MATLAB GUI BASED HOME AUTOMATION

FINAL REPORT SUBMITTED FOR

ELECTRICAL AND ELECTRONICS ENGINEERING SOCIETY SUMMER PROJECT PROGRAMME

BY

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CERTIFICATE

This is to certify that the contents of the report entitled

"**MATLAB GUI Based Home Automation**" is a bonafide work carried out by Alakshendra Singh. The contents of the report have not been submitted earlier for the award of any other degree or certificate and we hereby commend the work done by him in this connection.

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ABSTRACT

The home automation system achieved great popularity in the last decades and it increases the comfort and quality of life. Just a smartphone application is used to control and monitor home appliances using different types of communication techniques. Consistent with the marketing research firm ABI regarding 4 million home automation systems were subscribed globally in 2013.An equivalent firm additionally calculable that regarding 90 million homes would use the home automation system by the top of 2017.

The main aim of this project is to propose a system that demonstrates interfacing between MATLAB and Arduino board for household equipment monitoring and control. In the proposed system, the Arduino board is interfaced with MATLAB using serial communication to control home appliances. The image acquisition device is interfaced with MATLAB that will continuously show the status of household equipment on Graphical User Interface [GUI] designed in MATLAB. Proper commanding is done from MATLAB GUI, household equipment can be turned ON or OFF which are interfaced with Arduino through a relay board.

CONTENTS

INTRODUCTION

The home automation system is getting popular and widely used in a lot of houses worldwide. The basic problems faced by disabled people in day-to-day life in their own house to turn ON or OFF the equipment like lights, fans, and difficulty in analyzing switches are observed many times. It has tons of advantages to users even more to the handicapped and/or elderly users in which it will make it easier for them to control their home appliances. This system can be integrated closely with home security solutions to allow greater control and safety for homeowners. Also, this eases the lifestyle of humans and also helps in monitoring and conserving energy used. It can also be used for the official and industrial purposes to automate their work and can use for monitoring and management.

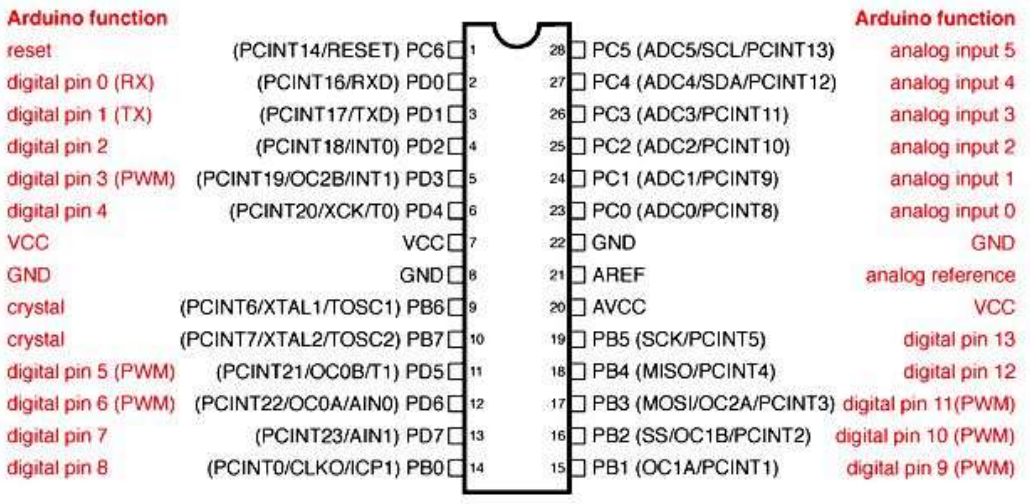
This project focuses on controlling the home appliances by using the interface of MATLAB and Arduino Uno board. In this project, the lights are represented by LED and a fan is replicated by DC motor. This project is an effort to simulate home automation using the above components.

ARDUINO UNO

The **Arduino Uno** is an open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by Arduino.cc. The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced with various other circuits and expansion boards. The board has 14 digital I/O pins (six capable of PWM output), 6 analogs I/O pins, and is programmable via a type B USB cable. It can be powered by the USB cable or by an external 9-volt battery.

The board is based on ATmega328P Microcontroller.

- It has 28 pin with 1.8 to 5.5 volts operating voltage.
- It has a CPU of 8-bit AVR, 1 kB SRAM, 2 kB EEPROM and 32 kB Flash Memory.
- Its performance is 20 MIPS at 20 MHz.



The functions of Pins are as follows

- LED: There is a built-in LED driven by digital pin 13. When the pin is high value, the LED is on, when the pin is low, it's off.
- VIN: The input voltage to the Arduino board when it's using an external power source as opposed to 5 volts from the USB connection or other regulated power source). You can supply voltage through this pin, or, if supplying voltage via the power jack, access it through this pin.
- 5V: This pin outputs a regulated 5V from the regulator on the board. The board can be supplied with power either from the DC power jack (7 - 20V), the USB connector (5V), or the VIN pin of the board (7-20V). Supplying voltage via the 5V or 3.3V pins bypasses the regulator, and can damage the board.
- 3V3: A 3.3 volt supply generated by the on-board regulator. The maximum current draw is 50 mA.
- GND: Ground pins.
- IOREF: This pin on the Arduino board provides the voltage reference with which the microcontroller operates. A properly configured shield can read the IOREF pin voltage and select the appropriate power source or enable voltage translators on the outputs to work with the 5V or 3.3V.
- Reset: Typically used to add a reset button to shields which block the one on the board.

Each of the 14 digital pins and 6 analog pins on the Uno can be used as an input or output, using pinMode(), digitalWrite(), and digitalRead() functions. They operate at 5 volts. Each pin can provide or receive 20 mA as the recommended operating condition and has an internal pull-up resistor (disconnected by default) of 20-50k ohm. A maximum of 40mA is the value that must not be exceeded on any I/O pin to avoid permanent damage to the microcontroller. The Uno has 6 analog inputs, labeled A0 through A5, each of which provides 10 bits of resolution (i.e. 1024 different values). By default, they measure from ground to 5 volts, though is it possible to change the upper end of their range using the AREF pin and the analogReference() function.

Some special functioned pins are as follows.

- Serial / UART (Pins 0 (RX) and 1 (TX)): Used to receive (RX) and transmit (TX) TTL serial data. These pins are connected to the corresponding pins of the ATmega8U2 USB-to-TTL serial chip.
- External Interrupts (Pins 2 and 3): These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value.
- PWM (pulse-width modulation)(Pin 3, 5, 6, 9, 10, and 11): Can provide 8-bit PWM output with the analogWrite() function.
- SPI (Serial Peripheral Interface): (Pin 10 (SS), 11 (MOSI), 12 (MISO), 13 (SCK)): These pins support SPI communication using the SPI library.
- TWI (two-wire interface)(Pin A4 or SDA pin and A5 or SCL pin): Support TWI communication using the Wire library.
- AREF (analog reference): Reference voltage for the analog inputs.

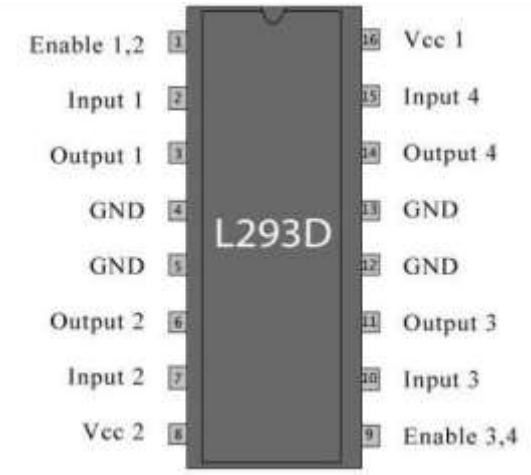
L293D MOTOR DRIVER

The **L293D** is a 16-Pin **Motor Driver IC**. A single L293D IC is capable of running two DC motors at the same time; also the direction of these two motors can be controlled independently. Motors that have an operating voltage less than 36V and operating current less than 600mA can be controlled by this. The IC works on the principle of H-Bridge. H-bridge is a circuit that allows the voltage to be flown in either direction. As you know voltage needs to change its direction for being able to rotate the motor in the clockwise or anticlockwise direction, Hence H-bridge IC is ideal for driving a DC motor. In a single L293D chip there are two h-Bridge circuits inside the IC which can rotate two dc motors independently. Due to its size, it is very much used in robotic applications for controlling DC motors. There are two Enable pins on l293d. Pin 1 and pin 9, for being able to drive the motor, the pin 1 and 9 need to be high. For driving the motor with left H-bridge you need to enable pin 1 to high. And for the right H-Bridge, you need to make the pin 9 to high. If anyone of them either pin1 or pin 9 goes low then the motor in the corresponding section will suspend working. It's like a switch.

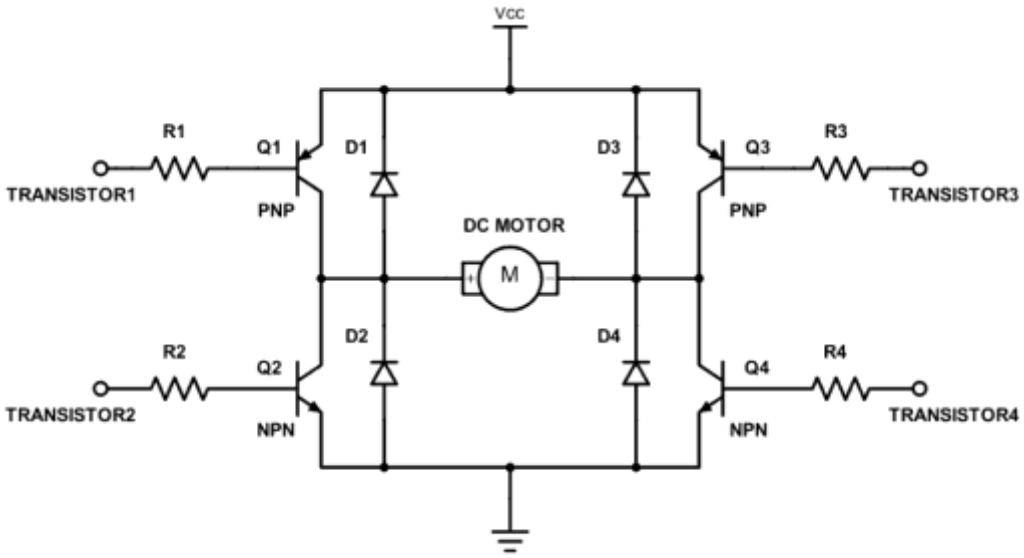
The functions of pins are as follows

- Pin 1 - Enable 1-2, when this is HIGH the left part of the IC will work and when it is low the left part won't work.
- Pin 2 - INPUT 1, when this pin is HIGH the current will flow though OUTPUT 1.
- Pin 3 - OUTPUT 1, this pin should be connected to one of the terminal of motor.
- Pins 4, 5, 12, 13 - GND, ground pins.
- Pin 6 - OUTPUT 2, this pin should be connected to one of the terminal of motor.
- Pin 7 - INPUT 2, when this pin is HIGH the current will flow though OUTPUT 2.
- Pin 8 - V_{CC2}, this is the voltage which will be supplied to the motor.
- Pin 16 - V_{CC1}, this is the power source to the IC. So, this pin should be supplied with 5 volts.
- Pin 15 - INPUT 4, when this pin is HIGH the current will flow though OUTPUT 4.
- Pin 14 - OUTPUT 4, this pin should be connected to one of the terminal of motor.

- Pin 11 - OUTPUT 3, this pin should be connected to one of the terminal of motor.
- Pin 10 - INPUT 3, when this pin is HIGH the current will flow though OUTPUT 3.
- Pin 9 - Enable 3-4, when this is HIGH the right part of the IC will work and when it is low the right part won't work.



An H-bridge is an arrangement of transistors that allows a circuit full control over a standard electric DC motor. That is, an H-bridge allows a microcontroller, logic chip, or remote control to electronically command the motor to go forward, reverse, brake, and coast.



- Q1, Q3: These are NPN transistors. They connect the motor to the ground (negative terminal of the battery).
- Q2, Q4: These are PNP transistors. They connect the motor to +2.2V to +9.6V (positive terminal of the battery).
- R1-R4: These resistors prevent too much current from passing through the base (labelled B) control pin of the transistor. The resistor value of 1 kilohm (1000 ohms) was chosen to provide enough current to fully turn on (saturate) the transistor. A higher resistance would waste less power, but might cause the motor to receive less power. A lower resistance would waste more power, but wouldn't likely provide better performance for motors running on consumer batteries.

- D1-D4: Diodes provide a safe path for the motor energy to be dispersed or returned to the battery when the motor is commanded to the coast or stop. I notice many H-bridge circuits on the web lack these diodes. I suppose that's safe enough for light loads at low voltages, but without diodes, a motor voltage spike can force its way through the unprotected transistors, damaging or destroying them.
- M1: This is a direct-current (DC) motor. These are very common. You can find them in surplus stores online or in salvaged toys. The motor should have only two wires. Measure the resistance of the two motor wires using a multimeter. If the motor resistance is less than 5 ohms, then the transistor parts listed in this article are too weak to power the motor.

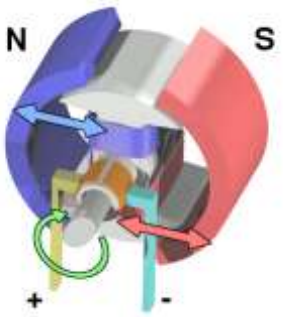
Input 1 = High Input 2 = Low Motor Rotates Clockwise	Input 1 = Low Input 2 = High Motor Rotates Anti-clockwise
Input 3 = High Input 4 = Low Motor Rotates Clockwise	Input 3 = Low Input 4 = High Motor Rotates Anti-clockwise

For rest of the cases the motor won't rotate in any direction.

DC MOTOR

A **DC motor** the device converts direct current electrical energy into mechanical energy. The most common types rely on the forces produced by magnetic fields. Nearly all types of DC motors have some internal mechanism, either electromechanical or electronic, to periodically change the direction of current in a part of the motor.

A coil of wire with a current running through it generates an electromagnetic field aligned with the center of the coil. The direction and magnitude of the magnetic field produced by the coil can be changed with the direction and magnitude of the current flowing through it. A simple DC motor has a stationary set of magnets in the stator and an armature with one or more windings of insulated wire wrapped around a soft iron core that concentrates the magnetic field. The windings usually have multiple turns around the core, and in large motors, there can be several parallel current paths. The ends of the wire winding are connected to a commutator. The commutator allows each armature coil to be energized in turn and connects the rotating coils with the external power supply through brushes. The brushed DC electric motor generates torque directly from DC power supplied to the motor by using internal commutation, stationary magnets (permanent magnet), and rotating electromagnets.



Advantages of a brushed DC motor include low initial cost, high reliability, and simple control of motor speed. Disadvantages are high maintenance and low life-span for high intensity uses. Maintenance involves regularly replacing the carbon brushes and springs which carry the electric current, as well as cleaning or replacing the commutator. These components are necessary for transferring electrical power from outside the motor to the spinning wire windings of the rotor inside the motor.

LED LIGHT

A **light-emitting diode** (**LED**) is a semiconductor light source that emits light when current flows through it. Electrons in the semiconductor recombine with electron holes, releasing energy in the form of photons. The colour of the light (corresponding to the energy of the photons) is determined by the energy required for electrons to cross the band gap of the semiconductor. White light is obtained by using multiple semiconductors or a layer of light-emitting phosphor on the semiconductor device.

In a light emitting diode, the recombination of electrons and electron holes in a semiconductor produces light (be it infrared, visible or UV), a process called "electroluminescence". The wavelength of the light depends on the energy band gap of the semiconductors used. Since these materials have a high index of refraction, design features of the devices such as special optical coatings and die shape are required to efficiently emit light.

MATLAB GUI

MATLAB (an abbreviation of "matrix laboratory") is a proprietary multi-paradigm programming language and numerical computing environment developed by MathWorks. MATLAB allows matrix manipulations, plotting of functions and data, implementation of algorithms, creation of user interfaces, and interfacing with programs written in other languages.

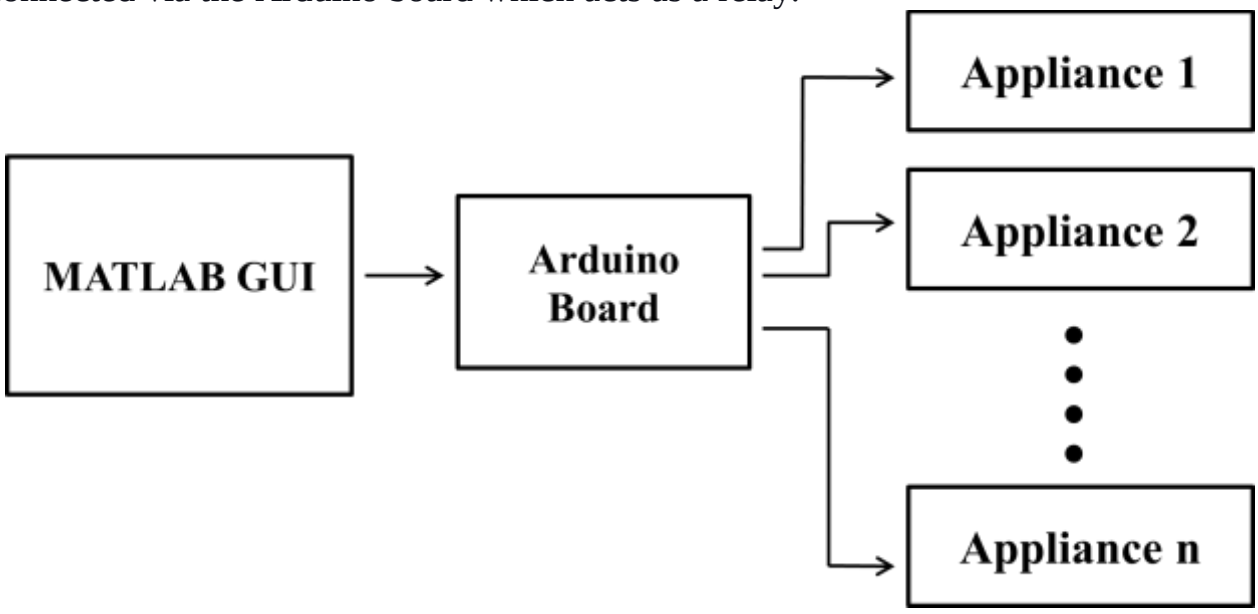
Although MATLAB is intended primarily for numerical computing, an optional toolbox uses the MuPAD symbolic engine allowing access to symbolic computing abilities. An additional package, Simulink, adds graphical multi-domain simulation and model-based design for dynamic and embedded systems.

MATLAB GUI is a graphical user interface that provides points and clicks control of software applications. It gives a graphical environment for controlling a program with the use of pushbuttons, sliders, etc.

For establishing communication of Arduino board with MATLAB, **"MATLAB and Simulink Support for Arduino"** is used**.**

METHODOLOGY

In this project, we intend to control the home appliances using MATLAB GUI as a command panel (used to give command or instruction). The appliances and MATLAB GUI are connected via the Arduino board which acts as a relay.



For this project, the hardware used is

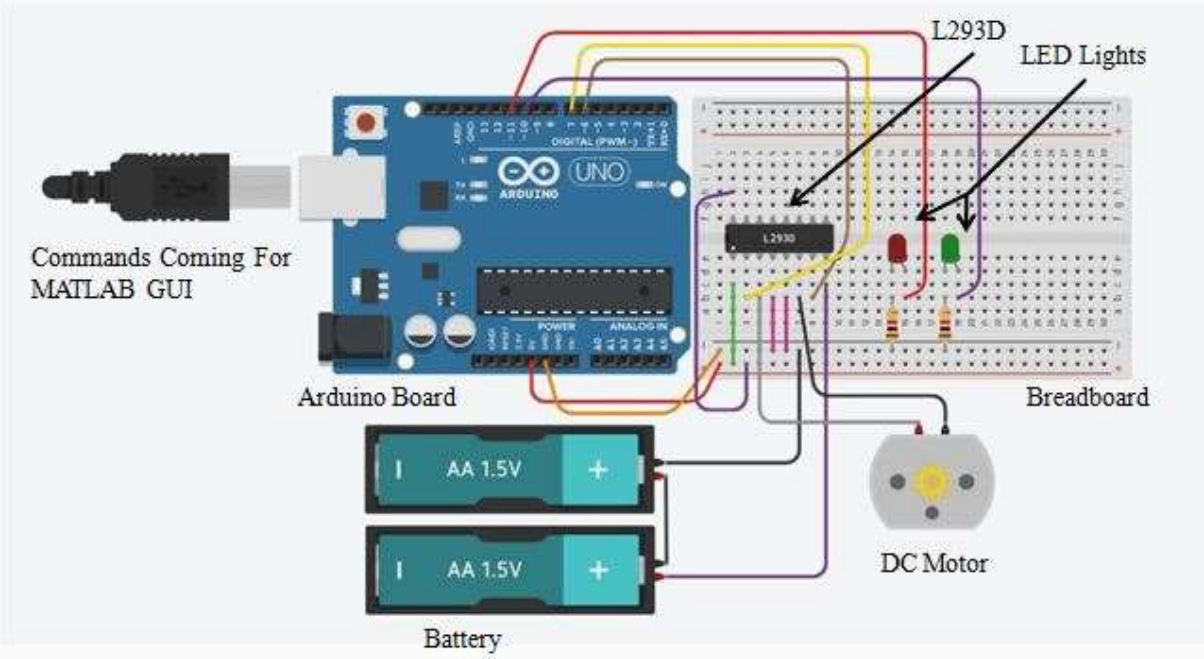
- Arduino UNO Board
- DC Motor
- 1.5V Battery
- LED Lights
- Breadboard
- Jumper Wires

- 1kΩ Resistor
- IC L293D Motor Drive

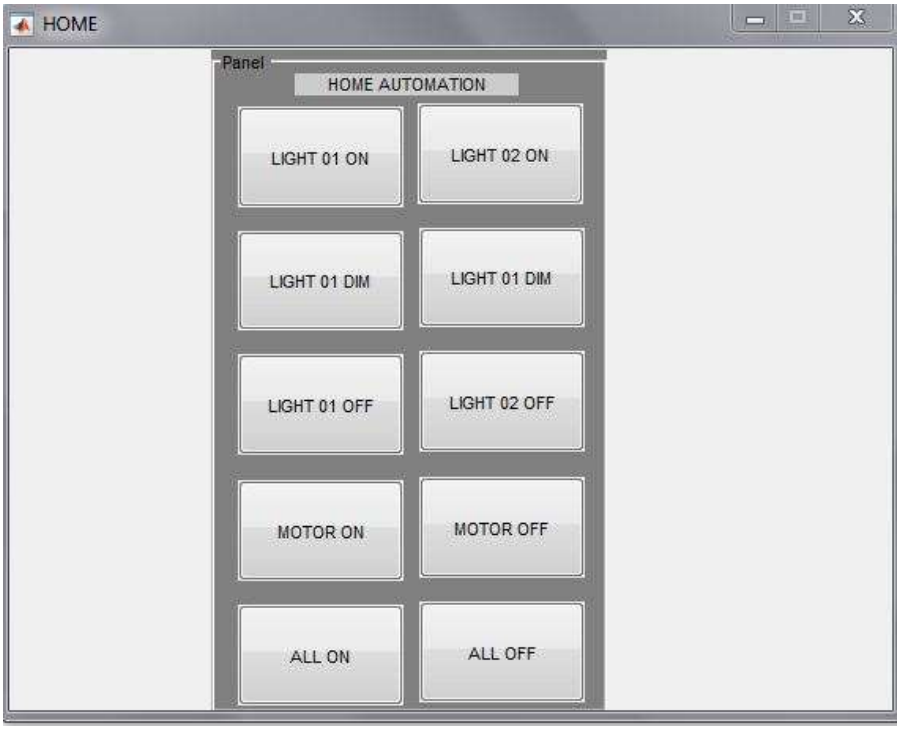
L293D was connected to the breadboard, and its pin 1 is connected to the 5V pin of the Arduino board in order to enable the left part of the IC. Pin 16 is also connected to the 5V pin of Arduino to ensure proper biasing of IC so that the IC works. The positive terminal of the 3V battery is connected to pin 8 of the L293D in order to drive the motor and the negative terminal of the battery is connected to the ground. A DC motor is connected to L293D at pin 3 and pin 6. Pin 2 and pin 7 of L293D are connected to pin D7 and pin D6 of the Arduino board respectively.

Two LEDs are connected to the breadboard. The cathode of each terminal is connected to 1kΩ Resistor and the other end of the resistor is grounded. The anode part of the two LEDs is connected to pin D11 and pin D10 of the Arduino board respectively.

The Arduino board is connected to a computer having MATLAB software via Type B USB cable.



Using **"MATLAB and Simulink Support for Arduino"** and **"MATLAB GUIDE"**, communication between the Arduino board and MATLAB was established. Using MATLAB GUI "**push buttons"** were created to control the home appliances. Ten buttons were created for performing ON, OFF, and Dimming functions. Then each push button was assigned a particular function to do.

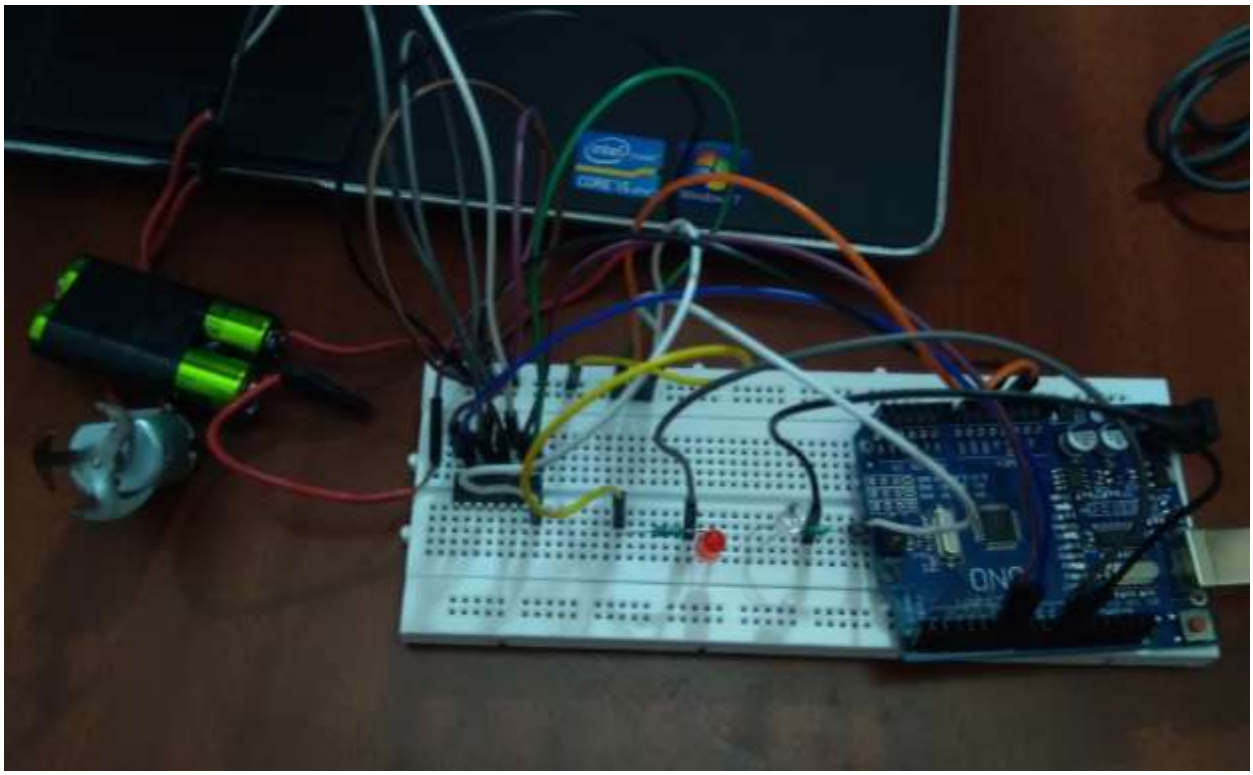


The functions assigned to the respective push buttons are

- LIGHT 01 ON: This is used to switch ON the first LED light.
- LIGHT 02 ON: This is used to switch ON the second LED light.
- LIGHT 01 DIM: This is used to decrease the intensity of first LED light.
- LIGHT 02 DIM: This is used to decrease the intensity of second LED light.
- LIGHT 01 OFF: This is used to switch OFF the first LED light.
- LIGHT 02 OFF: This is used to switch OFF the second LED light.
- MOTOR ON: This is used to switch ON the motor.
- MOTOR OFF: This is used to switch OFF the motor.
- ALL ON: This is used to switch ON both of the LED light and the motor.
- ALL OFF: This is used to switch OFF both of the LED light and the motor.

By clicking on the pushbutton, the respective function initiates. This is how, by using MATLAB GUI, LED lights and motor is controlled.

The hardware set-up used for this project is shown below.



CONCLUSION

This project achieved control over appliances using MATLAB GUI and Arduino Board. Also, it can be concluded that the objectives of this project have been successfully met. This project was designed and implements a cost-effective home automation system. Also, this project designed a user-friendly and safe system to control home appliances especially aimed to aid the elders and handicapped.

FUTURE SCOPE

This project can be extended by using relays to control high power circuits. Also instead of MATLAB GUI, the Bluetooth module or WiFi module can be used to make this wireless and easy to excess. This project has a bright future in the Internet of Things.

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