National Institute of Technology, Warangal

Department of Electronics and Communication Engineering

PROJECT REPORT

E-HOME SYSTEM

Concluding project of **LINEAR IC APPLICATIONS** course by

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E-HOME System project includes

- IR based Burglar Detection
- Automatic Night Light
- Temperature Controlled Fan
- Variable power supply(6-30V)

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Abstract:

This project proposes an E-home system that combines three essential functionalities: Automatic night light activation Burglar detection and Temperature-controlled fan operation. The system leverages readily available sensors and actuators to create a smart home environment that prioritises security, comfort, and energy efficiency.

Introduction:

E-homes, or Electronic homes, are residences equipped with smart devices that automate tasks and improve comfort, security, and efficiency. Imagine a home that keeps an eye out for you. A burglar detection system using sensors like motion detectors and door/window contacts that can trigger alarms if unauthorised entry is attempted, providing peace of mind and deterrence.

No more manually adjusting the thermostat. A temperature-controlled fan automatically activates when sensors detect a rise in temperature, maintaining a comfortable living environment without wasting energy. Stumbling around in the dark is a thing of the past. Light sensors automatically activate night lights when it gets dark, offering a guiding glow for nighttime navigation and improving safety, especially for children or elderly individuals. This automatic system also saves energy by eliminating unnecessary daytime lighting.

Automation brings convenience. It enhances security with automatic alerts and improves energy use by turning things on and off only when needed. With an e-home system, your house adapts to your needs, creating a comfortable and secure living space

Hardware Used:

1. Burglar Detection

Component	Specifications and Quantity
IR transmitter (sensor)	• Peak Wavelength : 870 nm • Angle of half intensity: ± 10° (1)
IR receiver (photo Diode)	• Daylight blocking filter matched with 870 nm to 890 nm emitters • Angle of Half sensitivity: ± 20° (1)
Continuous beep Buzzer (Actuator)	• Input Voltage: 5-24V (1)
uA741 OpAmp	• Max supply Voltage: -15 to +15V • Temperature rating: 0°C to 70°C (1)
NE555 Timer IC	• Max supply Voltage: 16V • Max Operating Frequency: 300kHz (1)
Resistors	• 220Ω(1), 10kΩ(1),1kΩ(1), 100kΩ(1)
Capacitors	• 0.01uF(1), 100uF(1)
Potentiometer	• 10kΩ (1)
IN4007 Diode	• Forward voltage: 0.6 to 0.8V (1)

2. Automatic Night Light

Components	Specifications and Quantity
LDR (photoresistor)	• Operating Voltage: 3 to 5V (1)
uA741 OpAmp	• Max supply Voltage: -15 to +15V • Temperature rating: 0°C to 70°C (1)
Relay	• Normal Voltage: 5V DC • Operate TIme: ≤ 10ms • Release time: ≤ 5ms (1)
2N222 transistor	• Transistor as switch (1)
IN4007 Diode	• Forward voltage: 0.6 to 0.8V (2)
Resistors	• 100kΩ(3), 330kΩ(1), 4.7kΩ(1)
Capacitors	• 0.01uF (1)
LED Light	• Operating Voltage: 9-12V (1)

3. Temperature Controlled Fan

Components	Specifications and Quantity
uA741 OpAmp	• Max supply Voltage: -15 to +15V • Temperature rating: 0°C to 70°C (1)
Thermistor (sensor)	• 100kΩ(ntc) (1)
IN4007 Diode	• Forward voltage: 0.6 to 0.8V (1)
Potentiometer	• 10kΩ (1)
2N222 transistor	• Transistor as switch (1)
Resistors	• 4.7kΩ(1), 33Ω(1)
DC fan	• Operating Voltage: 9-12V (1)

4. Voltage Regulator

Components	Specifications and Quantity
Transformer	• Step down voltage: 9-0-9V
IC 7809 voltage regulator	• 9V regulator (2)
IN4007 Diode	• Forward voltage: 0.6 to 0.8V (8)
Capacitors	• 1000uF(2), 1uF (2)
Plug	• Supply to transformer connector (1)

5. Variable Power Supply

Components	Specifications and Quantity
Transformer	• Step down voltage: 12-0-12V (1)
IC 7805 voltage regulator	• 5V regulator (1)
IN4007 Diode	• Forward voltage: 0.6 to 0.8V (4)
Capacitors	• 1000uF(1), 0.1uF (2)
Plug	• Supply to transformer connector (1)
Potentiometer	• 20kΩ (1)

Strip board(3), Connecting wires, Soldering Iron, flux, soldering silver, switches are of the common components used.

Project Working:

1. **Burglar detection**

An IR transmitter and receiver pair form the core of this burglar detection system. The IR transmitter constantly emits an invisible infrared beam. The receiver, positioned directly across from the transmitter, continuously detects this beam. An operational amplifier (op-amp) configured as a comparator plays a critical role. The receiver's output voltage is fed to the inverting terminal of the op-amp, while a constant reference voltage is applied to the other. As long as the IR beam remains uninterrupted, the receiver output stays high. This keeps the op-amp's output low.

Here's where the 555 timer comes in. It's set to monostable mode, meaning it generates a single, timed pulse upon receiving a trigger. However, in this setup, the high output from the op-amp acts as a continuous "enable" signal for the timer. Now, if an intruder breaks the IR beam, the receiver's output voltage increases. This change flips the op-amp's output to low. The ‘Low’ output from the op-amp acts as a trigger for the 555 timer, initiating a timed pulse. This pulse can be used to activate the alarm

Once the pulse duration set on the timer elapses, the timer automatically resets, and the system waits for the IR beam to be interrupted again. This combination of IR detection, op-amp comparison, and 555 timer timing creates a reliable system for identifying and responding to potential break-ins.

Calculations:

T_x and R_x (Transmitter IR and Receiver Photo Transistor) :

- V_Tx : 1.22 V
- V_R220 : 7.79 V

No Obstacle in b/w Tx and Rx case :

- V_Rx : 0.01 V
- V_R10k : 8.88 V

Obstacle in b/w Tx and Rx case :

- V_Rx : 6.35 V
- V_R10k : 2.62 V

<u>Comparator Section:</u>

No Obstacle in b/w Tx and Rx case:

- V_Pin2 : 0.01 V
- V_Pin3 : 3.66 V (R_pot at 4.07 kΩ)
- V_Pin6 : 8.1 V
- V_Diode : 0.44 V

Obstacle in b/w Tx and Rx case :

- V_Pin2 : 6.35 V
- V_Pin3 : 3.66 V (R_pot at 4.07 kΩ)
- V_Pin6 : 1.84 V
- V_Diode : 0.44 V

<u>Mono Stable Multivibrator Section:</u>

No Obstacle in b/w Tx and Rx case:

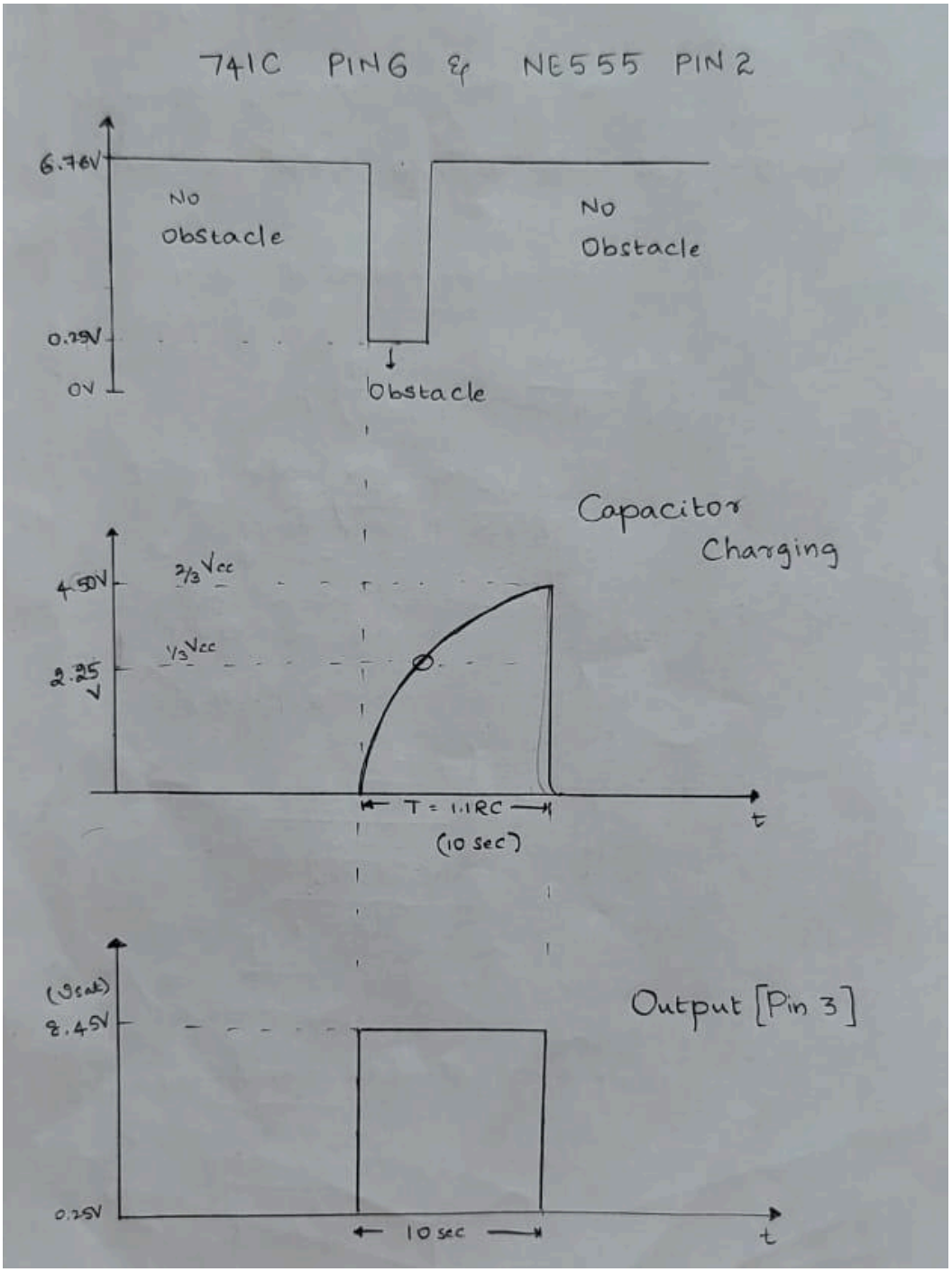
- V_Pin2 (Trigger) : 6.76 V
- V_Pin3 (Output) : 0.13 V

Obstacle in b/w Tx and TX case:

- V_Pin2 (Trigger) : 0.25 V
- V_Pin3 (Output) : 8.45 V
- Time_Period (T) : 1.1xRC

R : 100 kΩ C : 100 µF T : 11 sec

Note : For 11 sec after an obstacle is detected, the buzzer will be ON and then the buzzer will be automatically turned OFF. This time period (T) can be varied with the variation in the values of R and C.



2. Temperature controlled Fan

In a temperature-controlled fan system using an op-amp comparator, a temperature sensor like thermistor acts as the key player. As the temperature rises, the thermistor's resistance decreases as it is a negative temperature coefficient type . This change in resistance is converted into a voltage shift. This voltage is fed to one input of the op-amp comparator, while a reference voltage, set by 10k

potentiometer, is fed to the other. When the temperature is low, the thermistor's voltage remains higher than the reference voltage. The op-amp interprets this as a "low" signal and keeps the output low. This low output from the op-amp prevents a transistor from turning on, keeping the fan off. However, as the temperature increases and the thermistor's voltage dips below the reference voltage, the op-amp interprets this as a "high" signal. This triggers a high output from the op-amp, which activates the transistor. The now-conducting transistor allows current to flow to the fan, turning it on and providing cooling relief. This creates a feedback loop, where rising temperatures automatically activate the fan and falling temperatures deactivate it, maintaining a comfortable environment.

Calculations:

- R_pot : 2.09 kΩ
- R_NTC : 7.37 kΩ (At 32 ℃)

At 32℃

- V_Pin2 : 5.49 V (Due to R_NTC)
- V_Pin3 : 1.881 V (Due to R_pot)
- V_Pin6 : 1.80 V (Offset Voltage, compensated with 1N4007 and Resistor [33Ω])

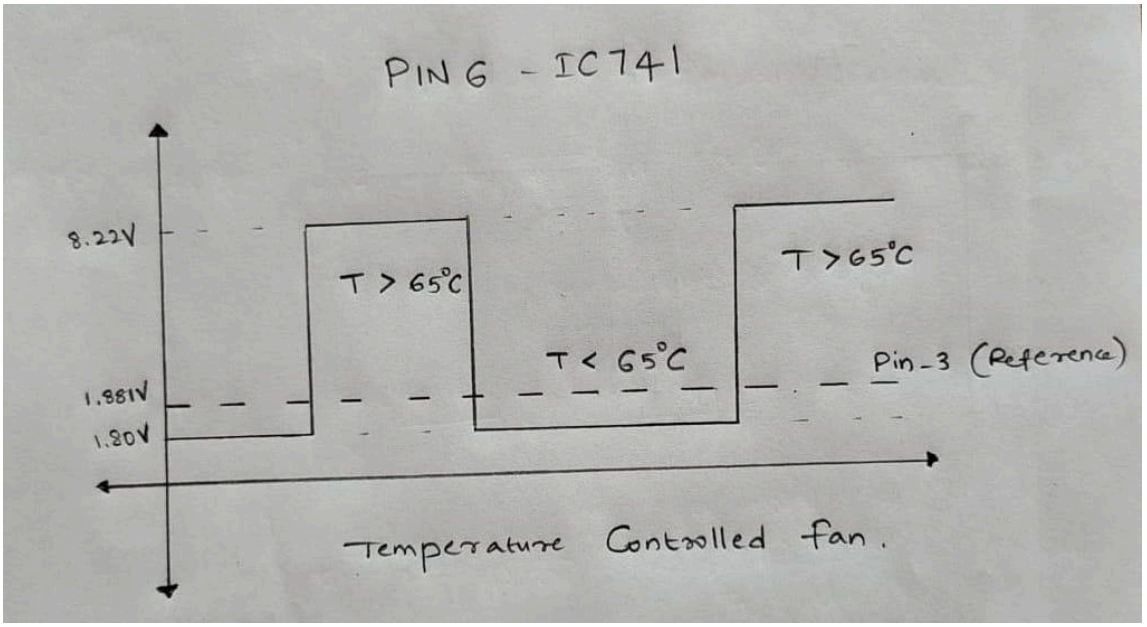
At Higher Temperature (> 65℃)

$$R(T) = R_0 \cdot e^{(\beta \cdot (1/T - 1/T_0))}$$

- R0 : 10 kΩ (At 25℃)
- β : 3950 ± 5% K
- R_NTC : 2.09 kΩ (At around 65 ℃)
- V_Pin2 : < 1.88 V
- V_Pin3 : 1.881 V (Due to R_pot)
- V_Pin6 : 8.22 V

Result : At a temperature of > 65℃, the Fan will be ON and the Fan is OFF for T < 65℃ .

Note : As the R_pot value varies, the temperature (T) over which the Fan will be 'ON' can be controlled. Here in this case, > 65℃ is considered.



3. **Automatic Night Light**

The heart of this automatic night light is the LDR (Light Dependent Resistor). As darkness falls and light levels decrease, the LDR's resistance rises. This translates to a higher voltage output from the LDR, fed to the inverting input of an op-amp configured as a Schmitt trigger. During daylight, the inverting terminal voltage stays higher than the V_Pin3 . The op-amp interprets this as a "high" signal, keeping its output low. This low output from the op-amp holds a transistor off, preventing current flow and keeping the night light off.

When darkness arrives and the LDR's resistance increases significantly, the voltage across the inverting terminal becomes lesser than the V_Pin3 (β Vsat) voltage. This triggers the Schmitt trigger's key feature: hysteresis. It has two distinct switching points. Once the V_Pin3 voltage exceeds the V_Pin2, the op-amp's output abruptly flips to "high." This high output from the op-amp activates the transistor, allowing current to flow through a relay module. The relay then switches on, completing the circuit for the night light, and illuminating it.

Calculations:

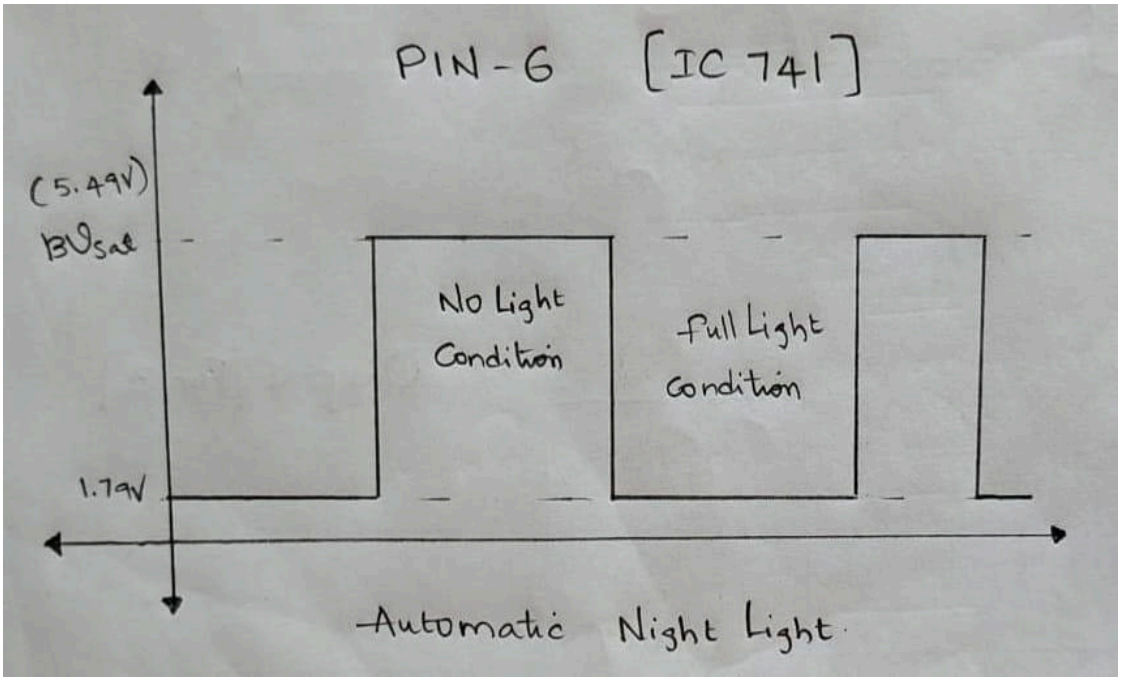
+Vsat : 5.49 V **-Vsat : 1.79 V (Offset)**

β : 0.232 (R1 is 100k and Rf is 330k)

1. Full light conditions
   - V_Pin2 : 3.2V
   - V_Pin3 : 0.39V
   - V_Pin6 : 1.79V (β Vsat due to offset voltage)
   - LDR_R : 116kΩ
2. No Light conditions
   - V_Pin2 : 0.38V
   - V_Pin3 : 1.17V
   - V_Pin6 : 5.49V (β Vsat due to Vcc of 9V)
   - LDR_R : 622kΩ

Note: As we are using 5mm LDR, it has a dark resistance range from 0-20MΩ and maximum operating temperature 800℃.

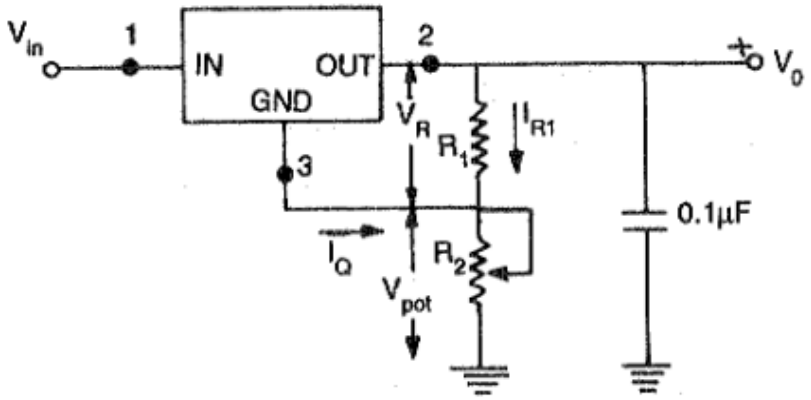
Result: When lights are turned off, resistance of LDR increases which flips output of Op amp and transistor high and switches normally closed pin of Relay to normally open. This magnetic switching action makes Light turn ON.



4. Variable Power Supply

We have designed a power supply circuit that can be used as an adjustable voltage regulator using IC 7805 to produce a constant DC voltage ranging from 6V to 33V. Here in this case the 3rd terminal of the 7805 is not connected to the GND terminal. The property of the 7805 to produce a constant DC 5V is exploited and it is provided to the resistance R1 as shown in the figure. The 3rd terminal is connected to a variable resistor which is also connected to the one end of R1.

As the Quiescent current flowing through the 3rd terminal is very small (4.2 mA) , the voltage generated by this small current is negligible if R2 (Pot) is chosen as a small value. And the total DC voltage generated is the summation of the voltage drop across R1 (constant 5V) and R2 (Pot). We have designed the value of R1 to be 4.7 kΩ and R2 (Pot) to be varying from 0.94 kΩ (6V) to 5.32 kΩ (33V).



$$V_o = V_R + V_{pot}$$

$$= V_R + (I_Q + I_{R1})\, R_2$$

$$= V_R + I_Q R_2 + \frac{V_R}{R_1} R_2$$

$$V_o = (1 + R_2/R_1)\, V_R + R_2 I_Q$$

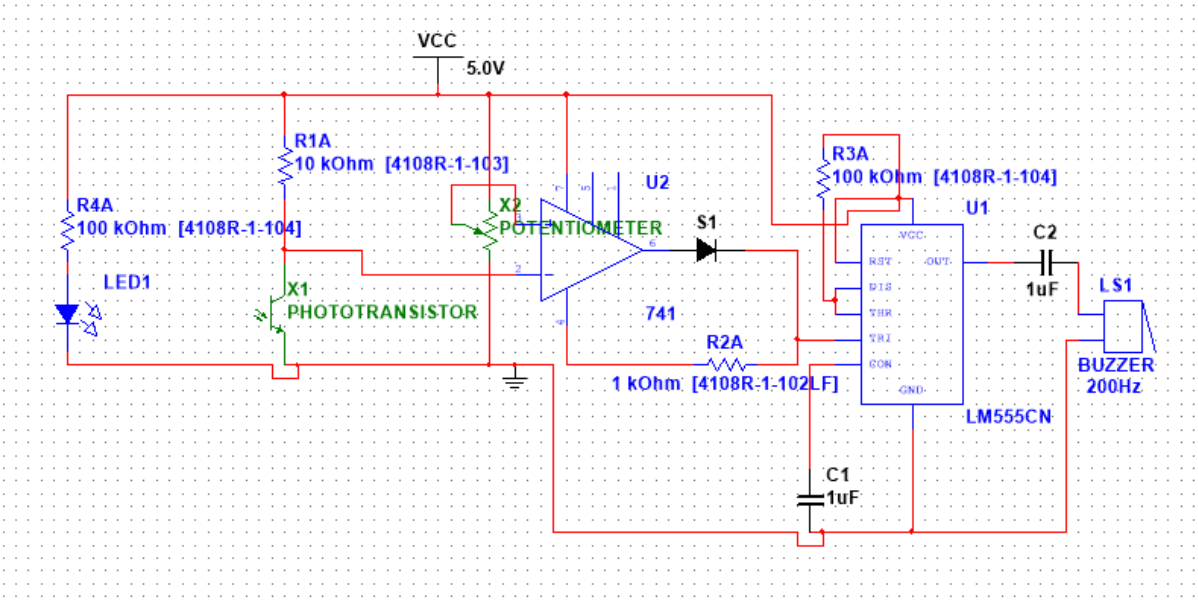
Calculations:

- R_R1 : 4.7kΩ
- R_pot : 1k-20kΩ
- Transformer : 12-0-12
- For R_pot=1kΩ, Vo(min) :6.06V
- For R_pot=20kΩ, Vo(max) : 26.27V

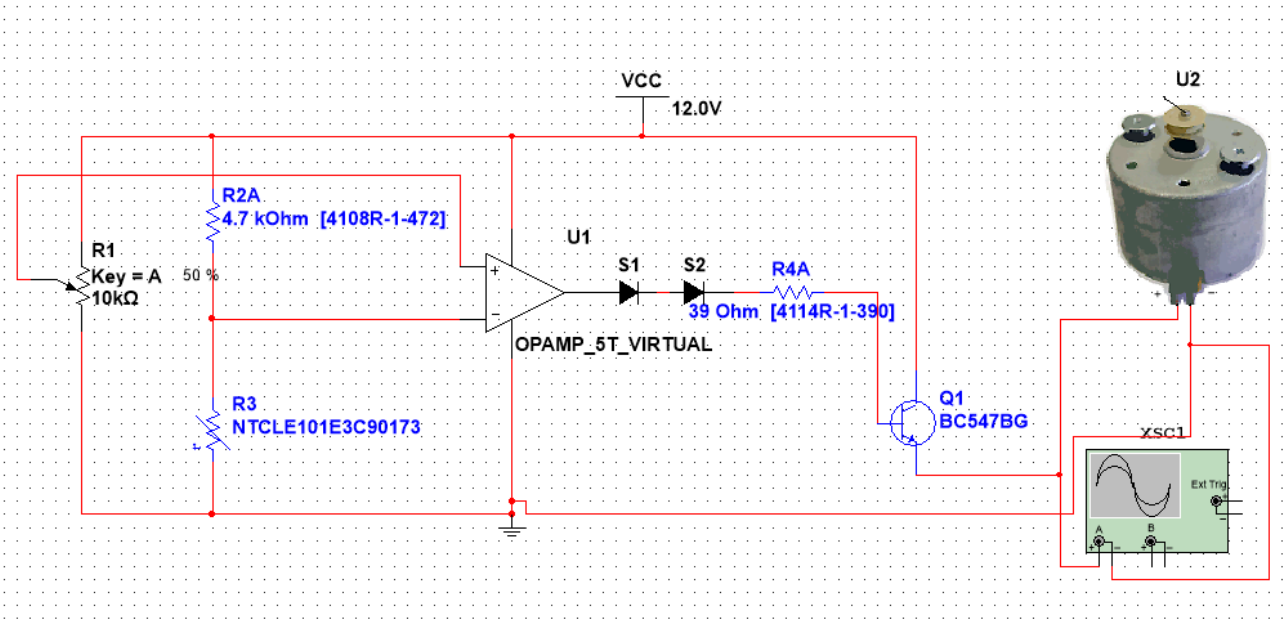
Result: As R_pot resistance is varied from 1kΩ to 20kΩ, the output voltage varies 6V to 26V.

Multisim Simulations:

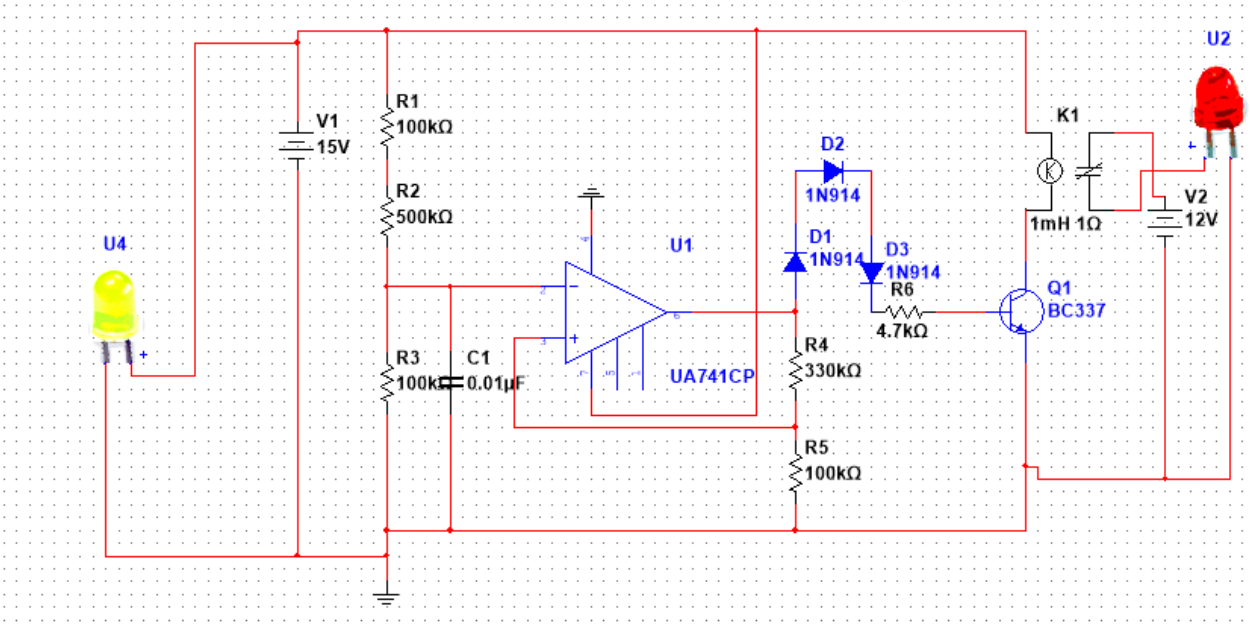
1. Burglar detection using Op amp and 555 Timer IC



2. Temperature Controlled Fan using Op Amp

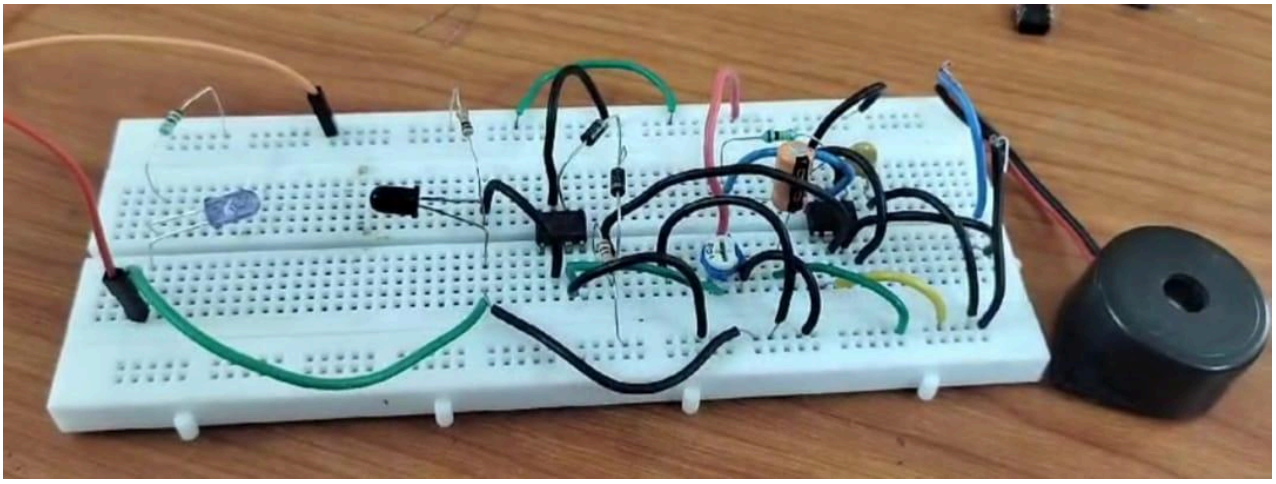


3. Automatic Night Light using Op Amp

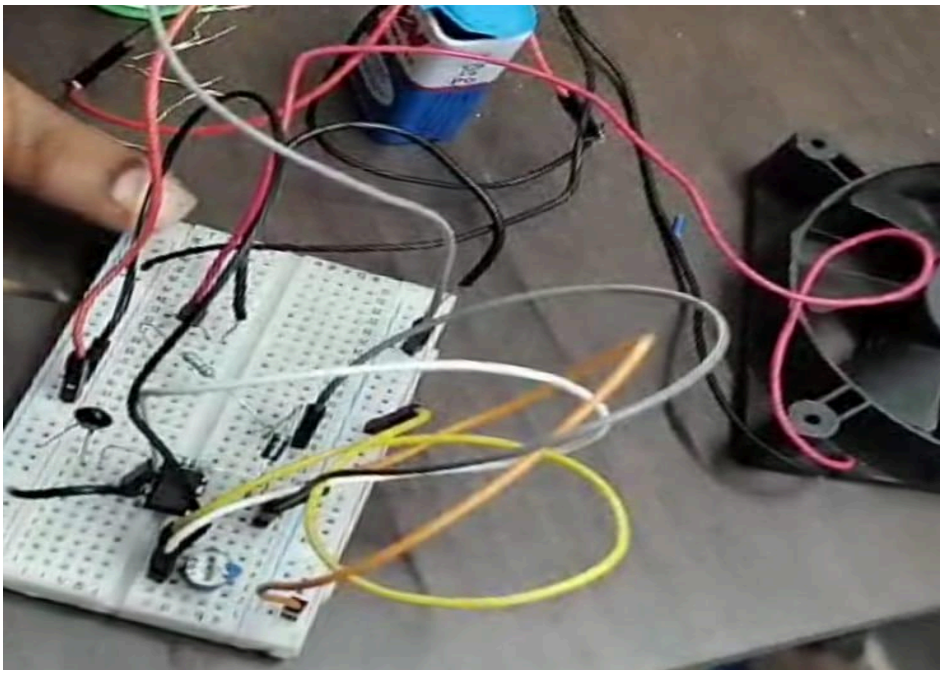


Breadboard Working:

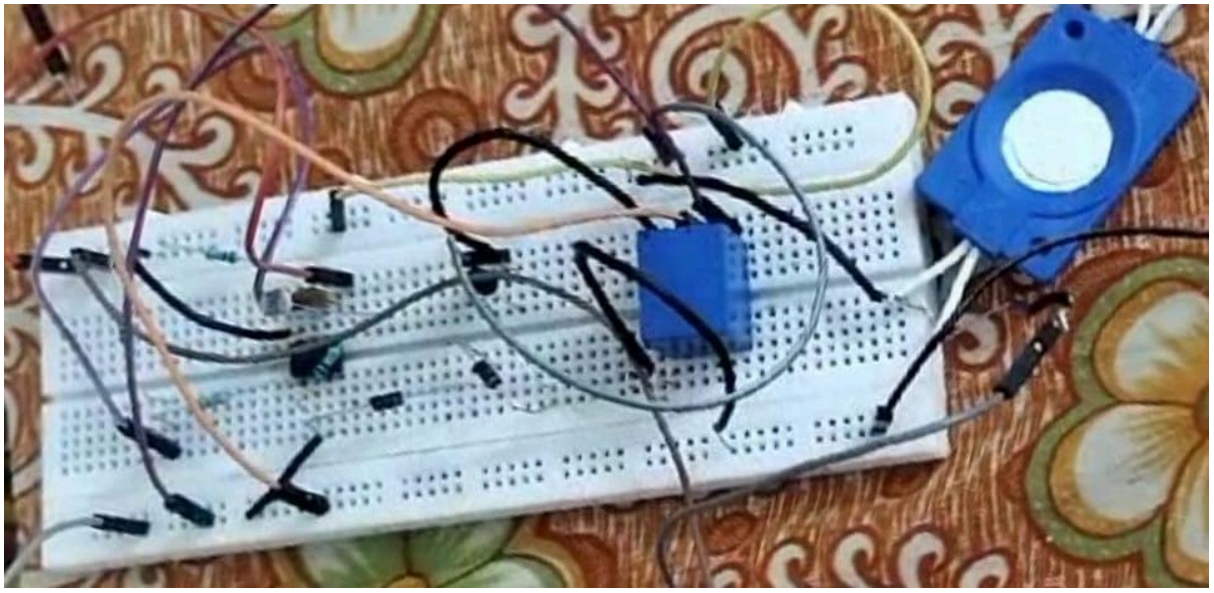
1. **Burglar Detection**



2. **Temperature Controlled Fan**

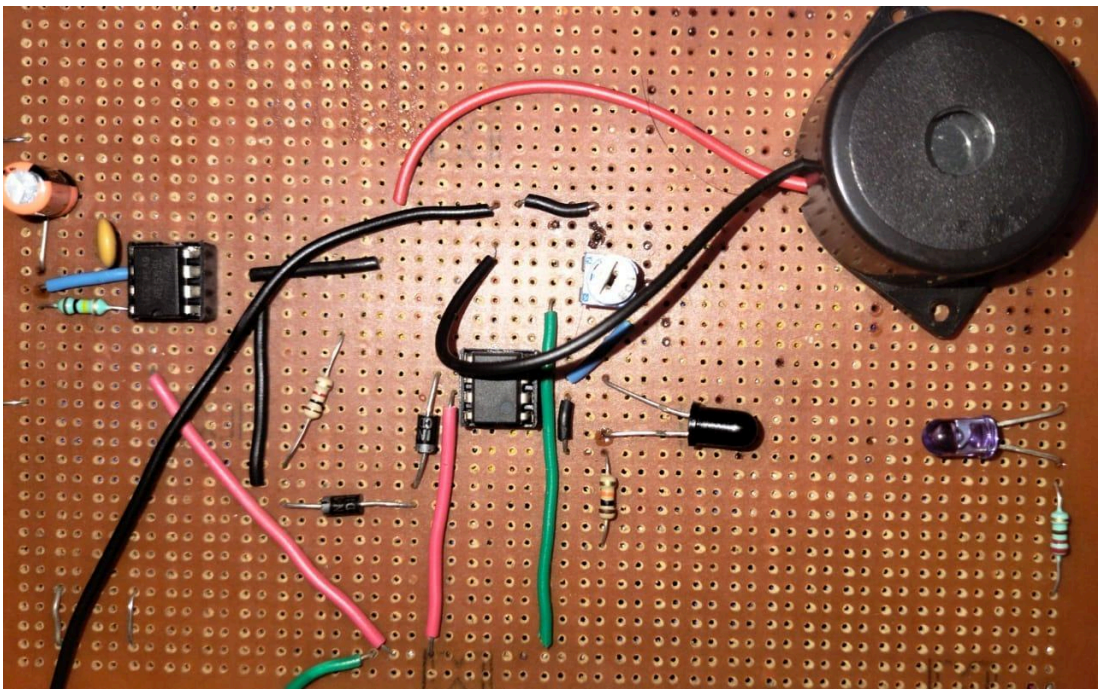


3. **Automatic Night Light**

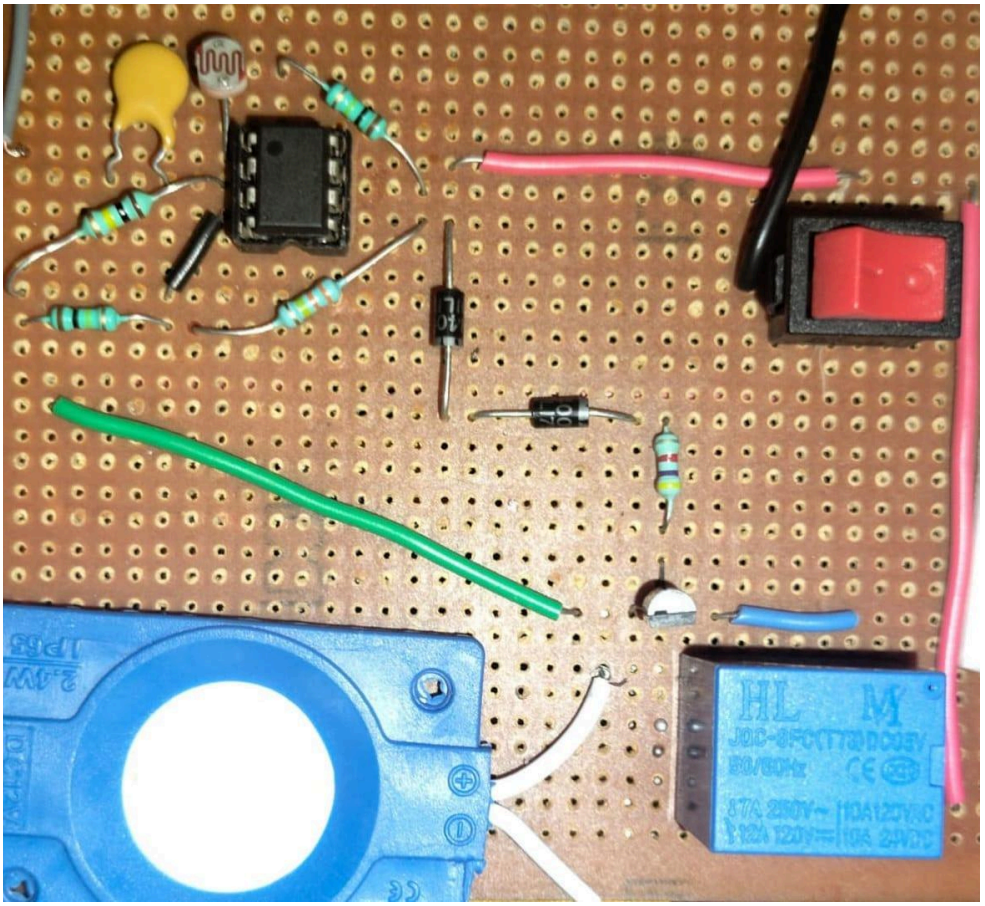


Strip Board Working:

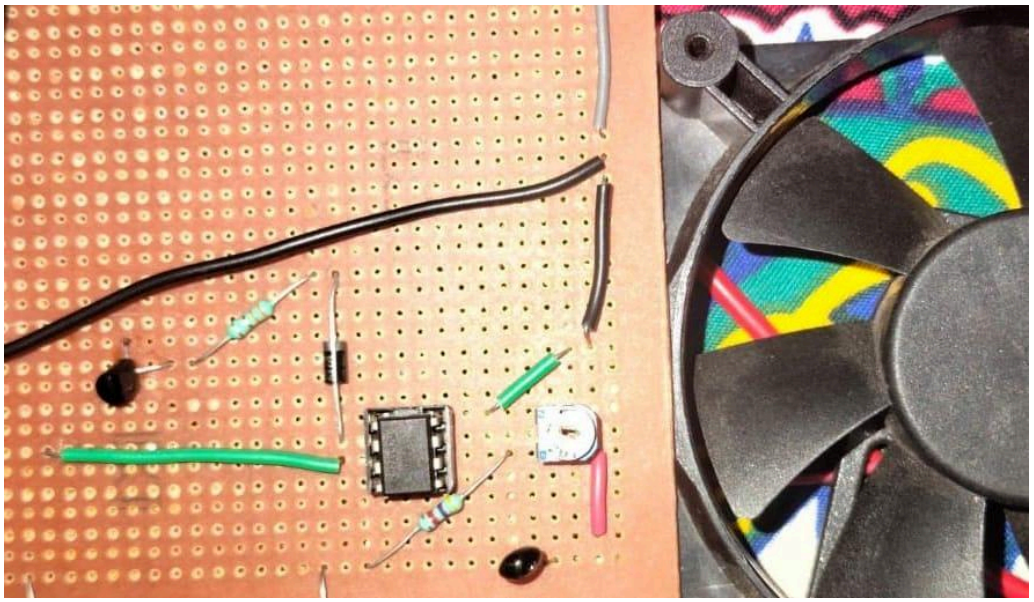
1. **Burglar detection**



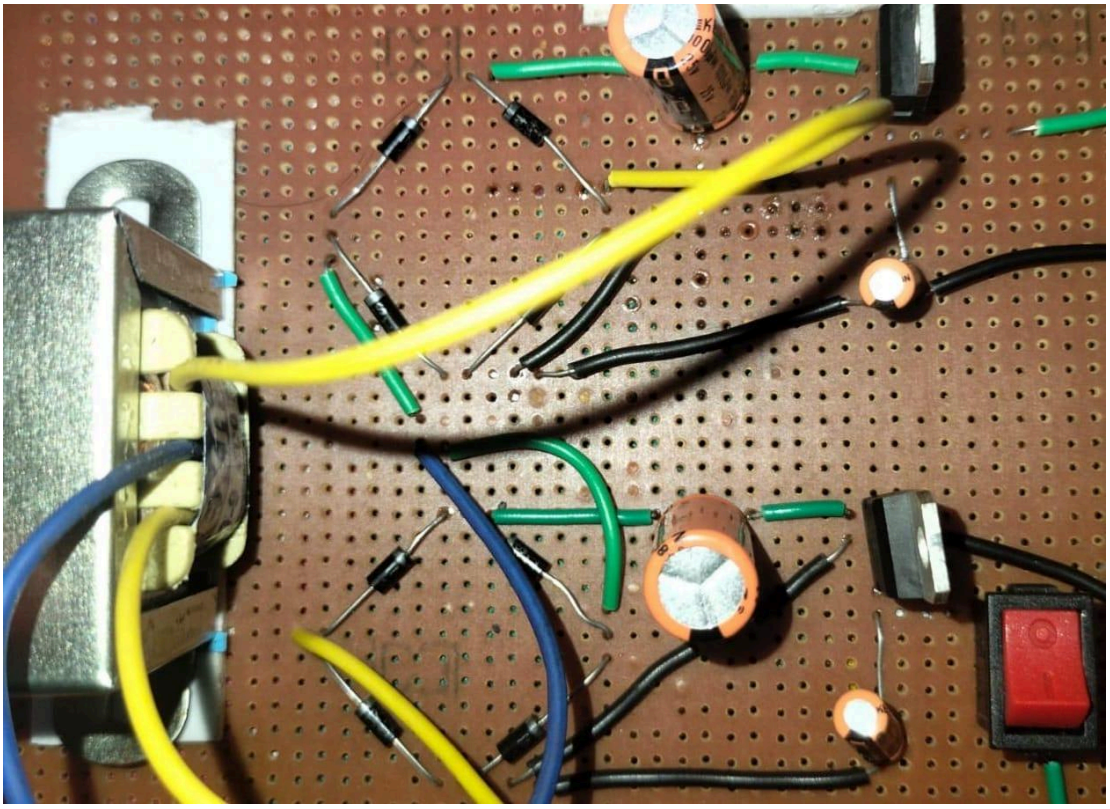
2. **Automatic Night Light**



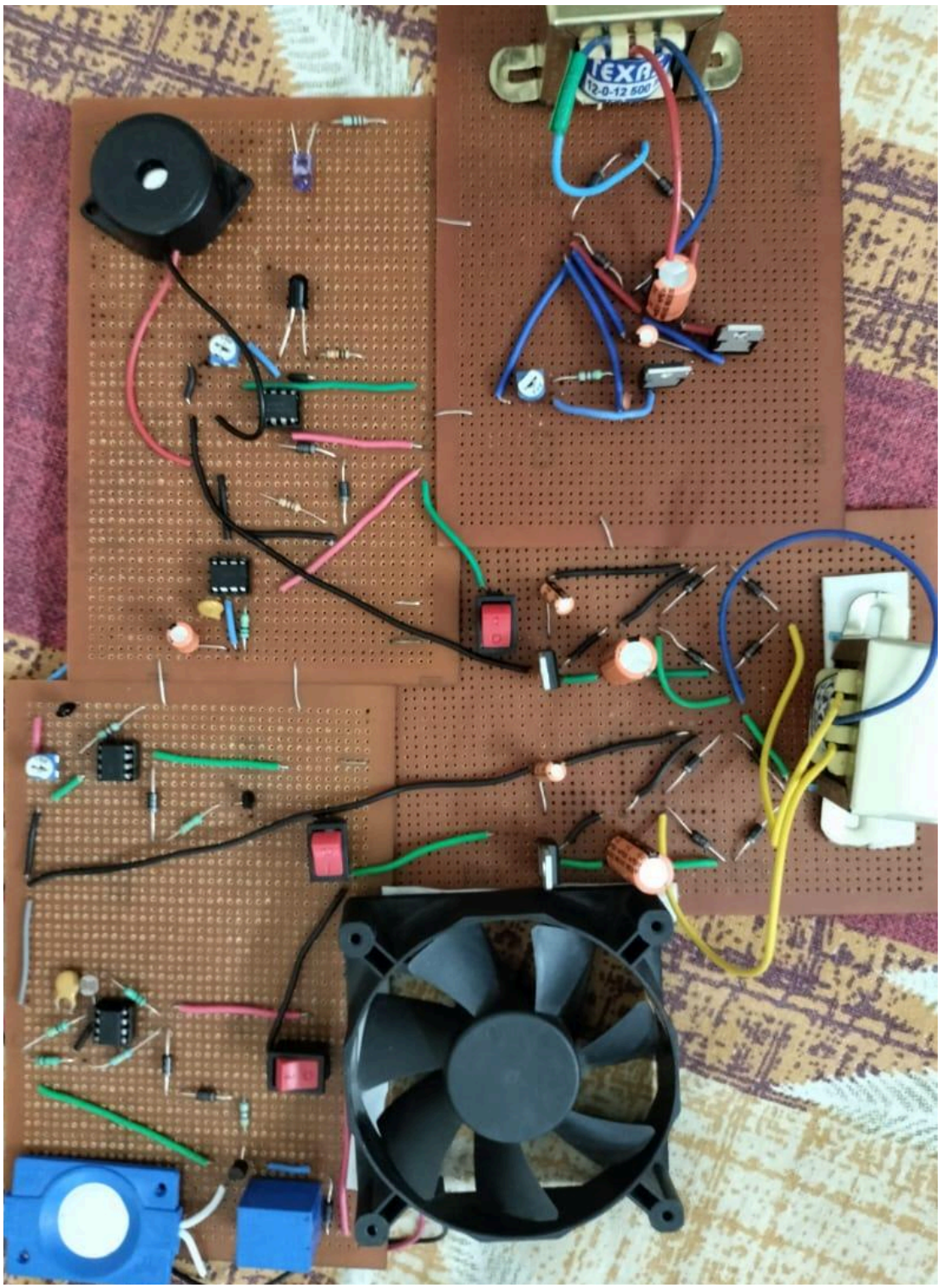
3. **Temperature Controlled Fan**



4. **Voltage Regulator**



Overall Circuitry



Applications:

Burglar Detection:

- **Residential Security**: Protects homes and apartments from unauthorised entry.
- **Businesses**: Secures offices, retail stores, and warehouses after business hours.
- **Critical Infrastructure**: Monitors sensitive areas in power plants, data centres, and other vital facilities.

Temperature Controlled Fan:

- **Homes**: Maintains comfortable temperatures, especially beneficial in regions with fluctuating climates.
- **Greenhouses**: Regulates temperature for optimal plant growth.
- **Server Rooms**: Ensures proper cooling to prevent overheating of critical equipment.

Automatic Night Light:

- **Homes**: Provides safe navigation for children and adults at night, preventing accidents.
- **Hospitals and Nursing Homes**: Offers low-level lighting for patient safety and staff convenience during nighttime checks.
- **Hotels and Corridors**: Offers a guiding light for guests navigating unfamiliar spaces at night.

Expenditure:

- one thousand two hundred fifty rupees only (1250/-)

Conclusion:

This project demonstrates a simple E-home system combining security, comfort, and efficiency. The 555 timer offers precise timing control for the Burglar detection, while op-amps provide adjustable thresholds for temperature control. These versatile ICs are ideal for home automation due to their affordability, low power consumption, and ease of use. By integrating these components, this project showcases the potential of E-home systems to create a smarter, more responsive living environment.