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IOT BASED OCCUPANCY MONITORING TECHNIQUES FOR ENERGY EFFICIENT SMART BUILDINGS

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Abstract

This paper presents an IoT-based occupancy monitoring system for energy-efficient smart buildings. The system uses IoT technologies to monitor occupancy in real-time, enabling informed decisions for efficient energy management. The system uses sensors like motion and occupancy sensors to collect occupancy data, which is processed and analyzed using machine learning algorithms to predict occupancy patterns and optimize energy usage. A centralized control unit receives occupancy data from sensors and communicates with the building's energy management system. Based on this information, the control unit can adjust lighting, heating, and ventilation systems to match actual occupancy levels, avoiding wasteful energy consumption in unoccupied areas.The system offers several advantages, including improved energy efficiency, reduced operational costs, and enhanced occupant comfort. By dynamically adjusting energy usage based on real-time occupancy data, the system ensures energy is only consumed when needed, leading to significant energy savings. Additionally, the system provides insights into occupancy patterns, allowing facility managers to optimize space utilization and make informed decisions about building operations.However, challenges such as sensor placement, data privacy, and system scalability need to be addressed to ensure the system's effectiveness and reliability. Despite these challenges, the adoption of an IoT-based occupancy monitoring system holds great potential for creating energy-efficient smart buildings and contributing to sustainable development.

I. Introduction

Smart buildings are revolutionizing the built environment by integrating advanced technologies to optimize energy consumption, enhance occupant comfort, and improve overall building performance. One key aspect of smart buildings is the ability to monitor and manage occupancy levels in real-time. Accurate occupancy information allows for intelligent control and automation of various building systems, such as lighting, heating, ventilation, and air conditioning (HVAC), based on actual occupancy patterns. The Internet of Things (IoT) has emerged as a game-changing technology in the field of smart buildings, enabling seamless connectivity and communication between devices and systems. IoT-based occupancy monitoring systems utilize a network of sensors, data analytics, and communication infrastructure to collect, process, and analyze occupancy data. These systems provide real-time insights into occupancy patterns, allowing for dynamic adjustment of building systems to optimize energy usage and ensure occupant comfort.

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Traditional occupancy monitoring techniques, such as manual tracking or static schedules, are often inadequate in meeting the evolving needs of energy-efficient smart buildings. IoT-based occupancy monitoring systems address these limitations by offering a more granular and accurate representation of occupancy levels. By deploying various sensors, such as motion sensors, occupancy sensors, and environmental sensors, throughout the building, the IoT-based occupancy monitoring system can continuously monitor and track occupancy patterns in different areas. The collected data is processed and analyzed using advanced algorithms, such as machine learning and predictive analytics, to estimate occupancy levels, detect anomalies, and make informed decisions for energy management.f

The benefits of implementing an IoT-based occupancy monitoring system in smart buildings are manifold. Firstly, it enables precise control and automation of building systems, leading to significant energy savings and reduced carbon footprint. Secondly, it improves occupant comfort by providing personalized and adaptive environments based on individual preferences and real-time occupancy information.In conclusion, IoT-based occupancy monitoring systems offer numerous benefits for energy-efficient smart buildings, ranging from energy savings and improved occupant comfort to enhanced security and data-driven decision making. By leveraging IoT technologies, these systems pave the way for smarter, greener, and more sustainable built environments.

Proposed system

The proposed IoT-based occupancy monitoring system aims to provide accurate, real-time, and granular occupancy data for energy-efficient smart buildings. It uses a network of sensors, data analytics, and communication infrastructure to enable intelligent control and optimization of building systems based on actual occupancy patterns. The system includes occupancy sensors, data collection and processing, real-time monitoring and visualization, energy optimization and automation, predictive analytics, alerts and notifications, and scalability. Sensors detect the presence or absence of occupants in specific areas, while data is transmitted to a central data collection unit or cloud server for analysis. The system also integrates building automation systems, such as lighting, HVAC, and energy management systems, to dynamically adjust lighting levels, temperature settings, and energy usage based on occupancy levels. Predictive analytics forecast occupancy levels based on historical data, enabling proactive planning and resource allocation. The system can generate real-time alerts based on predefined rules or thresholds, enabling timely response and action. The system is designed to be scalable and adaptable to different building environments, enabling smart buildings to achieve optimal energy efficiency, improved occupant comfort, and effective resource management.

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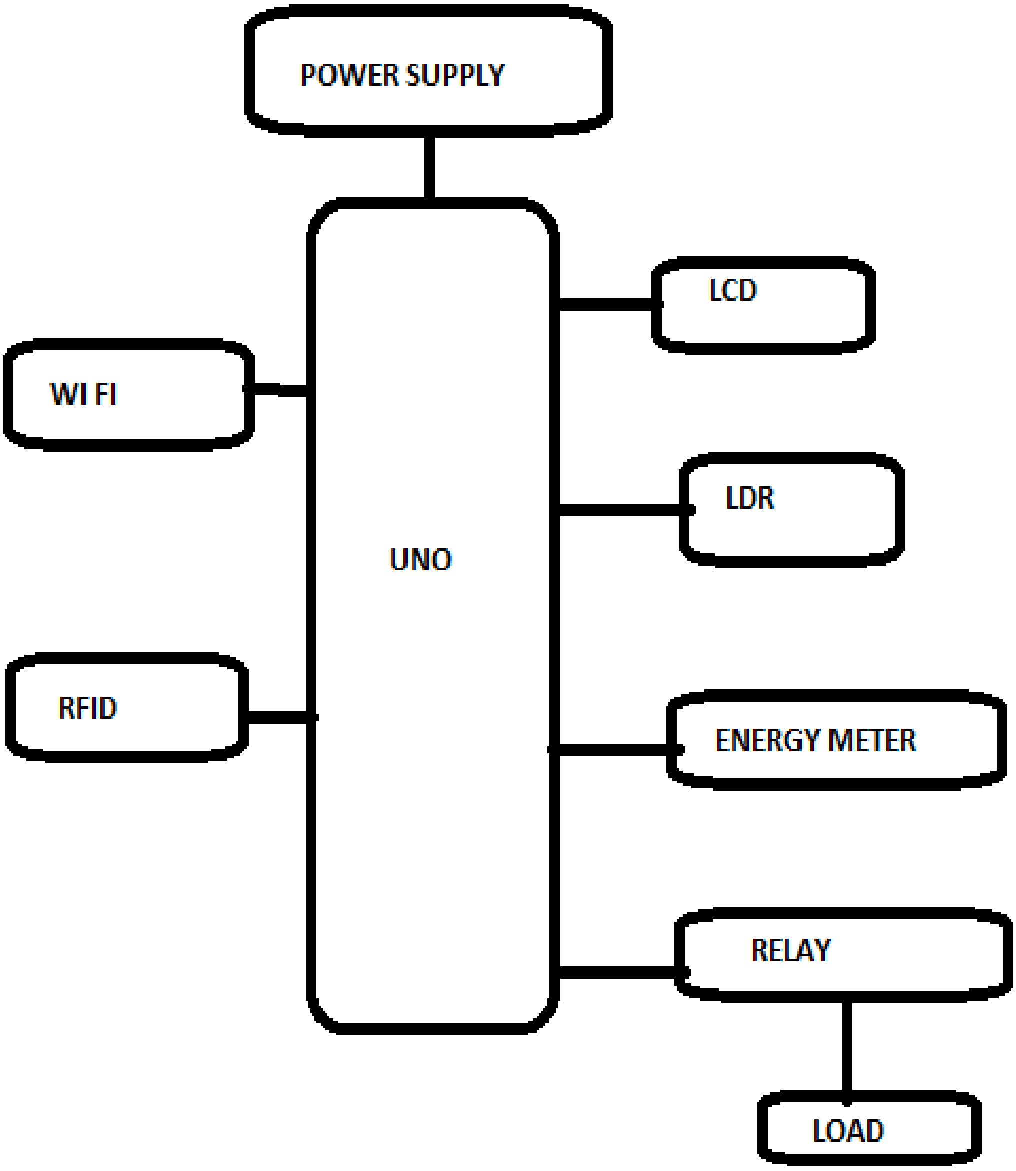
BLOCK DIAGRAM:



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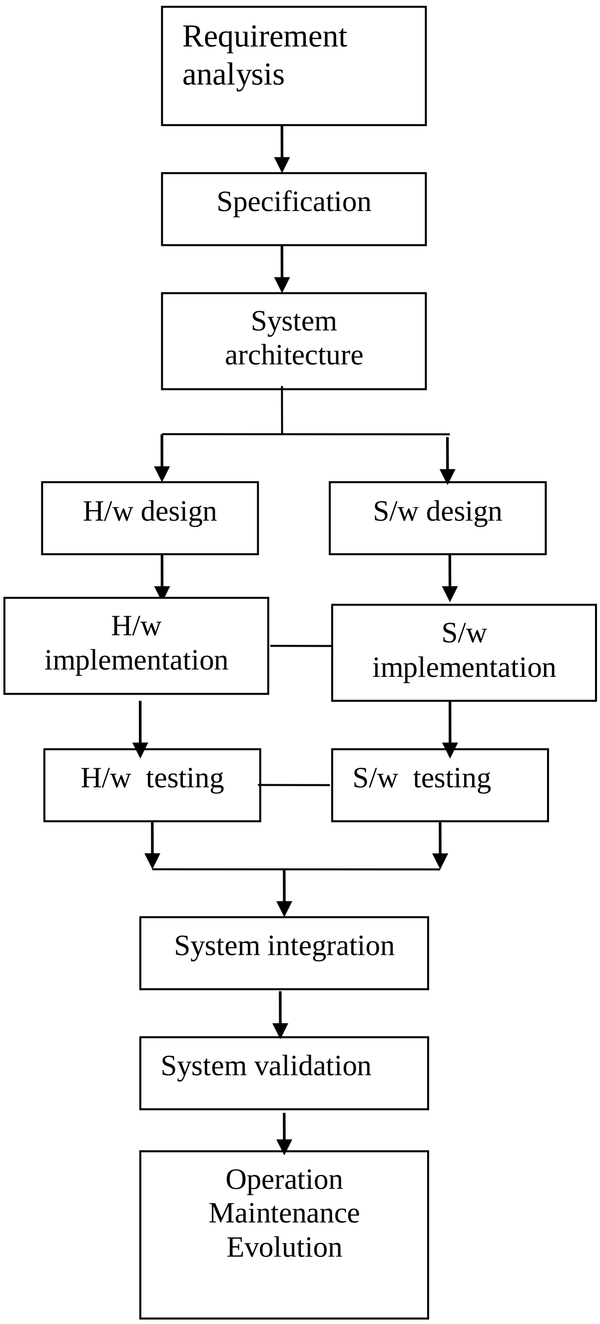
II. APPLICATION OF IOT IN SMART GRID

Embedded systems are increasingly being integrated into various products, including robotic toys, electronic pets, intelligent cars, and remote controllable home appliances. Major toy makers are creating interactive toys that can become lifelong friends, such as Furbies and AIBO, which are robotic dogs with a distinct life cycle. Telematic systems in cars provide navigational security, communication, and entertainment services using GPS and satellite. Home appliances are also adopting embedded technology, with LG electronics' digital DIOS refrigerator allowing for internet browsing, email checking, video phone calls, and TV watching. IBM is developing an air conditioner that can be controlled over the internet. The broad range of embedded systems makes generalization difficult.



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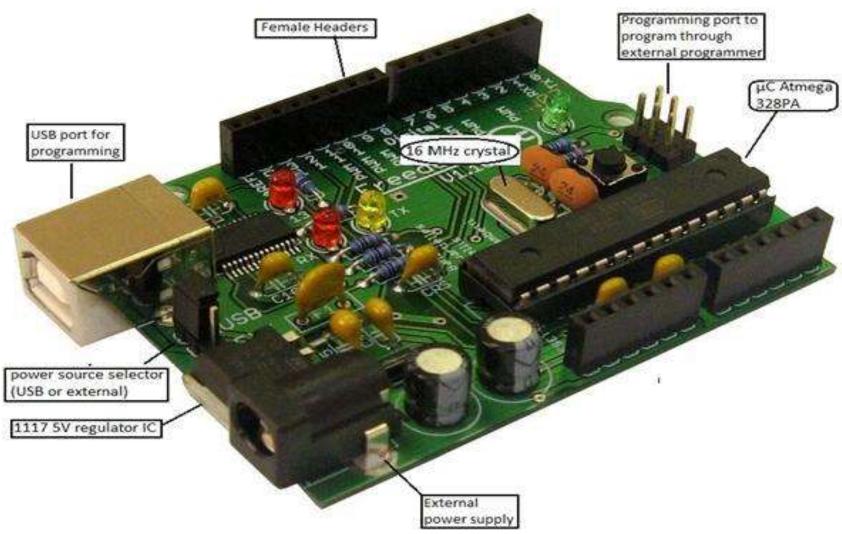
- **Aerospace and defence electronics**: Fire control, radar, robotics/sensors, sonar.
- **Automotive**: Autobody electronics, auto power train, auto safety, car information systems.
- **Broadcast & entertainment**: Analog and digital sound products, camaras, DVDs, Set top boxes, virtual reality systems, graphic products.
- **Consumer/internet appliances**: Business handheld computers, business network computers/terminals, electronic books, internet smart handheld devices, PDAs.
- **Data communications:** Analog modems, ATM switches, cable modems, XDSL modems, Ethernet switches, concentrators.
- **Digital imaging**: Copiers, digital still cameras, Fax machines, printers, scanners.
- **Industrial measurement and control:** Hydro electric utility research & management traffic management systems, train marine vessel management systems.
- **Medical electronics:** Diagnostic devices, real time medical imaging systems, surgical devices, critical care systems.
- **Server I/O:** Embedded servers, enterprise PC servers, PCI LAN/NIC controllers, RAID devices, SCSI devices.
- **Telecommunications**: ATM communication products, base stations, networking switches, SONET/SDH cross connect, multiplexer.
- **Mobile data infrastructures**: Mobile data terminals, pagers, VSATs, Wireless LANs, Wireless phones.

A. Arduino UNO

Arduino is a family of microcontroller boards designed to simplify electronic design, prototyping, and experimentation for artists, hackers, hobbyists, and professionals. They are built around an ATmega microcontroller, a complete computer with CPU, RAM, Flash memory, and input/output pins. Arduinos are designed to attach various sensors, LEDs, motors, speakers, servos, etc. directly to these pins, which can read or output digital or analog voltages between 0 and 5 volts. Arduinos connect to your computer via USB and can be programmed in C/C++ from the Arduino IDE. Once programmed, the Arduino can run with the USB link back to your computer or stand-alone without it, requiring no keyboard or screen.



Starting clockwise from the top center:

- Analog Reference pin (orange)
- Digital Ground (light green)
- Digital Pins 2-13 (green)
- Digital Pins 0-1/Serial In/Out - TX/RX (dark green) - These pins cannot be used for digital i/o (Digital Read and Digital

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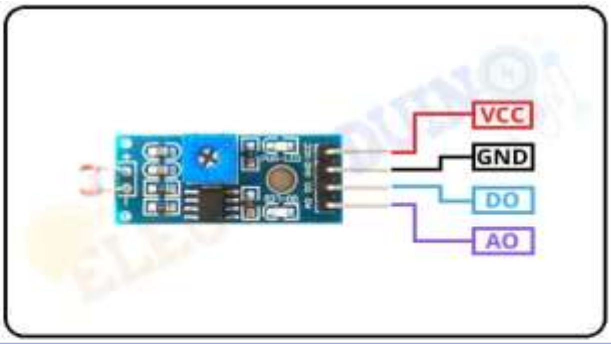
Write) if you are also using serial communication (e.g. Serial.begin).

- Reset Button - S1 (dark blue)
- In-circuit Serial Programmer (blue-green)
- Analog In Pins 0-5 (light blue)
- Power and Ground Pins (power: orange, grounds: light orange)
- External Power Supply In (9-12VDC) - X1 (pink)
- Toggles External Power and USB Power (place jumper on two pins closest to desired supply) - SV1 (purple)



- USB (used for uploading sketches to the board and for serial communication between the board and the computer; can be used to power the board) (yellow)

A. LDR Sensor

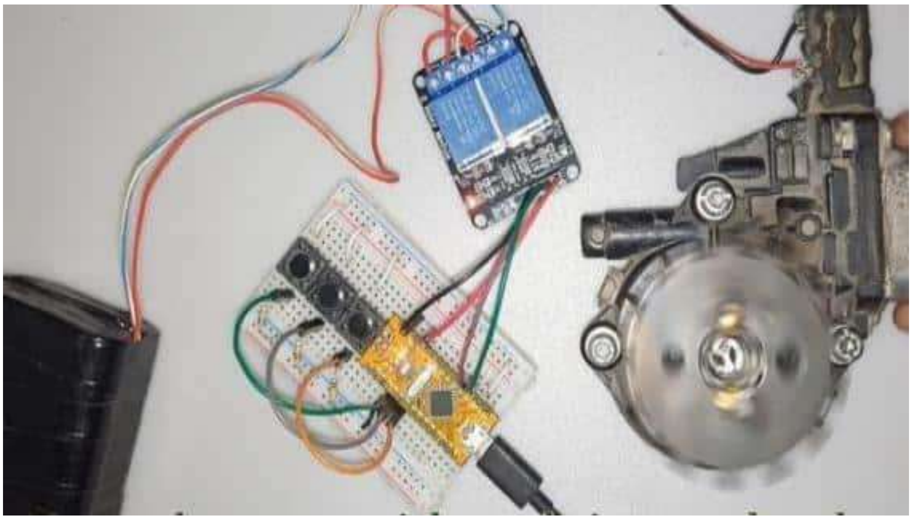
The LDR sensor module is a low-cost digital and analog sensor module that measures and detects light intensity. It features an onboard LDR (Light Dependent Resistor) for light detection. The module has four terminals, with the "DO" pin for digital output and the "AO" pin for analog output. The sensor's sensitivity can be adjusted using an onboard potentiometer.

Parameter	Value
Operating voltage	5V or 3.3V DC
Comparator chip	LM393
Module Pins	3 pins
Output type	Digital outputs (D0)
Sensitivity	Adjustable
Indicator LED	Output and power LED indicator
PCB size	3cm * 1.6cm

A. Relay module

Relay modules have input and output sides with jumper pins and screw terminals. When a control signal is applied, the electromagnet activates, attracting an armature and closing switch contacts on the output side, allowing electricity to flow. A flyback diode is placed parallel to the electromagnet

coil to prevent flyback voltage damage. An optocoupler is used for higher isolation, controlling the electromagnet's switching action with a photoelectric device on the input side..



A. LCD Display

A liquid crystal display (LCD) is a flat, color or monochrome display device with a column of liquid crystal molecules suspended between two transparent electrodes and two polarizing filters. These filters allow light to pass through one filter without blocking the other. LCD displays are commonly used in microcontroller devices to output visual information. They are inexpensive, easy to use, and can produce readouts using the 5X7 dots plus cursor. For an 8-bit data bus, the display requires a +5V supply and 10 I/O lines, while for a 4-bit bus, it requires supply lines and 6 extra lines.

PIN	SYMBOL	FUNCTION
1	Vss	Power Supply(GND)
2	Vdd	Power Supply(+5V)
3	Vo	Contrast Adjust
4	RS	Instruction/Data Register Select
5	R/W	Data Bus Line
6	E	Enable Signal
7-14	DB0-DB7	Data Bus Line
15	A	Power Supply for LED B/L(+)
16	K	Power Supply for LED B/L(-)

IV. Conclusion

An IoT-based occupancy monitoring system for energy-efficient smart buildings offers real-time, granular occupancy data, enabling informed decisions about energy consumption, space allocation, and resource management. This system integrates building automation systems, ensuring optimal energy efficiency and reduced carbon footprint. Predictive analytics enable proactive planning and resource allocation, improving space utilization and occupant comfort. The system's scalability and integration with other IoT devices enhance its efficiency and functionality. Implementing this system can lead to enhanced energy efficiency, occupant comfort, and sustainable operations.

V. References

[1]Gupta, R., & Kaushik, S. (2017). IoT based smart homes: A review. In 2017 International Conference on Intelligent Sustainable Systems (ICISS) (pp. 663-668). IEEE. doi: 10.1109/ISS1.2017.8389042 Islam, M. S., & Hossain, M. S. (2018).

[2]Internet of Things (IoT) based smart home system: A comprehensive review. In 2018 IEEE Region 10 Humanitarian Technology Conference (R10-HTC) (pp. 1-6). IEEE. doi: 10.1109/R10-HTC.2018.8604505 Panssila, M., & Kostakos, V. (2015).

[3]IoT in the wild: Exploring the challenges of using low-cost, self-contained devices in outdoor environmental monitoring. In Proceedings of the 2015 ACM International Joint Conference on Pervasive and Ubiquitous Computing (pp. 523-534). ACM. doi: 10.1145/2750858.2804280 Zhou, B., Zhang, D., & Zhao, Z. (2020).

[4]An intelligent system for environmental monitoring and control in smart home based on Internet of Things. IOP Conference Series: Materials Science and Engineering, 738(4), 042008. doi: 10.1088/1757-899X/738/4/042008 Li, S., Da Xu, L., & Zhao, S. (2015).

[5]The internet of things: A survey. Information Systems Frontiers, 17(2), 243-259. Doi: 10.1007/s10796-014-9489-1 Akram, U., Anwar, M. W., Imran, M., & Imran, A. (2020).

[6]IoT-based environmental monitoring system using wireless sensor networks: A review. SN Applied Sciences, 2(1), 1-21. doi: 10.1007/s42452-019-1925-3 Dinh, T. T., Nguyen, T. Q., Nguyen, T. T., & Pham, V. D. (2020).

[7]An IoT-based environmental monitoring system for smart agriculture. In Proceedings of the 2020 4th International Conference on Recent Advances in Vietnam (pp. 150-155). IEEE. doi: 10.1109/ICRAV.2020.9164226 Gubbi, J., Buyya, R., Marusic, S., & Palaniswami, M. (2013).

[8]Internet of Things (IoT): A vision, architectural elements, and future directions. Future Generation Computer Systems, 29(7), 1645-1660. doi: 10.1016/j.future.2013.01.010 Jayaraman, P. P., Rajkumar, M., & Kannan, A. (2017).

[9]Internet of Things based environmental monitoring system for smart cities. Procedia Computer Science, 115, 252-259. doi:10.1016/j.procs.2017.09.037
Porambage, P., Militano, L., Liyanage, M., Capponi, A., & Ylianttila, M. (2017).

[10] Kumar D, Aseri TC, Patel RB. EECHDA: Energy Efficient Clustering Hierarchy and Data Accumulation for Sensor Networks. BIJIT. 2010; 2(1):150–7.

[11] Fortino, G., Giannantonio, R., Gravina, R., & Russo, W. (2014). An IoT-aware architecture for smart healthcare systems. IEEE Internet of Things Journal, 1(2), 144-152.

[12] Baccour, N., Yassein, M. B., & Koubâa, A. (2018). Environmental monitoring with wireless sensor networks: A review. In 2018 15th IEEE Annual Consumer Communications & Networking Conference (CCNC) (pp. 1-6).

[13] MQ-2 Gas Sensor Library. (n.d.). MQ2 Gas Sensor Arduino Library. Retrieved from https://platformio.org/lib/show/1687/MQ2