Efficient Illumination: Arduino-Based Street Light Automation for Energy Savings

Group 7

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# Literature Survey

**1.Energy Efficient Smart Street Lighting System in Nagpur Smart City using IoT**

**Authors: Ruchika Prasad**

**Year:2020**

The paper outlines a case study centered on a smart lighting system within Nagpur's smart city framework, with a primary focus on curbing energy usage and minimizing carbon emissions. The study involved the implementation of a smart lighting infrastructure equipped with motion-sensing technology and LED lighting. This deployment resulted in a noteworthy reduction of approximately 55% in monthly energy consumption. The adoption of smart street lighting systems, exemplified by Nagpur's initiative, has gained widespread acceptance in developed urban centers, primarily to enhance energy efficiency and decrease power consumption. The incorporation of LED lamps and advanced controllers in this intelligent lighting system contributed significantly to energy conservation, all while maintaining the citizens' quality of life. Comparable smart lighting models are currently undergoing deployment in other smart cities globally and hold potential for expansion into rural regions of India.

**2.Development of Smart Street Light System and Density based Traffic System using Internet of Things**

**Authors: Ranjitha L, K S Ananda Kumar, Kavitha H L, Harshitha K R, Manisha C**

**Year:2020**

The paper discusses the development of a smart street light system and density-based traffic system using the Internet of Things (IoT).It mentions the use of IR sensors to monitor traffic density and alter the timing of traffic signals accordingly. The paper also highlights the use of GPS modems to find nearby ambulance services and hospitals for emergency situations.

The smart street light system utilizes LDR sensors and timers to automatically control the operation of street lights, reducing power wastage during low traffic periods The concept of a smart city is introduced, which includes smart street light management, smart traffic control management, and smart healthcare management. The paper emphasizes the conservation of electric energy and the potential for efficient utilization in various sectors. The proposed model includes a Smart Traffic Control (STC) technique that prioritizes emergency vehicles and adjusts traffic light timings based on traffic density.

**3.Development of Street Lighting System with Object Detection**

**Authors: Juvy Amor Galindo; Meo Vincent Caya**

**Year:2018**

The study aims to develop an energy management methodology applied in the streetlights of a school campus, using a street lighting system with object detection. The proposed system in this study uses Python interpreter, OpenCV, Raspberry Pi, and Pi Camera Module for object detection, and does not require very high-performance devices and complex algorithms

The system uses Histograms of Oriented Gradients (HOG) algorithm for object tracking and Daugman algorithm for feature extraction used in iris recognition. Other studies have analysed the effect of integrating wireless systems and surveillance sensor networks in street lighting, as well as combining solar energy and LED technology to design an autonomous street lighting system. The proposed system in this study processes captured images to enhance the process of detecting moving objects and minimize energy consumption on the streetlights

**4.Design, Fabrication and Testing of Smart Lighting System**

**Authors: Nikhil Xavier, Arun Kumar, Sanjib Kumar Panda**

**Year:2016**

The paper makes reference to several pertinent sources within the realm of smart lighting systems. These sources encompass studies involving ZigBee-based home automation systems, smart home energy management systems employing IEEE 802.15.4 and ZigBee technologies, and the integration of motion and illumination sensors within smart lighting systems. Additionally, the paper duly acknowledges the financial support provided by the Building and Construction Authority (BCA) and the National Research Foundation (NRF) of Singapore. In essence, the literature review within this paper comprehensively encompasses pertinent research concerning ZigBee-based systems, smart home energy management, and the incorporation of sensors into smart lighting systems..

**5.ZigBee and Power Line Communications Interconnectivity Applied to Fuzzy Logic Controlled Automated Lighting System**

**Authors: Jessie R. Balbin, Dionis A. Padilla, Felicito S. Caluyo, Carlos C. Hortinela IV, Febus Reidj G. Cruz, Janette C. Fausto, Ramon G. Garcia, Ernesto M. Vergara Jr., Glenn Phillip S. Baluyot, Clint Yves B. de Luna, John Christopher R. Orio**

**Year:2016**

The paper explores the integration between the ZigBee wireless protocol and Power Line Communications (PLC) within the context of an automated lighting system controlled by fuzzy logic. In light of the European Commission's adoption of PLC as part of the Smart Grid transition, there is a recognized need for further research and development to facilitate its implementation. The study primarily concentrates on the creation of a gateway that harmonizes the ZigBee and PLC protocols into a unified protocol. This involves a technique that modifies the Programmable System on Chip (Pesco) of the PLC, essentially transforming it into a computer architecture.

The researchers conducted an assessment of the lighting system's energy consumption both with and without this interconnection. The results reveal a substantial disparity in energy usage when employing the integrated system. Furthermore, the paper includes a visual representation in the form of a flowchart, illustrating the operational process of the overall lighting system.

**6.Power Efficient Automated Lights Results to Security for Underground Parking Space**

**Authors: Vishwas H N, Ullas S**

**Year:2015**

The paper delves into the concept of an energy-efficient illumination system tailored for underground and indoor parking facilities. This system employs the Zigbee protocol for data communication and relies on Passive Infrared (PIR) sensors to detect motion. The prototype described in the paper effectively creates an automated system with the capability to sense motion within the covered area, consequently managing the activation and deactivation of lights as needed. Within this system, PIR sensors play a crucial role by detecting objects through the measurement of infrared light emissions within their sensor range.

Additionally, the paper references alternative lighting systems, including an automatic street lighting system that utilizes Light Dependent Resistor (LDR) sensors and Infrared (IR) sensors for regulating light intensity.

The overarching goal of the proposed system is to curtail unnecessary power consumption by automating lighting within parking zones. It accomplishes this by leveraging PIR sensors for motion detection and establishing a Zigbee network for data transmission.

**7.Smart Adaptable Indoor Lighting System (SAILS)**

**Authors: S. Bouzid , M.Mbarki , C.Dridi ,M.N.Omri**

**Year:2019**

These studies encompass a range of approaches to lighting control, which encompass methods like adjusting lighting levels based on the amount of ambient light detected by photosensitive sensors, employing motion detection through cameras, and utilizing wireless sensors. These systems have varying objectives, with some aiming to achieve energy efficiency and user satisfaction, while others prioritize adapting lighting to both daylight intensity and user presence.

In the realm of smart indoor lighting systems, the ZigBee standard stands out as a popular choice due to its advantageous attributes, including cost-effectiveness, low power consumption, and simplified complexity. Its applications have extended across diverse settings, including street lighting, office environments, theater and entertainment spaces, media production, and residential lighting solutions.

Nonetheless, it's worth noting that certain limitations persist in some of these existing systems. These limitations encompass factors such as being tailored to specific workspace contexts, lacking support for the modification of light sources or activity types, and not providing guidance on user-specific strategies.

**Proposed Smart Lighting System:**

The paper proposes a new smart lighting system that overcomes the limitations of existing systems. It suggests different lighting strategies based on user preferences and lighting norms, and provides recommendations for the number and positions of lighting sources. The proposed system integrates motion and light-dependent resistor sensors, allowing for monitoring of different events and actions, as well as detection of node failures.

**8.IOT Based Smart Street Light Management System**

**Authors: Fathima Dheena P.P , Greema S Ra,Gopika Dutt , Vinila Jinny S**

**Year:2017**

The paper discusses the implementation of an IoT-based smart street light management system, aiming to conserve energy and reduce CO2 emissions. The system utilizes light dependent resistors (LDR) as darkness detectors and LED lights as the light source, providing advantages such as power saving, reduced maintenance cost, and high intensity light when needed the system is cost-effective, eliminates the need for manual switching of streetlights, and provides wireless accessibility and control. Previous research in this area includes studies on smart street lighting systems using GSM technology, automated control based on surrounding parameters, and IoT-based intelligent street lighting systems. The existing streetlight systems often operate with traditional light sources, leading to energy wastage and light pollution.

**9.Smart Street-lighting using Green Energy**

**Authors: Shubham Sarkar, Kshitij Mohan, Prajakta Vankhande**

**Year: 2017**

The paper explores the conception and execution of an independent solar-powered LED panel lighting system for streetlights. It underscores the escalating cost of electricity and the imperative to integrate sustainable energy sources into everyday applications. The system's components encompass solar panels, a lead acetate battery, a boost converter, a microcontroller, a transceiver module, high-powered LEDs, Light Dependent Resistors (LDRs), and an LCD panel.

A notable feature of the system is its exclusive reliance on solar energy as the primary power source. This approach results in substantial electricity savings that would otherwise be expended on illuminating roadways. Additionally, the system incorporates an intelligent battery level monitoring unit, which monitors the battery's charge status and issues warnings when it reaches critical discharge levels.

Both the practical design of the boost converter and the intensity control system are executed and verified experimentally, with simulation and practical results meticulously documented. The system's performance yields a noteworthy outcome, as it achieves a 30% reduction in total energy consumption through the application of this technology.

**10.Efficient Power Generation to Automated Street Lights based on Traffic Density**

**Authors:Mrs. Kalaimaithi B.,Ms. Charuamathi.V.S, Ms. Annie Prasanna. M,**

**Ms. Aishwarya.T**

**Year: 2021**

The proposed model focuses on efficient power generation and smart power consumption for automated street lights based on traffic density. The paper suggests using renewable energy sources, such as solar energy, for street lighting systems to achieve energy savings. It emphasizes the importance of saving energy and reducing power consumption in street lighting systems. The project aims to solve the major problems of energy loss and wastage in street lighting systems. The incorporation of IoT and automation into street lighting systems is suggested to achieve efficient power consumption. The paper highlights the need for an automated street lighting system to enable efficient power consumption and reduce energy wastage.

**11.Automated Lighting Control System for Workplaces**

**Equipped with Displays**

**Authors: Kudryashov A.V.,Fedorov V.B.,Popov E.A**.

The paper presents an automated lighting control system for workplaces equipped with displays, considering special standard requirements .The proposed system is equipped with a DALI-controller and designed to improve power efficiency by considering both daylight illumination and artificial light sources .Workrooms were selected, and the 24-hour daylight distribution dependent on window aperture orientations was taken into account .The system includes a compact detection device equipped with two sensors for measuring illumination at the worktable area and on the screen surface.The algorithm of the lighting system allows for switching and stepless adjustment of the light flux, maintaining a constant predetermined level of illumination, and accounting for the presence of people in the room .The use of individual light sensors for individual dimming is recommended for workplaces with special requirements for employment with PCs .The proposed lighting control system meets the specific requirements of national standards for lighting workplaces with Display Screen Equipment (DSE).

**12.Development of Automated Microcontroller-Based**

**Lighting Control System For Indoor Room**

**Implementation**

**Authors: Nurul Afiqah Binti Mohd Arifin, Nurul Afiqah Binti Mohd Arifin**

The paper proposes a microcontroller-based lighting control system for indoor rooms to increase energy efficiency and reduce electricity expenses .The system uses a light depending resistor (LDR) to measure natural light in the room and adjust the LED bulb's intensity accordingly.The experiments conducted on different activities such as nap, leisure, and study show that the proposed system can reduce energy consumption by approximately 50% compared to normal practice .The voltage and current consumption of the lighting system with and without the automated adjustment control system are measured, showing a significant gap in voltage usage and indicating a reduction in power consumption with the proposed system.The energy consumption per day is calculated, and it is found that the proposed system is efficient in minimizing energy wastage in a room.Overall, the paper presents a comprehensive study on the development and implementation of a microcontroller-based lighting control system, highlighting its effectiveness in reducing energy consumption and improving energy efficiency in indoor rooms.

**13.Experimental Pilot Project For Automating Street Lighting System In Abu Dhabi Using Powerline Communications**

**Authors:E.H.T.El-Sherbiny, M.E.Bakka**

The paper discusses a pilot project in Abu Dhabi that aimed to automate the street lighting system using powerline communications (PLC) technology. The existing street lighting system faced issues such as high maintenance costs, unexpected malfunctions, and improper switching of street lamps. The pilot project sought to improve system performance and reduce operational costs by implementing an automated PLC-based computerized control system. This involved installing a package substation unit and using a graphical user interface for control and monitoring. The paper covers system design, operation, and component reliability, and field tests were conducted to evaluate performance under varying conditions, assessing its suitability for large-scale implementation.

**14.Sensor Lighting System using Microcontroller in Energy Conservation**

**Authors: B Annapurna, P Haribabu, R Karthik, Mahendra Vucha**

The paper proposes a sensor lighting system using a microcontroller for energy conservation, with the goal of making the pavement lighting system free from programmed operation and reducing power consumption by 65%-70%.The system utilizes solar panels and batteries to store sunlight and convert it into electrical energy for the pavement lighting system.The system incorporates different sensors for detecting brightness, humans, and the number of vehicles, which determine the ON/OFF movement of the LEDs.The design of the system is less complex, inexpensive, and can be modified as per the requirement.The system can be implemented in lighting systems of garages, highways, pavements, and gardens.The paper highlights the importance of using sustainable energy sources for street lighting to conserve energy and reduce costs.The system is automated and reduces the cost of energy and system management.The paper references other studies on energy-saving lighting systems, intelligent street lighting, and road lighting energy-saving projects.

**15.Automated Lighting System for Park Pathways**

**Authors: Rachel Dunning, Jasbir Harnal, Bradley Barrett, Sinan Yucesan, Benjamin Browning, Thomas Harrison, and Gregory C. Lewin**

This paper extends a prior capstone project, aiming to create an automated lighting prototype for a Charlottesville park. The core goal is an energy-efficient system that illuminates the park only when users are present. It's designed to retrofit existing light poles, using readily available components and wireless configuration. The City of Charlottesville seeks to modernize park lighting to conserve energy and improve safety. Current lights run all night, leading to unnecessary energy consumption. The proposed system uses motion sensors to activate lights, addressing this issue. User feedback suggests keeping lights on but dimmed when no users are present, creating a more welcoming environment. Charlottesville Parks and Recreation also values the system's potential to enhance security and save costs. This project strives to create a sustainable, user-friendly, and cost-effective lighting solution for public spaces.

**16.Measurement of illuminance of interior lighting system automatically dimmed to the constant level depending on daylight**

**Authors: Pavel Valíþek, Tomáš Novák, Jan Va Ėuš, Karel Sokanský, Radek Martinek**

The paper discusses the measurement of illuminance in a regulated lighting system in a Smart Home (SH).It proposes a method of measuring illuminance caused by daylight as an upgrade for evaluating interior illuminance curves.The paper highlights the difference between the set value of illuminance regulated by a KNX system and the real illuminance in the place of a visual task, which may lead to the lighting system not meeting normative requirements.The placement of sensors and the constant for conversion to real illuminance in the places of visual tasks should be taken into account when designing lighting systems.The paper also verifies the dependence of reflectivity of surfaces on measured data, specifically for three types of surfaces: dull light oak, white paper, and green cloth.The measurement was done in a specialized training center for education and development of human resources, which is a wooden house in passive standard.

**17.Analysis energy efficiency of automated control system of LED lighting**

**Authors: S. Grigoryeva, A. Baklanov, D. Titov, V. Sayun, E. Grigoryev**

The paper discusses the current state of energy consumption in Kazakhstan and Russia, and the outlook for the introduction of LED lighting technology. The authors present the LED lighting control system based on programmable counters and an information system for monitoring energy consumption. The comparative analysis of LED lamps and compact fluorescent lamps is shown. Energy conservation legislation for the phase-out of incandescent bulbs is being developed or enforced in various countries, including Russia. The study of energy efficiency of LED lighting systems is enabled by the transmission of information from the counters to a server and database. The developed application provides information on electric power consumption and efficiency of lighting systems. The paper highlights the potential for energy conservation in lighting, with estimates of power consumption reduction in Russia and Kazakhstan.

**18.Simulation of Intelligent Room Lighting Illuminance Control**

**Authors: Deepak Makkar,Dr. Poonam Syal**

The paper discusses the present state of lighting technology, energy-saving, and advanced smart lighting systems, as well as potential advancements through integration of visible light. The paper also references the work of Kurian et al., who proposed a control strategy for lighting systems that includes occupancy sensors and lux sensors. Another study by Lu et al. discusses the concept of smart daylight harvesting, which uses automatic modeling and daylight prediction methods to control window transparency and achieve proper lighting intensity. The paper also references the work of Kaur et al., who focused on shading to prevent glare and optimize suitable sunlight while obstructing glare and indoor heat gain. Additionally, the paper cites the work of Shen and Tzempelikos, who developed a daylight-linked synchronized shading operation using simplified model-based control. Gunay et al. also developed an adaptive lighting and blinds control algorithm for energy-efficient lighting. Finally, the paper mentions the work of Soori and Vishwas, who proposed a lighting control strategy for energy-efficient office lighting system design.

**19.Microcontroller Based Automated Lighting Control System for Workplaces**

**Author: Heronafine C. De Guzman**

The research conducted a thorough and systematic literature review to gather information about the lighting system and the latest technology on control systems. The study considered the factors for indoor lighting system design, including the size and shape of the space, finishes on the ceilings, walls, and floors, construction details, economic considerations, compatibility with architectural design, and the type of activities in the area. The prototype was tested and evaluated based on the recommended illumination level of the Energy Efficiency Division of the Department of Energy of the Philippines and the standards of Occupational Safety and Health Standard, specifically Rule 1075 pertaining to workplace illumination requirements. The results of the series of tests showed that the prototype was able to maintain the proper illumination level of the workplace and conform to the recommended standards.

**20.Intelligent type LED illumination control system**

**Author: Wang Fenghui**

The paper titled "Intelligent type LED illumination control system" proposes a system that automatically controls the on-off and brightness of LED illumination equipment based on the presence of a person and the environmental supplementary light brightness. It aims to improve power consumption efficiency, save electric energy, and alleviate power supply pressure during peak consumption. The paper does not explicitly mention a literature survey or review of related works. However, it can be inferred that the authors have conducted a literature survey to identify the need for an intelligent LED illumination control system and to understand existing approaches in the field. This survey likely informed the design and development of the proposed system.

**21.Arduino Based Energy Saving System for Public Lighting Purpose**

**Author: V.Amarnath, N.B. Venkata Muni, K. Meenendranath Reddy, V. Srikanth**

**Year:2021**

The paper presents a case study of Smart Street Lights will be turned ON even in the day time. The main purpose and use of it is in transportation after the dusk time or when day atmospheric light less in intensity. In our paper that present that system with a reduced energy/power consumption in comparison to it. The objective is develop that which reduces the consumption of electricity by using UNO, LDR, IR sensor, Bread board. Operation links to street lighting functionality & maintenance. Functions such as on/off/dimming are the basics of any connected lighting system. Optimization is information Arduino, but it needs not to be confused with it. Recent studies credit smart system that are open to integration to lead the smart city revolution. Circuit meets expectation appropriately to turn road light on/off depending on the movement of the vehicle.

**22. A Smart Street Light System with Auto Fault Detection**

**Author: Piyush Saini, Prateek Saini, Ajay Kumar Jangid, Udit Mamodiya**

**Year:2018**

The paper presents a case of Smart Street light system. This is one domain thar needs major attention if we look at improving of power consumption with an objective of saving energy. The lights are switched off based on a predefined time rather than lighting needs, which vary based on season and location of city. It is using LDR and microcontroller which automatically switches on lights when pedestrians and vehicles comes and switches off or reduce brightness when no one is there. Consider advantages of using LED lamps instead of a High-Pressurised Vapour lam(SVL).Its offers 50-80% energy saving over SVL. We can use a sensor and a communication network for detection of proper functioning of street lights and for sending information to the municipalities. This elaborates that for energy efficiency, the classical street light system can be replaced by a microcontroller, motion detector and a communication network. It gives an operator the ability to individually control and monitor street lights in an entire locality.

**23.Arduino Based Auto Street Light Intensity Controller**

**Author: Monika Vaghela, Harshil Shah, Hardik Jayswal, Hitesh Patel**

**Year:2017**

The paper presents a case of smart light intensity controller its working in such manner could sometimes result in large disasters and destructions. The main problem that manual controls on the street lights face is that there would be a lot time taking during evening times when they are to be switched ON and significant waste of energy is done at all could not be turned OFF together at once. The system uses Arduino, MOSFET based driver circuit for controlling intensity. To energy conservation is to eliminate time slot and introduce a system that could sense brightness environment and act accordingly so that seasonal changes would not affect intensity of street lights.

**24. Design, Fabrication and Testing of Smart Lighting System**

**Author: Revathy .M, Ramya. S, Satyavati. R. Bharathi and V. Maria Anu**

**Year:2019**

The paper presents a case of smart lighting plays a vital role in any city in contribution of traffic and pedestrian safety. The existing model is observed to be inefficient leading to wastage of manpower as well as electric power. The life span of LED lamps is almost 50 times better than other conventional lamps. We have devised a smart street lighting system which includes dimming control circuit that can increase or decrease the intensity of the street lamps accordingly. The status of the street lamp is monitored using the GSM technology. The proposed system is capable of integrating the latest technologies to provide an intelligent street light system which reduce maintenance cost and improves life span of street lighting system. The system is highly efficient in terms of installation and extension. Image processing can also be employed to detect vehicles. The batteries can be replaced by solar panels for renewable usage of energy.

**25. Smart Street light system with energy saving function based on the sensor network**

**Author: Yusaku Fujii, Noriaki Yoshimura, Akihiro Takita, Naoya Ohta**

**Year:2013**

The paper presents a case of smart street lighting system is reviewed. It consists of a LED light, a brightness sensor, a motion sensor, and short distance communication network. The lights turn on before pedestrians and vehicles comes and turn off or reduce power when there is no one. To propose an autonomous -distributed-controlled light system. Some companies and universities have developed centrally-controlled smart street light systems with the host computers. Lights turn on before pedestrians comes and turn off or reduce power when there is no one.

**26. Internet of Things Based Intelligent Street Lighting System for Smart City**

**Author: Parkash, Prabu V, Dandu Rajendra**

**Year:2016**

The paper presents a case of designing and executing the advanced development in embedded systems for energy saving of street lights. A manual system where the street will be switched ON in the evening before the sunsets and they are switched OFF in the next day. Also, manual operation of the lighting system is completely eliminated. The proposed system provides a solution for energy saving. An intelligent street lighting system can cut municipal street lighting costs as much as 50%-70%. The data from the street light controller can be transferred to base station using wireless technology to monitor the system. The control system will switch on-off the lights at required timings. The scope in various other applications like for providing lighting in industries, campuses, and industries.

**27. Arduino Based Automatic Street Lighting for Energy Conversion**

**Author: Prof. Minakshi. L. Jadhav, Sharik Abdulgani Shaikh, Faisal Babasaheb Sayyad, Arun Atul Solanke, Arun Pradip Kata Dhond**

**Year:2022**

The paper presents a case of Arduino based automatic street automatic street lighting for energy conversion Its about street light will turn on while vehicles is passing through it. Here we are using 4IR sensors that senses the position of the vehicle, each IR sensor controls 3LEDs. It is using sensors and wireless modules for implements a system. The LDR sensing the weather condition. Whenever PIR sense the motion of vehicle, the street light will glow as bright or normal. otherwise, its glow as dim. One can save surplus amount of energy which is done by replacing sodium vapour lamps by LED adding an additional feature for security purpose. The system is versatile, extendable, and totally adjustable to user needs.

**28. Arduino Based Smart Home Automation System**

**Author: Ma Naing, Ni San Hlaing**

**Year:2019**

The paper presents the design and prototype implementation of automation system that can be used 2 Arduino Nano with sensors. To demonstrate the effectiveness of this system. The functions of the sensors are to monitor and control the light and temperature. The microcontroller will send SMS to the owner if the sensors detect abnormality. Accessed automatically in response to any signals came from related sensors. The security system is powered by another power source for security safety. Without security it does not complete the whole system.

**29. Design and Implementation of Smart Solar LED Street Light**

**Author: Mr. Maheshkumar Nasaya Bhairi, Mr. Manohar Suresh Educe, Ms. Shubhangi Shital Kangal, Mr. Bhaskar Shivraj Madgundi**

**Year:2018**

The paper presents the propose energy efficient of smart street lighting system using low-cost microcontroller-based Arduino. The system consists of LED luminaire, LED driver, PV panel, Charge controller light sensor, motion sensor, Arduino. It can be operated free of cost by using automatic controlled, self-powered, efficient solar LED street light. Around 70%-80% of power consumption can be reduced by using this system as compared with existing sodium vapour streetlights. It also be energized with footstep generation system. It can be integrated with CCTV camera, water level monitoring and air quality monitoring systems.

**30. Intelligent Street Lights**

**Author: Y M Jagadeesha, S Akilesha, S Karthika, Prasantha**

**Year:2015**

The paper presents that operation of lighting during night time. The system that has to combine the existing network with intelligence to think itself. It reduces the wastage of energy in unused hours. It controls the intensity of the lights based on density of lane. Is experimented through IR and PIR sensor and the output obtained through proteus 7 simulation software. This energy crisis in today’s world can be reduced to some extent.

# **Components used**

The following table shows different sensors, microcontrollers and other components mentioned in the research papers:

|  |  |  |  |
| --- | --- | --- | --- |
| **Reference**  **Number** | **Sensor** | **Microcontroller** | **Electrical component** |
| 1 | Motion sensors | Not mentioned | LEDs |
| 2 | LDR IR | NXPP89V1RD2 | LCD display, |
| 3 | PIR ,LDR ,ultrasonic, | Arduino Nano | PiCamera,LED, Raspberry Pi |
| 4 | PIR,illumination sensor | Arduino UNO | Light source, ZigBee transceiver |
| 5 | Motion and photo sensor,LDR | UART | - |
| 6 | PIR | Arduino Uno | LEDs,Xbee module |
| 7 | Motion,LDR, | Arduino Nano | Raspberry Pi 3 |
| 8 | LDR,DHT11 | Arduino Nano | ESP8266EX Wi-Fi Module,LEDs |
| 9 | LDR | Atmega328p | HP-LEDs, HC-12,LCD display |
| 10 | LDR,IR | NodeMCU 8266 | Solar panel,battery,MUX,LEDs |
| 11 | LDR | ATmega168 | Dimmable LEDs |
| 12 | Occupancy sensors, Radar motion sensor, lux sensors(simulation) | (simulation) | Fuzzy tool, dimming drivers (simulation) |
| 13 | --Analysis--- | --Analysis-- | --Analysis-- |
| 14 | PIR ,LDR | Arduino UNO At mega 328P-PU | LED,LCD display |
| 15 | WSNs,KNX,luxmeters(DT86 | KNX light luminance controller UP255/11 | - |
| 16 | PIR | Name not mentioned | Xbee module, led driver,ac/dc converter |
| 17 | LDR, PIR | Arduino UNO At mega 328P-PU | LEDs and LCD |
| 18 | Photo sensor | - | Powerline technology |
| 19 | PIR, LDR | Arduino Uno | LCD, LED bulb |
| 20 | Illumination sensor or light sensor | - | DALI bus system,LEDs |
| 21 | LDR,IR | Arduino Uno | LEDs |
| 22 | LDR | Arduino Uno | LED,light source |
| 23 | LDR | Arduino Uno | LEDs |
| 24 | LDR, IR | Not mentioned | LEDs,Solar panel |
| 25 | LDR | Not mentioned | LEDs |
| 26 | LDR, IR | Not mentioned | LEDs |
| 27 | LDR, IR | Arduino Uno | LED,Zigbee |
| 28 | LDR,motion | Arduino Nano | LED |
| 29 | LDR,motion | Arduino Uno | LED |
| 30 | PIR,LDR | Arduino Uno | LED |

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