Project proposal for
DST & Texas Instruments Inc.
India Innovation Challenge Design Contest 2016
Anchored by IIM Bangalore

GREENOVATION
Jadavpur University

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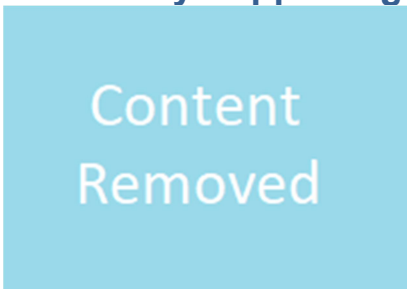
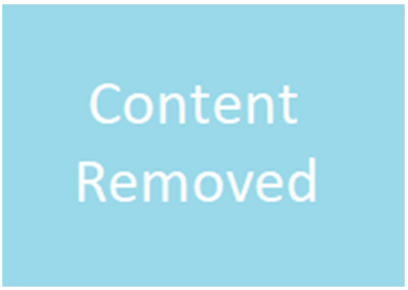
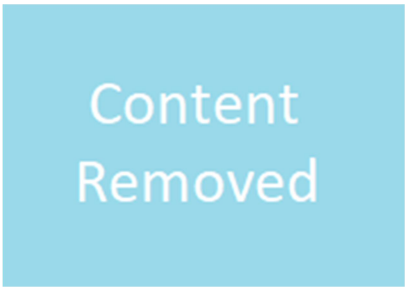
Mandatory Supporting Document



Ayush Agarwal



Sourav Dokania



Chirag Mehta

Project Abstract

Recently there has been an unprecedented rise in the amount of CO2 in the atmosphere. Amongst the various sectors of contributors of CO2, buildings accounts for the largest share nearly about 39% by wasting precious electrical energy. It is often noticed that the electrical appliances like lights, AC's, HVAC are kept running even when the rooms are partially or completely unoccupied [Reference – Seminar Hall, Jadavpur University] also places where the users do not have to pay for the electricity bills so they do not give much attention to power loss. This gives a scope of installation of a smart, integrated, low cost module to the existing infrastructure, which can automatically sense the human presence and optimize the energy consumption by switching on/off and regulating the temperature/fan speed of the AC's.

Team Members – Roles & Responsibilities

S.No.	Name	Role	Justification
1	Ayush Agarwal	Technical & Operations	Being in the field of electronics and instrumentation, have clear understanding of micro controllers programming and sensors.
2	Sourav Dokania	Technical & Operations	-do-
3	Chirag Mehta	Marketing	Along with being good with electronics, also has experience in management. 2nd Year coordinator of the Tech fest SRIJAN, Jadavpur University 201, also is presently doing business under his father.

Market Analysis

We did a market survey as below. (market is refered to places/Halls where few indiviual ACs are used)

Are you satisfied with the present scenario of the electric consumption by various electrical appliances mainly ACs ?	Yes: 20%	No: 80%

What is the main area of concern regarding ACs?	Power Consumption:		Long lasting of AC:		Automation		Environmental concers:	
	Yes	No	Yes	No	Yes	No	Yes	No
	80	20	60	40	25	75	40	60

And after explaining our product:

Would you be interesed in installling such product ?	Institutes:		Restaurants:		Small Offices:		Small showrooms:		Others:	
	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
	70	30	50	50	90	10	80	20	50	50

Is the product cost effective?	Yes : 75%	No : 25%

(Source of survey : Restaurants like JFC, Aamir's. Offices like Jetsave Visa, BuyHere.in, Shreshta Consultants, U.S.Dollar showrooms, IEM and Techno India colleges, etc.

Also Professor *Dr. Rajib Bandyopadhya, Instrumentation and electronics engineering.*

Dr. Kumardeb Banerjee, Instrumentation and electronics engineering.

Dr. Ratna Ghosh, Instrumentation and electronics engineering.

Dr. Amitava Gupta, Power engineering.

Dr. Ranjan Ganguly, Power engineering.)

A. Customer Need Identification - As visible from the survey, people's main pain points were power consumption by ACs and other electrical appliances. Lots of energy gets wasted in places where the occupents are not always present but the Ac's are kept on continuously. The survey helped us understand that people need an easily installable cheap, relaible system that works autonomously

and can control the AC's thereby increasing their efficiency and life span therefore reducing the electricity bill.

B. Serviceable Addressable Market (SAM) Identification & Justification – Institutional buildings,Educational buildings, Small scale offices, Retail showrooms, where the users or occupants are not directly or indirectly linked with the payment of energy bill.

C. Product Differentiation w.r.t. Competition & Justification – There is almost no company in this particular segment as competition for us. There are multiple companies working in home automation sector but those are for luxury residential purpose. The customer segment that we are targeting has not been approached by other companies with exact similar intent.

D. Understanding of your customer & user- Our customers would include institutes, restaurants, conference rooms, showrooms, offices, etc.
These places could use our module to automatic switch ON/OFF the AC's and other appliences around the user and regulate the overall temperature of the room and hence providing user with a comfortable environment.

E. Distribution Channel Identification - Texas Instruments would be a great platform for the sale of the module. The module could be sold in electronics stores, and institutional markets.

Also I would like to mention that it is a self-motivated project which we considered of doing seeing the present scenario of our College Seminar Halls. But later down the road after taking to many of our professors and some small scale offices, we did realize that this problem addressed a wider area and solving this will have a much wider impact than just in our college.

Proposed Design

A. Objective – The proposed solution aims to solve the following real life problems:

1. To reduce power consumption and thereby improve power efficiency in institutional, government and educational buildings.
2. To help the environment by reducing CO2 and CFC emission levels thereby checking serious global issues like global warming and ozone depletion.
3. To bring manageability and better insight into the existing infrastructures and options for data analysis of power consumed by different appliances.

B. Proposed Solution:

The proposed solution comprises of three interdependent modules the block diagrams and brief explanations for each is written below.

Brief Explanation:

The Module has three components:-

1. The Person Counter: It tracks the person count in the room using two interruption based IR proximity sensors. The person count is wirelessly sent to the Master Module (main master) after each update and also after a fixed time interval.

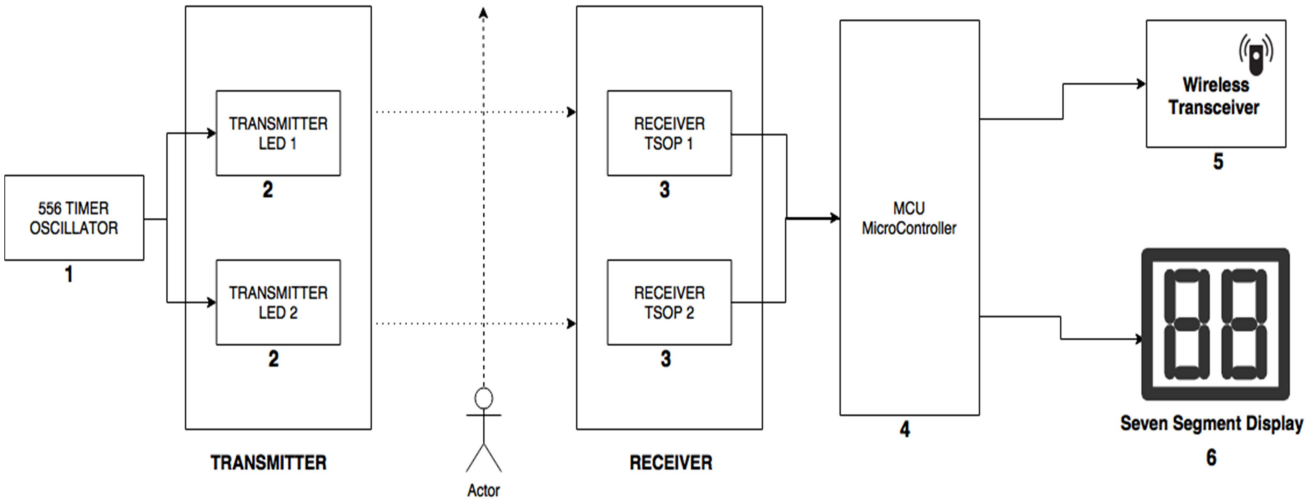
2. The User Interface (UI): It is an interactive module with an LCD interface and push button inputs. The LCD displays all the relevant data in the room like person count, the status of AC's, the temperature of the room and other factors

3. The Master Module: The module collects data from PIR sensors data, temperature sensors data, and person counter data and regulates the AC's with all this information with the help of remotes fitted in front of the AC's.

Detailed Explanation:

1. Person Counter:

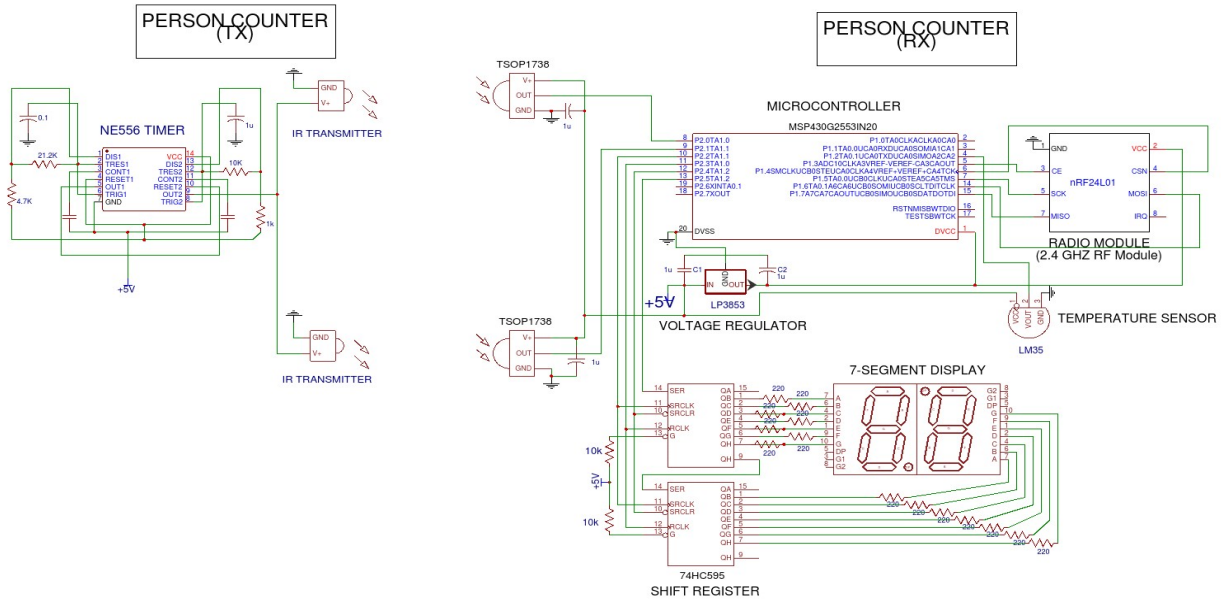
a. Block Diagram –



Explanation:

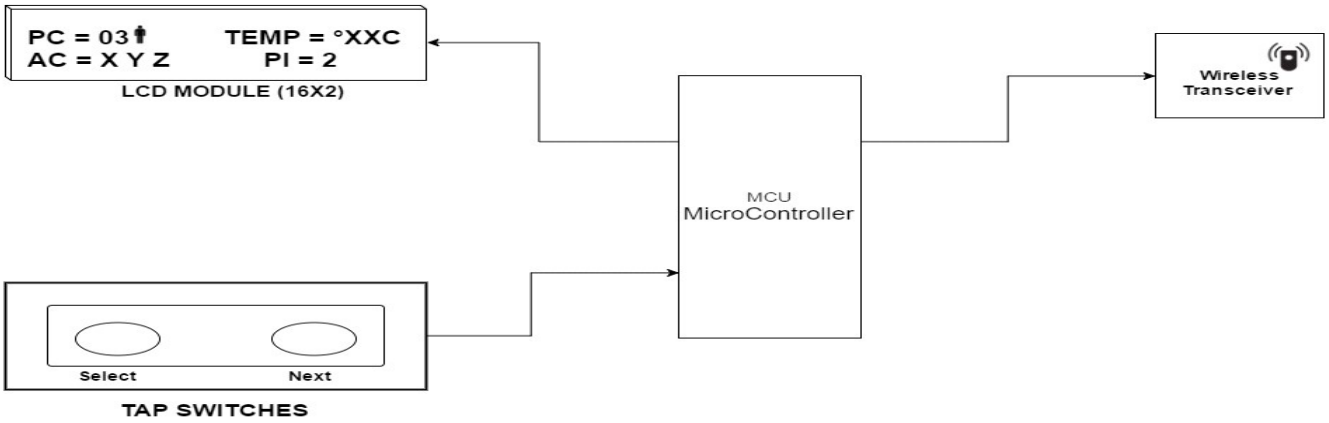
Sr. no	Component	Working description	Functional Description
1	556 Timer oscillator	The module produces a frequency of about 20 HZ and 60% duty cycle superimposed over a digital carrier frequency of 38 KHZ.	The produced signal is fed to the infrared transmitters. Using a carrier of 38KHZ gives noise immunity and strong signal strength.
2	Transmitter LEDs	These are just two infrared LEDs which produce the required optical signal.	The digital signal from the oscillators is transmitted to the TSOP receivers using IR light. A person acting as an obstacle shall interrupt the same which will be recognized by the receivers ahead.
3.	Receiver (TSOP 1738)	These are two IR light sensors with internal band pass of 38KHZ and a demodulator with digital output.	They receive the signals from IR receivers and feed the demodulated signal to the next block for processing.
4.	The Micro-controller	This is the CPU of the module. All the processing occurs here. The signals from TSOP modules are intercepted and the	These are the functions of the MPU here: 1. Intercepts and further demodulates the signals from TSOP modules.

	(MSP430 G2)	interrupted signals are passed through an algorithm which generates person count.	2. Runs algorithms to process TSOP signals and produce change in person count data. 3. Talks to transceiver for data exchange between Master and itself. 4. Displays generated person count in a seven segment display.
5.	The Transceiver	Radio frequency transmitter cum receiver using on SPI communication with up to 6 channels of transmission.	Transmits and receives generated person count and necessary commands from the master module.
6.	Seven Segment Display	General Display device to display numbers, using additional shift register latch.	Displays the current person count value as commanded by the MPU.



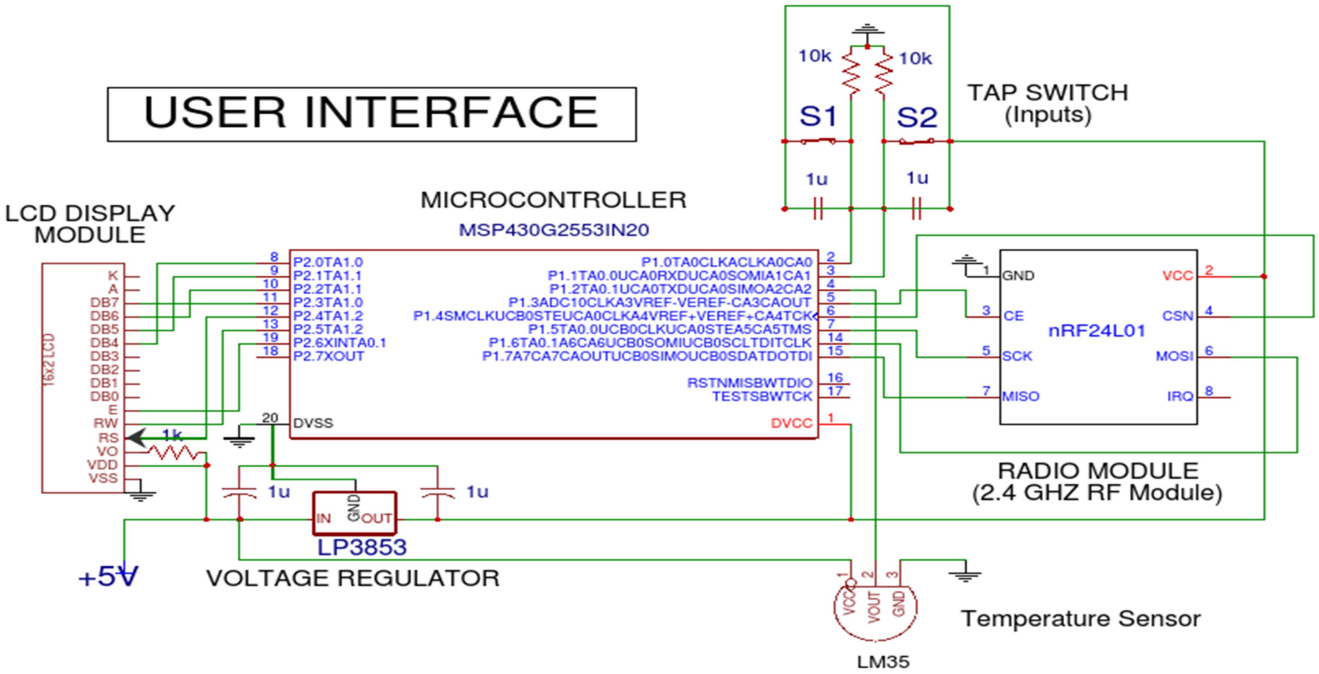
Person Counter Schematic

USER INTERFACE MODULE:-



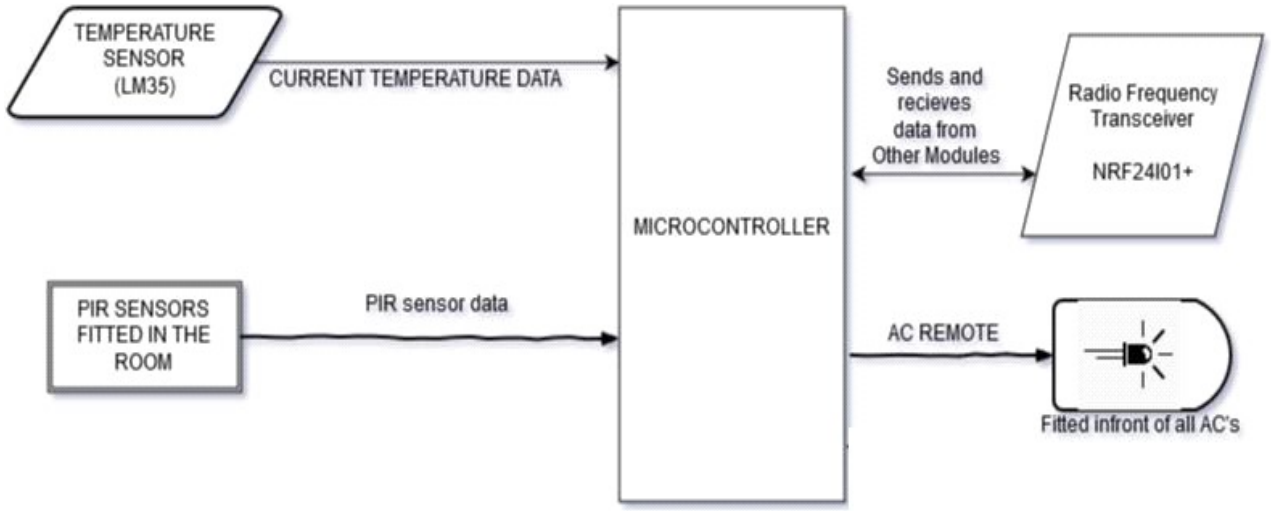
Explanation:

Sr. no.	Component	Working description	Functional Description
1	LCD Module (16X2)	The LCD is used to display data to the user. It has a data and command bus connected to the MPU.	The USER interacts with this and any other module using this interface. It displays the following information: 1. Current Person Count 2. Average Temperature of the room. 3. The Status of all the AC's. 4. The Performance Index.
2	TAP switches	These are denounced tap switches, and can send digital signal to MPU.	The user interacts through these inputs. The various menus transversal occur using them.
3.	The Micro-controller (MSP430G2)	This is the CPU (Brain) of the module. All the processing occurs here. The MPU takes inputs and gives output through various ports and runs the control algorithm.	The MPU is responsible for following operations: 1. It controls the LCD and displays data received from the transceiver. 2. It collects data from push-switches about setting modifying parameters (like person count) etc. 3. Talks to transceiver for data exchange between Master and itself.
4.	The Transceiver	Radio frequency transmitter cum receiver using on SPI communication with up to 6 channels of transmission.	Transmits and receives generated person count and necessary commands from the master module.



User Interface Schematic

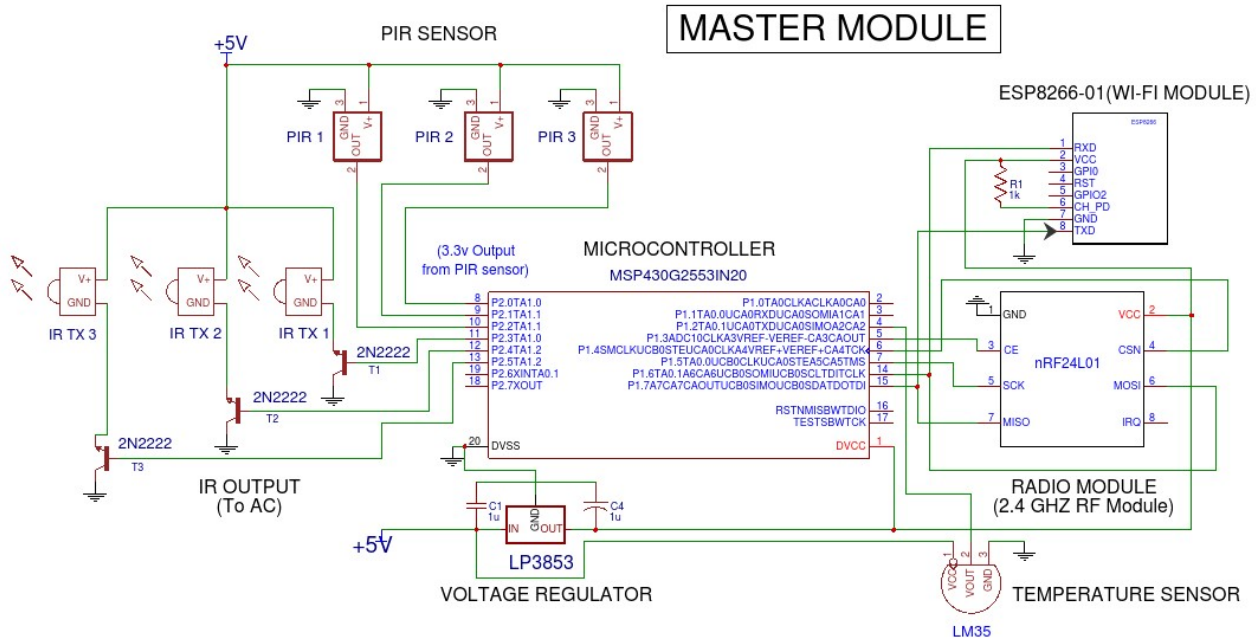
MASTER MODULE:-



Explanation:

Sr. no.	Component	Working description	Functional Description
1	Temperature Sensor	Senses the temperature and gives analog output.	This data is collected by the MPU's analog pin and is required for the working algorithm.
2	Passive Infrared Sensor	Senses change in infrared levels and generate digital outputs.	An array of PIR sensors is required to sense the probable position of a person. The data is used by MPU for its control algorithm.
3.	The Micro-controller (MSP430G2)	This is the CPU (Brain) of the module. All the processing occurs here. The MPU takes inputs and gives output through various ports and runs the control algorithm.	The MPU is responsible for following operations: 1. The PIR data collection from all PIR sensors. 2. The Temperature data is collected from temperature sensors through an A/D channel. 3. The person count data is received from the person counter module thought the transceiver. 4. All the above are then used with a control algorithm to generate appropriate AC status codes which include Temperature, Fan Speed and Modes of Operation. 5. The modulated data is sent to the user interface module for providing user the updates about all current scenarios. 6. The MPU regulates the ACs by transmitting signals to the IR remote.
4.	The Transceiver	Radio frequency transmitter cum receiver using on SPI communication with up to 6 channels of transmission.	Transmits and receives data and necessary commands from and to the other modules.

5.	The IR Remote	These are general IR LEDs which transmit IR signals fed by the MCU.	They are responsible for controlling the AC's wirelessly by providing necessary commands from the MPU.



Master Module Schematic

C. Component Used -

D. TI Part	Quantity	Function
MSP430G2	3	It serves as the brains of the system It is in charge of collecting and processing of all the required data in order to generate the required statuses of all the appliances that has to be controlled
LP3853	3	Linear voltage regulator for supplying power to the microcontroller, NRF module, ESP module and other necessary components.
74HC595	2	Serial in Parallel out shift register used for displaying the person count on a seven segment.
LM35	3	Simple Temperature sensor, which gives us the temperature map of the working area.
2N2222	3	Small signal NPN transistor for high speed switching of the Infrared Transmitters.
NE556	1	Timer chip to produce a 38KHz frequency infrared signal at a frequency of 20 Hz for the TSOP receivers to intercept.

Non - TI Parts	Quality	Function
NRF24L01	3	For the wireless RF communication between all the three modules namely the person counter, User interface and the Master Module.
ESP8266	1	This module will connect the system to the cloud sending and receiving data from the server through Wi-Fi.
Passive Infrared Sensor	3	These sensors record the movement of any living creature by intercepting the change in the room's infrared levels.
TSOP1738	2	A 38KHz demodulator IR receiver for intercepting the IR light transmitter from the transmitter.
16x2 LCD	1	Used in the user interface module for showing all the relevant data like the person count, as statuses, current room temperature to the users.

Innovativeness of the Proposed Solution :

The project addresses a practical problem with immense scientific & industrial impact. The proposed project addresses all the basic issues of a large complexity using credible approximations for s lab-scale venture. Owing to the fact that this project aim to reduces day-to-day power consumption, we have tried to make the modules power efficient by making them small and using low power consuming parts. The true innovativeness of the of the project lies in the fact that along with it being very cost efficient it can also be easily reproducible for an industrial application, with a little change in the hardware, but the basic concept behind the control system still remaining the same.
Further down the road, control of other electrical appliances can also be easily added to the system, which intern will lead it to become a very powerful and efficient energy saving automation system.

Impact of the proposed solution : The proposed project has been successful and further aims to rectify the following:

- The energy savings up to 30% in the institutional and government buildings thereby bringing down electricity bills and saving energy.
- Robust and automated system with easy to use interface giving users more comfort and security.
- The data logging through IOT interface allows for easily manageable system and adds more control and insight into an existing infrastructure.
- The reduction in the levels of CO2 by consuming less energy, thereby helping the environment.
- The longevity of the appliance lifetime adds to the cost benefit.

Feasibility

As per the test run in the Jadavpur university seminar hall, the module is given good results. The main feature of the module is that, it is easily installable. There is no need to change the internal wiring of any appliances; also it could be used in any infrastructures. It could be used in market in India in large scale as it is not very expensive (around Rs.4000) and the outcome of the product could be seen instantly in energy meters and electricity bill.

Also all the parts used in the system are cheap, reliable and easily available, so reproducing it in a large scale will not only increase the product quality but also the overall pricing.