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AUTOMATIC LIGHT SWITCHING AND TEMPERATURE BASED FAN SPEED CONTROL USING MICROWAVE, TEMPERATURE AND LDR SENSOR

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Abstract - *Since energy is the driving force for necessities, ease and comfort the use of energy has tapered and hence most of the times we tend to disgrace its use, hence the following paper will discuss and emphasize a method for automatic switching of lighting system and temperature apparatus, by checking for the intensity of sunlight, detecting human presence and controlling fan speed depending on the temperature of the room. Our design can be categorized into human detection circuit using Microwave sensor (RCWL-0516), LDR based light detection circuit to detect the sunlight and temperature sensor (DS18B20) based speed control of fans along with its switching circuits. There will be two modules associated, first will be a combination of Microwave sensor and LDR for lighting fixtures and the second module will be a combination of Microwave sensor and a temperature sensor for fans. The basic idea behind this project is to conserve the amount of power which is otherwise wasted in case of absence of an entity or human behaviors. The system will restrict the turning ON/OFF of the lights utilizing sunlight entering the room and turning ON/OFF the fan automatically based on the temperature detected. The design gives the user its flexibility to choose the modes of operation either automated that is based on sensors or just the conventional switching.*

Key Words: Microwave Sensor, Temperature sensor, LDR, Light Intensity, Energy Conservation, Doppler Effect.

1. INTRODUCTION

Automation in the recent years has become a leading trend. Since undertaking of one machine replaces a significant amount of man power, automation has developed its roots and propagated its influence in all the sectors of industries, commerce and now in residencies too. Wherein the generation is made at the most efficient end it is a challenge to transmit this generated supply and above all utilizing the supply efficiently is now, a task. Around the total percentage of the energy utilization 20% of the energy is wasted just because of the negligence and lack of awareness in the people about energy and its usage.

Let me give you an example to explain how exactly the energy is wasted; when the person goes out from the room and forgets to turn the lights OFF, also sometimes we refrain from getting up just because we are being lazy and the lights/fans remain ON unwantedly. The more the human involvement we reduce the more the errors we are going to reduce and conserve energy undoubtedly thus eventually land up reducing minor electrical accidents. Conservation of the energy is as important as generation because generation completely depends upon conservation. 19% of energy use in the world is used for lighting, and 6% of greenhouse emission in the world is derived from this energy.

Energy saving has attracted great attention as a global issue because of recent environmental problems. Most of the people are trying to produce energy using renewable sources and actually investing large amounts of finance in such utilities rather people should try to use the energy efficiently since generation is not the concern, but utilization is! Electricity has its core roots in the generation but when the utilization is not up to the mark there is always a burden on the generating capacities of the generating station. Hence utilization needs to be proper enough to ensure energy conservation. Indulging automation in the system will make system more compact. People are now aware of saving energy that is consumed daily or simply conserving energy which was thus wasted unknowingly. We see violation of energy almost in all the sectors whether it be commercial or industrial. Hence to overcome this power loss we either intentionally have to turn off the lights while leaving the room or just find out a better solution to overcome this power loss which thus leaves us with just one option getting automation in the system. Also this adds up in the account like, indulging automation in the system makes the system more effective and renders it clutter free.

2. CONCEPTUAL DETAILS

2.1 COMPONENTS USED

i. **Arduino Mega-2560**: The Arduino Mega 2560 is a microcontroller board based on the ATmega2560. It has 54 digital input/output pins (of which 14 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. It contains everything needed to support the microcontroller. The Arduino Mega2560 can be powered via the USB connection or with an external power supply.

ii. **Microwave Sensor (RCWL-0516):** The microwave sensor is a simple sensor that uses Doppler radar to detect moving objects using microwaves. This differs from the method used by a regular infrared (IR) sensor as the microwave is sensitive to a variety of objects that can reflect microwaves, and its sensor readings are not affected by the ambient temperature.

iii. **Temperature Sensor (DS18B20):** This is a 1-wire programmable Temperature sensor from maxim integrated. The core functionality of the DS18B20 is its direct-to-digital temperature sensor. It has an operating temperature range of –55°C to +125°C and is accurate to 0.5°C over the range of –10°C to +85°C.

iv. **LDR (Light Dependent Resistor):** A photoresistor or LDR as the name suggests will change its resistance based on the light around it and works on the photoconductivity principle. When the resistor is placed in the dark room it will have a resistance of a few Mega ohms and as we gradually impose light over the sensor its resistance will start to decrease from Mega Ohms to few ohms. It can detect the amount of light falling on it and thus can predict days and night.

v. **Fan Regulator Resistance:** of the wire Resistors are made by winding a wire around a core and its resistance depends upon the resistivity, cross section and the length of the wire. If the value of resistor decreases it eventually increases the voltage that results in increasing the speed and vice versa. There are tappings provided that ensures variety of resistances and thus affecting voltages. The tappings are kept outside for adjusting the variable value of resistance for achieving the speed of fan.

vi. **Miscellaneous Equipments:** All the other miscellaneous equipment are LCD, Relay and Relay drivers. LCD displays all the results while relays are driven by the relay drivers(ULN2003) used to drive the load

2.2 CONCEPT OF THE SYSTEM

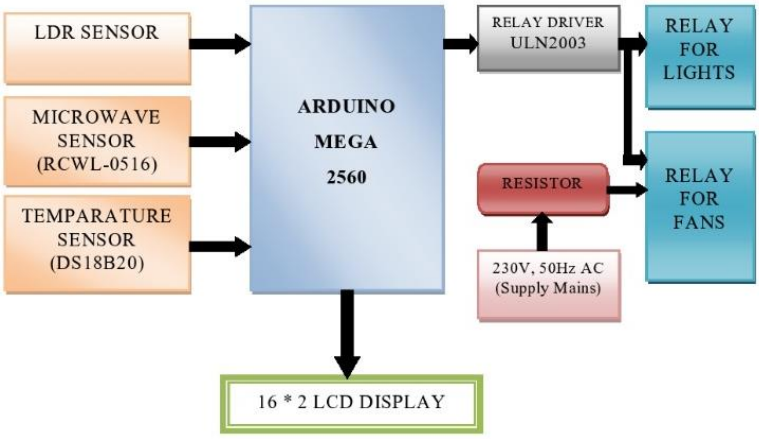

Fig -1: Block Diagram of the system

Arduino Mega2560 serves as the heart of the entire system that blends together the input and the output side of the system. Since there are two lights and two fans in the room that we have implemented in this scheme, out of which one light and one fan in one section each of the system having 2 sections which is divided by a beam. We have thus used 2-LDR's and 2-Microwave sensors with 1-Temperature sensor to the input side. Whereas the output is reflected by the LCD, resistor that changes the speed and the load that is operated.

The following room plan is of the room that we have automated:

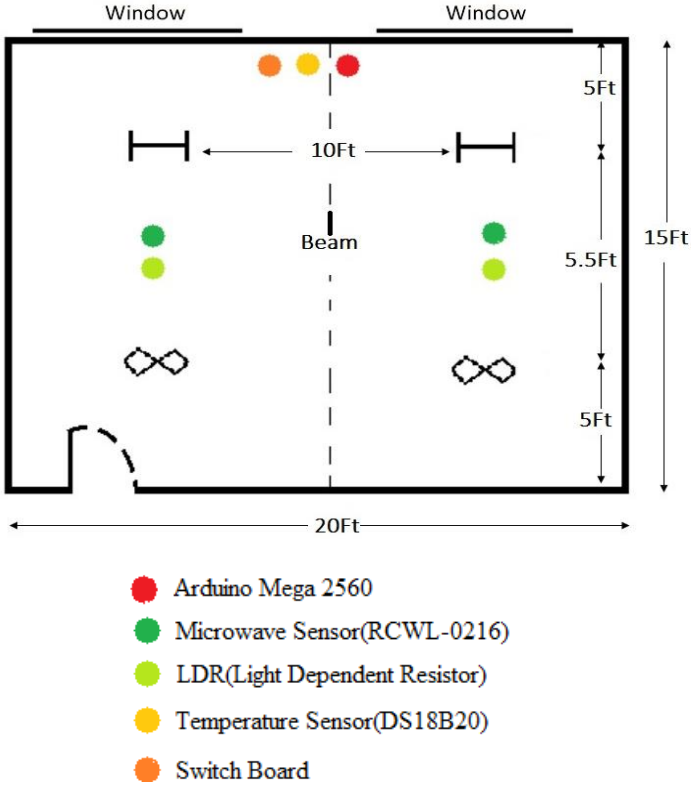

Fig -2: Room Plan with Sensor Sectioning

The working of the project can be thus explained in the room containing the respective Microwave, LDR and temperature sensor in the following way;

- **For Lights**: The first action that the entire circuit does is analyzing the inputs. The circuit will first sense the no of entities in the room by the use of microwave sensor. Since the sensor is a digital sensor it will send the output in terms of 0's and 1's to the Arduino. The next step in lighting circuit is carried out by LDR. LDR (Light Dependent Resistor) senses the amount of light (Lux) present in the room and being an analog sensor it is connected to the analog pin of the Arduino. The sensed output by the LDR will be compared with the desired output of lux levels which will be pre-determined.

Switching of lights: The signal received by the Arduino (Micro Controller) from Microwave sensor and the result achieved through the LDR will thus tell the Arduino to take the necessary step. Since energy conservation is our sole purpose the Arduino will wait for both the results that is result through the microwave sensor and the result through the LDR (by means of comparing it with the desired level) to be appropriate. The light will then be turned ON by the function of the relay. If the microwave sensor detects an entity and the light measured through the LDR is low/below the desired lux level only and only then the light will be turned ON. This clearly states that Arduino will wait for both the commands to be true. The common terminal of the relay connected to 230V will be given to NO which was otherwise NC. We did this with the help of ULN2003 Relay driver which will either sink or source the supply.

- **For Fans:** When the person enters the room more precisely in the particular section the microcontroller will first receive the information from the microwave sensor about the human presence in the form of 0's and 1's, then it will check for the signal from the temperature sensor, the signal from the temperature sensor will be digital signal which will contain the data containing the information about the room temp. This is so done by predetermining the temperatures so that it suits the current temperature scheme. When a temperature is sensed by the sensor it will eventually compare it with the defined values for the operation of fans.

Switching of fans: The signal received by the Arduino in case of fans is through the temperature sensor, Microwave sensor that we have used. Once the motion is detected and the temperature is recorded by the Arduino it will then select the state for the fans that is either turn ON/OFF. The question than arises about its speed control. We have incorporated separate relays for each fan speed (which means we have 5 separate dedicated relays for each respective fan speed). Each relay is been tapped through a specific resistance that drops the voltage levels for the fans eventually resulting into speed losses. To be more specific tappings of the resistor are taken out and fed to the common terminals of the relays. Arduino is fed through a specific set of command that will decide which relay associating to what speed should be in the picture. Which means the COM that is fed through a specific voltage that is been dropped and managed by the resistor is given to the NO of the relay where the load is connected. Hence depending on the resistor value there is a change in the speed. The relays are driven with the help of relay drivers (ULN2003).

2.3 FLOWCHART OF THE PROJECT

The following flowchart explains the complete layout and the bodyline of the project.

- The program begins with sensing the entity using the microwave sensor.
- Then forms the former two sub branches of detecting the amount of light using LDR and measuring the temperature using temperature sensor.
- The Arduino will switch the electrical apparatuses only if the all the individual commands as a group are true.

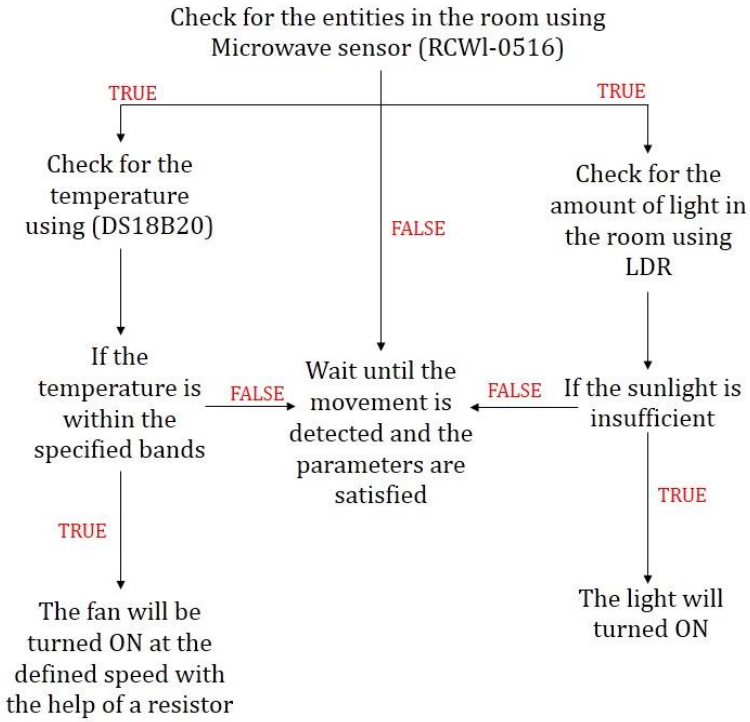

Fig -3: Flowchart of the project

2.4 ANALYTICAL DIAGRAMS

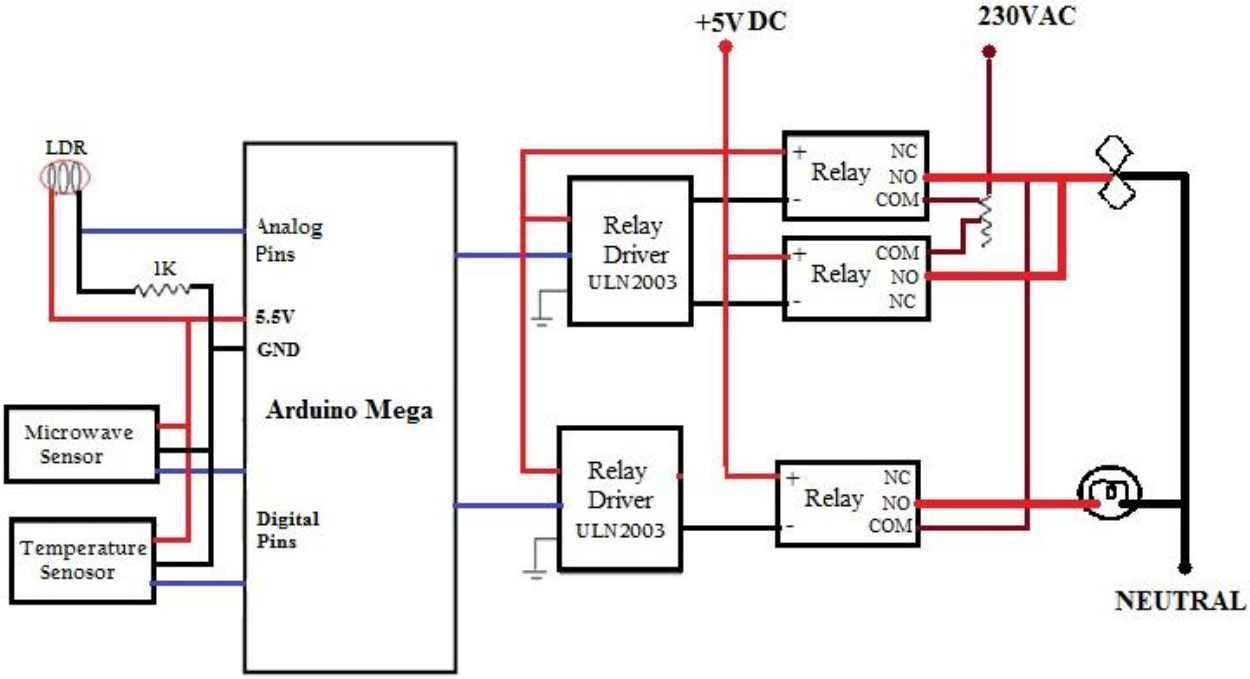

Fig -4: Main proposed circuit diagram

The connections with the Arduino are made in the following ways:

- Since LDR is an analog sensor and we have two LDR's we have used A_0 and A_1 pins of the Arduino to connect it with the LDR's.
- Microwave sensor being the digital sensor, since we have used 2- Microwave sensors we have connected it to (2, 3) no pins of the Arduino respectively.
  - As we are incorporating sensors in a group we have named it 'module' which holds Microwave sensor and a LDR.

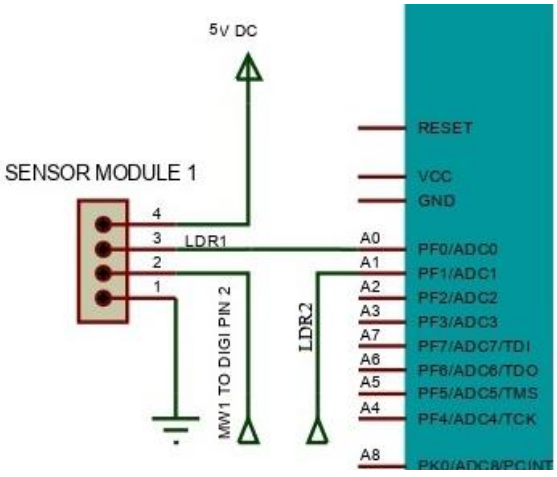

Fig -5: Connection of the module1 with Arduino

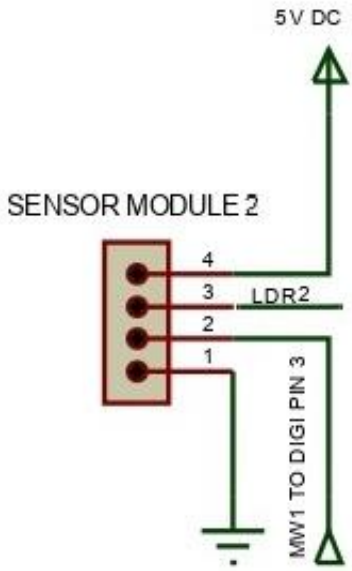

Fig -6: Module-2 pins

This is the connection that we have used to house the necessary sensors in order to assemble the module.

- The connectors displayed are for the sensors which are nothing but the pins that are coming out for its connection with the sensors.
- We have configured power rails to all the sensors so that the necessary supply drives through the circuit similarly the grounding is also done.

- The main connector here has 4 terminals that are pretty understood 1st and 4th is for V_{CC} and Ground while the other two are for data lines for the sensors.

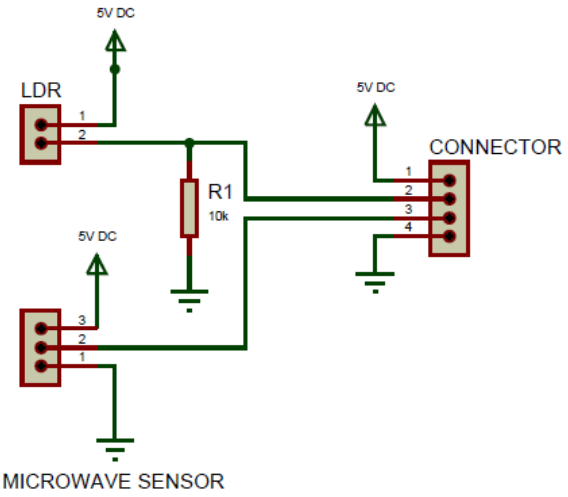

Fig -7: Internal connections of the Module

- Temperature sensor being the digital sensor, is connected to the 4 no pin of the Arduino.
  - We are placing just 1-temperature sensor on PCB itself assuming an idea that there will be no drastic changes in the temperature in every corner of the same room and is almost constant.

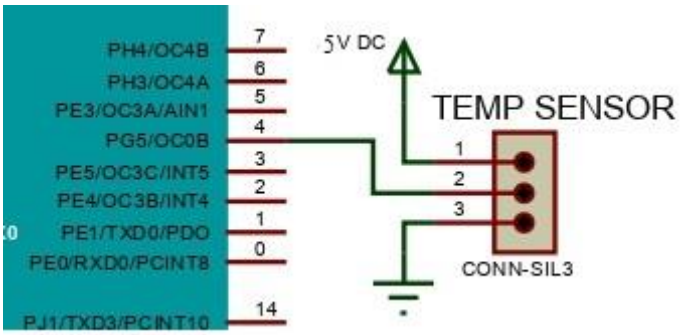

Fig -8: Connection of the temperature sensor with Arduino

The following is the connection of LCD with the Arduino

- LCD display is connected to (8, 9, 10, 11, 12, and 13) pins of the Arduino.
- Vcc and ground pins of the LCD are connected to the +5.5 and GND of the Arduino.
- A special provision of placing a 10KΩ preset is made so as to ensure that the contrast of the LCD can be varied as and when required.

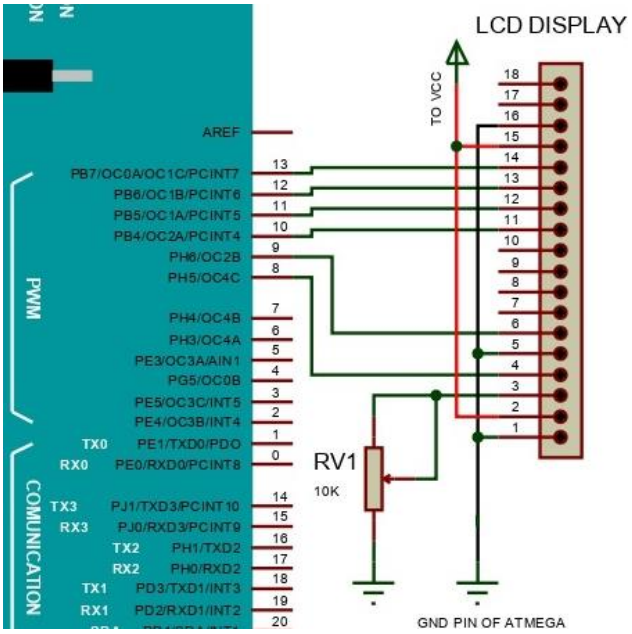

Fig -9: Connection of the LCD (16X2) with Arduino

Relay being the driving agent of the loads we have connected relays via ULN2003 and for which we have used (23, 25, 27, 29, 31, 33, 35, 37, 39, 41, 43, 45, 47, 49) pins of the Arduino. For relay connections we have used a diode in the reverse biased mode that acts as freewheeling diode and a LED to indicate the switching of relay

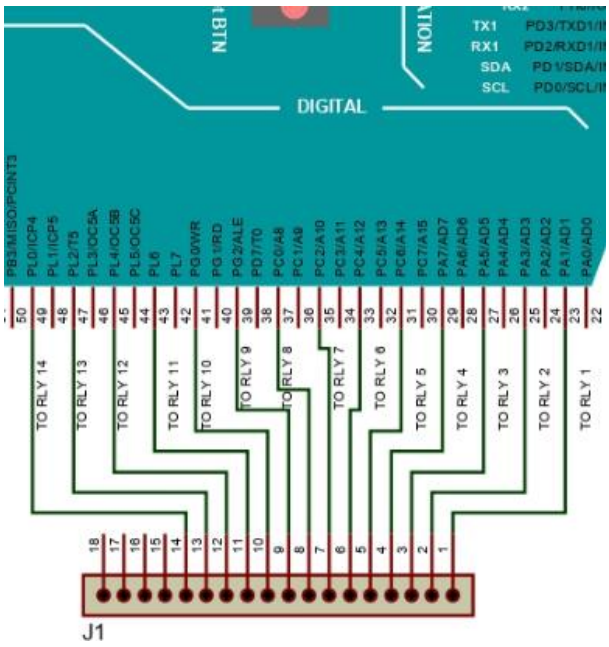

Fig -10: Connection of the Relays through Drivers with Arduino

3. CODING

3.1 Flowchart of the code

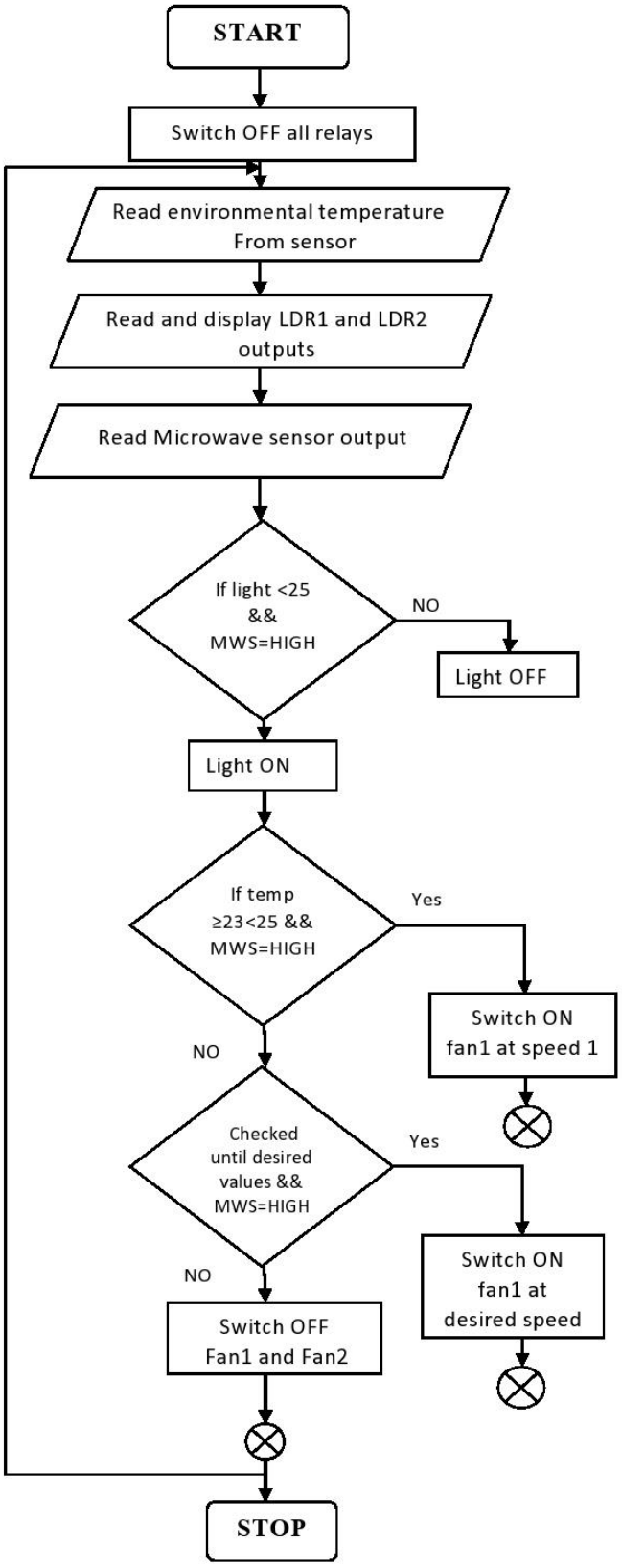

Fig -11: Flowchart

3.2 Algorithm of the code

1. Switch off all the relays.
2. Read and display all the outputs of the sensors.
3. If the light is less than 25 and the motion detected then turn the light ON.
4. If the temperature is in between 23 to 25° C and the motion is detected then turn ON the fan at speed-1 and by switching on the main fan relay.
5. If the temperature is in between 25 to 27° C and the motion is detected then turn ON the fan at speed-2 and by switching on the main fan relay.
6. If the temperature is in between 27 to 30° C and the motion is detected then turn ON the fan at speed-3 and by switching on the main fan relay.
7. If the temperature is in between 30 to 33° C and the motion is detected then turn ON the fan at speed-4 and by switching on the main fan relay.
8. If the temperature is above 33° C and the motion is detected then turn ON the fan at speed-5 which is by switching on the main fan relay.
9. Otherwise turn OFF the fan.
10. Repeat the process from step no 2.

4. FEATURES

- **Benefits**

  Since the smart room works on human detection, sunlight presence and temperature in the room there is no human involvement/intelligence required. Providing a 2 way switch to operate the entire system on separate modes like manual and sensors so that the system pertains self-isolation from one in working and the other on standby and hence the system is more compact, reliable and safe when it comes to operation. The biggest advantage of the system is that since we are providing sections for the room the light will glow and fans will rotate only if the entity is present in the respective sections keeping the other section dead/non-working.

- **Limitations**

  There are no disadvantages for the system except for the fact that the system will become costly than the conventional system and there needs to be a timer circuit (IC555) which is associated with the light that will latch the position of the light when it is ON for a particular time or else if not so than there will be a need of continuous human action for the circuit to work. Also the resistor that the system has included results in heating that might hamper the working of the other components as well.

- **Application**

  It is best suited as a part of home automation, it can also be used in Commercial complexes where there are small spaces which involves restrooms and changing rooms. Since sectioning is what the best that we can do, this will make it effective if we use it in the industries specifically on a particular machine.

5. CONCLUSIONS

Electrical energy has become a boon to the modern infrastructure and the contemporary aspects of the architectural structures. Most of the part of the energy just gets overused and creates a burden for 'more generation'. Hence, to make a long story short, large amount of power in totality if considered is wasted on a daily basis just because of human tendency of procrastinating things. With the same audacity this wasted energy can be conserved if utilized smartly and will eventually lead to the contribution of a large amount of saving of energy and this can be done either just by altering human actions or by introducing the traditional system to automation. It is evident that 1unit of power saved equals 1unit of power produced. Hence the project is made considering this as the core feature to highlight the simple consideration of 'Energy conservation and efficient utilization'. For detection of an entity entering/exiting the room Microwave sensor is used, but its cost is high as compared to IR, PIR or Ultrasonic sensor but the outputs achieved through the sensor is way more accurate and precise. Whereas the fan speed can be controlled by using the Temperature sensor through resistor which means, by using the temperature in the room the controller will thus define the desired speed of the fan. The cost of the system is on the lower edge as compared to the other products in the market which in all is the most advantageous aspect of the system. If this system is adopted at every single possible place it will in all contribute a larger saving not just in terms of Energy conservation that will reflect in our energy bills but on the basis of generation too.

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