion-based LED on off, ambient intensity control of a bulb, temperature-based fan control. Lastly car parking automation which displays the density of cars and space left in parking garage. The virtual platform offers great flexibility in connections and ease of programming through block concept.

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