ADAMSON UNIVERSITY

"Combination of 3 Sensors: Light Dimmer, Motion, and Water level in one circuit using Arduino"

A Project Study
Presented to
Fundamentals of Mixed Signals & Sensors
Subject Course

Group Leader:

Gepila, Christopher H.

Group Members:
Arnaiz, Clayde
Jamandre, Jan Nathan J.
Sarvida, Franchesca
Turiano, Joshua S.
Valdez, Reynard James M.

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By:

Gepila Chritopher
Arnaiz Clayde
Jamandre Jan
Sarvida Francheska
Turiano Joshua
Valdez Reynard

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Group Leader:

Gepila Chritopher

Group Members

Arnaiz Clayde

Jamandre Jan

Sarvida Francheska

Turiano Joshua

Valdez Reynard

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Chapter 1

INTRODUCTION

A practical way to increase automation and control in different applications is to integrate multiple sensors in a single circuit. Light Dimmers, water level sensors and motion detectors all serve essential roles in sensing and how environmental conditions are monitored and managed. If used in combination with a microcontroller such as the Arduino, these sensors can be employed to form a multi-function system, which is able to react to multiple inputs.

The aim of this research is to design and implement a circuit for integrating three sensors: light dimmer, motion sensor and water level sensor using Arduino and each sensor operation is dependent on a switch. This switch enables as well as disabling particular sensors to suit the actions that users may or may not choose to enable or disable. The light dimmer adjusts lighting levels according to ambient brightness, the motion sensor allows you to control lighting or security systems and the water level sensor detects how much fluid level you have in applications such as irrigation or water management.

This research explores the capability of developing a flexible, user friendly system with selective control of these sensors via a switch to enable flexible monitoring of environments and tasks specific to the tasks. Through the integration with Arduino, the control and automation can facilitate efficient resource management, and the increase of the overall system's responsiveness. In this study, emphasis would be put on how the design, functionality and some of the benefits of such a system, such as energy saving, ease of use and automation are achieved.

STATEMENT OF THE PROBLEM

As automation and energy efficiency have become essential in homes, businesses, and industrial settings, there is a need for systems that can manage multiple environmental factors, including light, motion and water levels, at once in a user-friendly way. Unfortunately, existing systems often take separate controllers or devices for each sensor type place much in the way of complexity, cost, and inefficiency. In addition, the lack of selective control of which sensor is active at a particular time prevents flexibility to tailor for different user needs and environment requirements.

The problem being addressed in this research involves integrating multiple sensors (light dimmer, motion sensor, etc.) into a single circuit which is controlled by Arduino where each sensor can be independently switched on or off using a switch. The idea is to simplify the management of these sensors in a cheap and efficient way whilst keeping the user able to enable and disable specific functionalities on demand. The approach will be studied with regard to how this changes automation, reduces energy usage, and enhances adaptability in the system over existing solutions.

OBJECTIVE OF THE STUDY

This study focuses on the design and development of integrating circuits using three sensors: a light dimmer sensor, a motion sensor, and a water level sensor all within one circuit on an Arduino microcontroller. The specific objectives included the following:

Incorporate diverse sensors. A system that combines light dimmer, motion and water level sensors efficiently in one circuit; will therefore work simultaneously and coordinate.

Program the Arduino: Then write and optimize the Arduino code that will process the information coming back from sensors to control lights, motion sensing, and level.

Testing and evaluation of sensors Test sensor sensors for their response, accuracy, and general system performance under different environmental conditions with and without integration into a single circuit.

This system, therefore, needs to be pragmatic and flexible in order that circuit design is scalable and adaptable for suitable real-world applications that may include home automation, water management, and energy efficiency. To discuss power efficiency, it is important to analyze how the integrated sensor system can sustain energy efficiency, particularly in the aspect of decreasing power consumption over time when sensors are not in use.

SIGNIFICANCE OF THE STUDY

Integrating a light dimmer, motion sensor, and water level sensor into a single Arduino-based circuit has significant implications for modern automation and control systems. This study investigates the benefits and applications of this combination, which can boost energy efficiency, enhance user experience, and support sustainable practices. By merging these sensors, the system can optimize energy use, with the light dimmer adjusting brightness based on ambient light detected by the motion sensor, ensuring energy is used only when needed. This reduces electricity costs and minimizes the environmental impact of excessive energy consumption. The sensor combination allows for higher automation levels in various settings, such as homes, offices, and industrial environments. For example, the motion sensor can activate the light dimmer when movement is detected, ensuring spaces are well-lit when occupied and dimmed or off when unoccupied, enhancing convenience and user comfort. Integrating a water level sensor enables effective monitoring and management of water resources, crucial for applications like irrigation systems, aquariums, or water storage tanks. The system can automatically adjust water levels based on sensor readings, promoting responsible water use and preventing overflow or wastage. Using Arduino as the central control unit makes the system affordable and accessible. Arduino's open-source platform allows easy programming and customization, enabling users to tailor the system to specific needs without significant investment in proprietary technologies. This study also serves an educational purpose, demonstrating principles of circuit design, sensor integration, and programming. By exploring this combination, students and enthusiasts gain hands-on experience with real-world applications of electronics and programming, fostering interest in STEM fields. The system's modular nature allows for easy scalability, with additional sensors or functionalities integrated without significant redesign, making it adaptable to various scenarios and future technological advancements.

This study aligns with the trend of smart technology and the Internet of Things (IoT). By combining these sensors, the research contributes to

developing intelligent systems that respond dynamically to environmental conditions, enhancing overall user experience and operational efficiency. In conclusion, combining a light dimmer, motion sensor, and water level sensor using Arduino offers practical benefits in energy management and automation and serves as an educational tool and a step toward advanced smart technology solutions.

SCOPE AND LIMITATIONS

The study focuses on the seamless integration of a light dimmer, motion sensor, and water level sensor into a single Arduino-based system, demonstrating how these sensors can work together to enhance automation and efficiency across various applications. It explores potential applications in residential, commercial, and industrial settings, such as smart homes, automated lighting systems, and water management solutions, specifically addressing use cases like automatic lighting control based on occupancy and water level monitoring in tanks or gardens. Another key focus of this study is on energy management, highlighting how the system can reduce energy consumption through smart lighting control, while also aiming to quantify potential energy savings and provide insights into sustainable practices. Additionally, the project serves as an educational tool for students and hobbyists, illustrating basic principles of electronics, programming, and sensor integration, thereby promoting learning and interest in STEM fields through hands-on experience. Lastly, the study will encompass the design, prototyping, and testing of the combined system, evaluating its performance and reliability under various conditions to provide a functional prototype that can be tested in real-world scenarios.

Chapter 2

Methodology

Block Diagram of Hardware

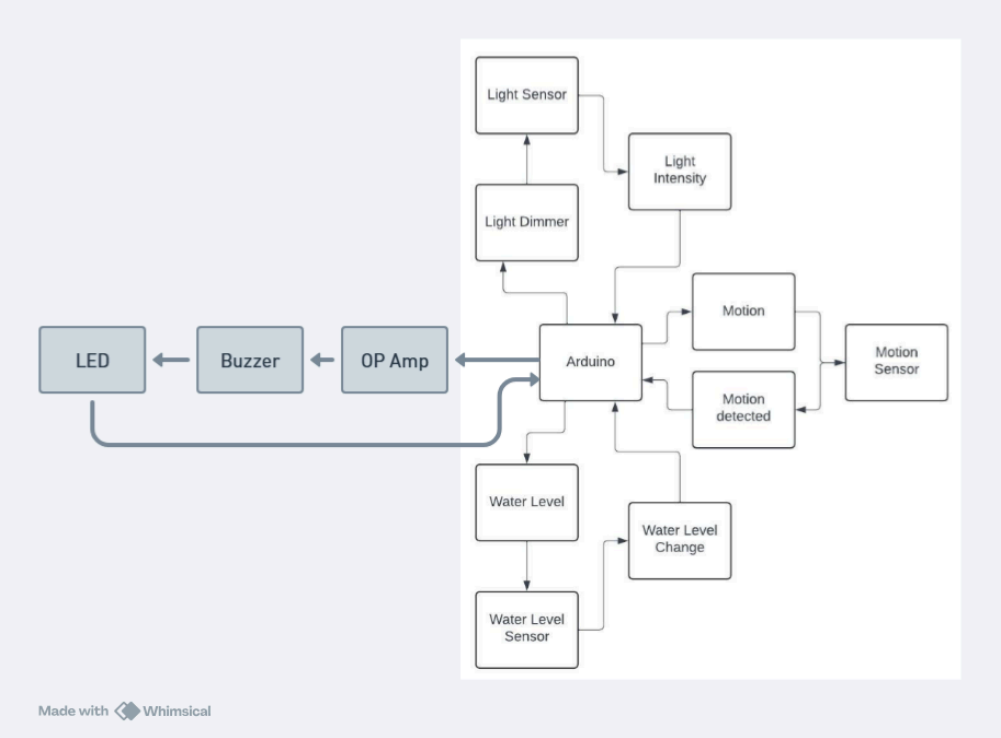


Figure 1.1 Block Diagram of Hardware

Flow Chart of Software

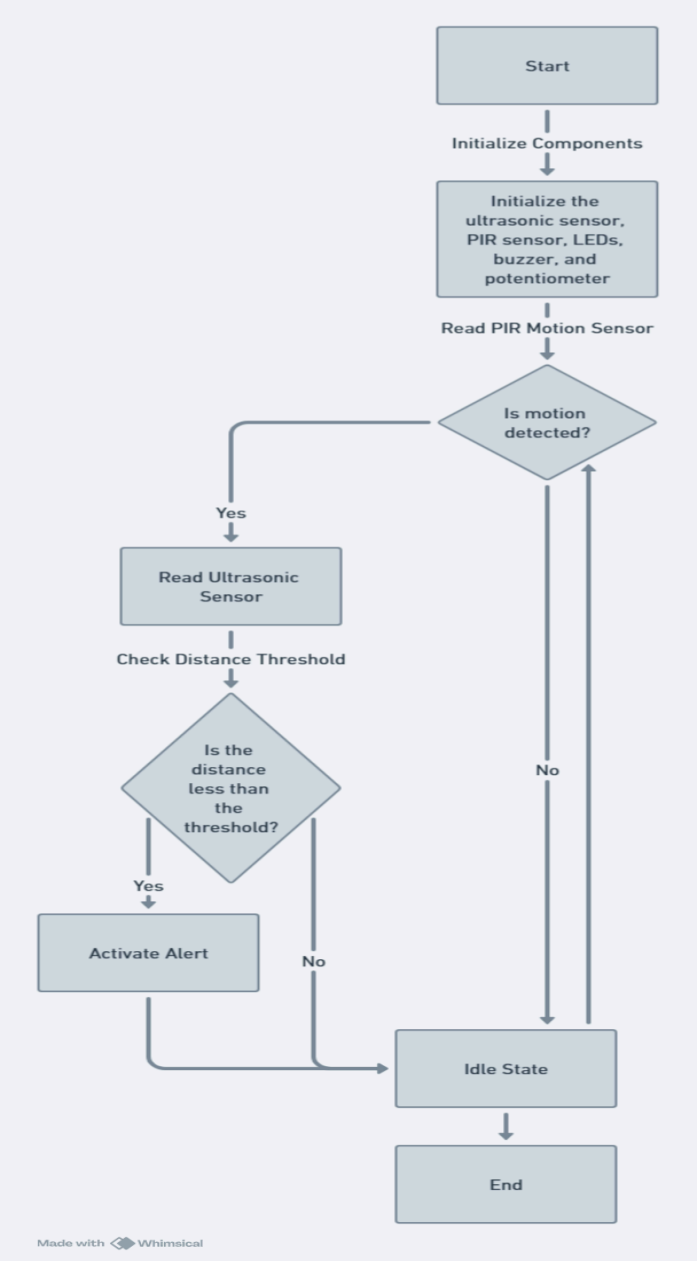


Figure 1.2 Flowchart

Complete Schematic Diagram

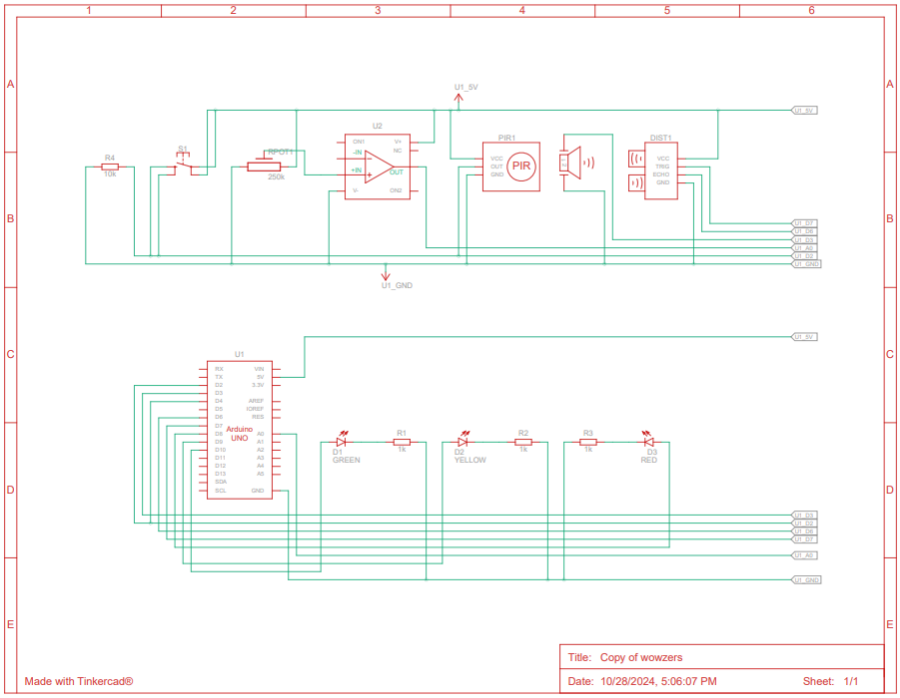


Figure 1.3 Schematic Diagram

An Arduino based sensor system that monitors motion and distance and alerts when appropriate is shown in this schematic, created in Tinkercad. This core component is Arduino Uno, which acts not only as a controller, but also a way to connect with several sensors and output devices. A PIR motion sensor detects the movement and causes the Arduino to send possible and ultrasonic sensors measuring the distance using ultrasonic waves. Most likely, an operational amplifier (op-amp) is included to amplify or condition signal from the sensors for higher accuracy. Furthermore, a 10k ohm potentiometer provides the opportunity to adjust thresholds or sensitivity, which is connected to 5V, GND, and out through an integrated output pin to the system. There are three LEDs (green, yellow and red) for indications of the system in standby, warning, alert are connected in series with 1k ohm resistors to minimize the current. It also includes a buzzer as an audio alert to sound when a specific condition manifests, such as motion detection. All of the components of the circuit are routed for (5V) and ground connection to supply. The controller connects to

each element using a designated pin connected to each element, and can collect sensor data and output through the programmed logic.

PCB Layout

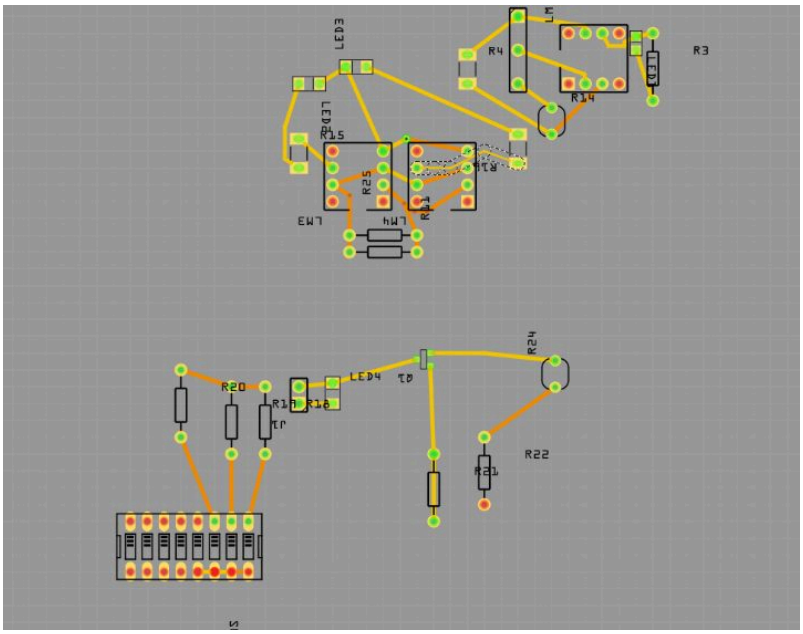


Figure 1.4 Unorganized PCB Layout

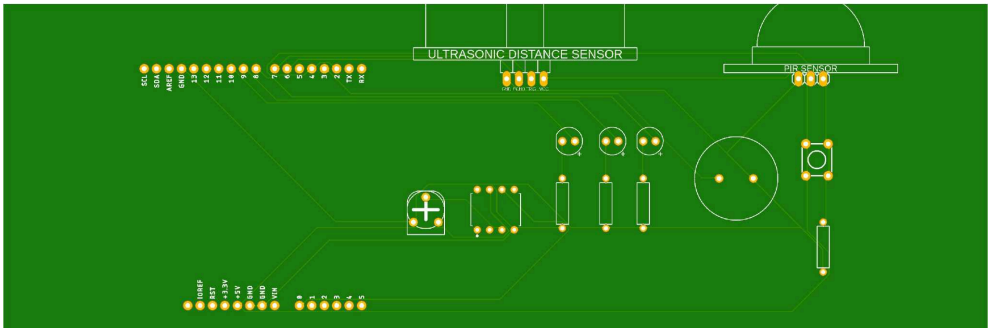


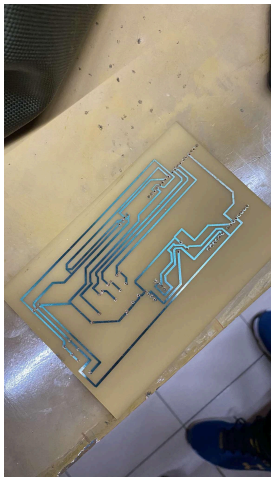
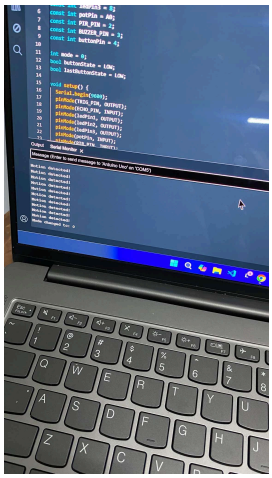
Figure 1.5 Final PCB Layout

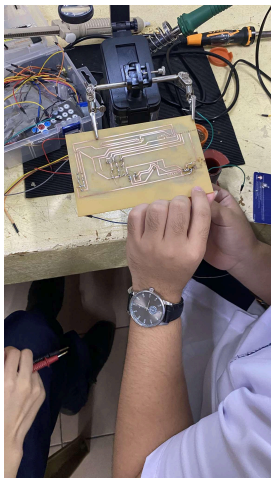
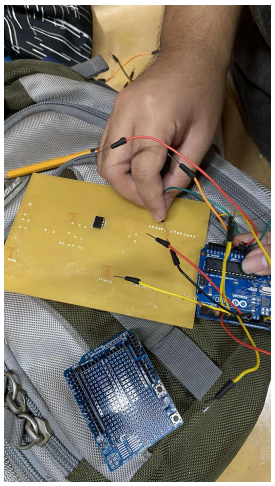
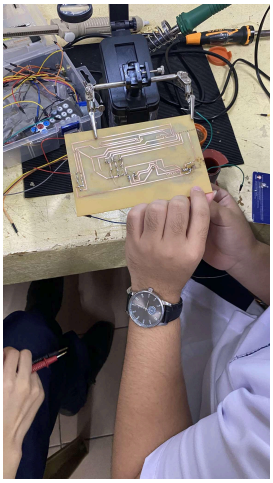
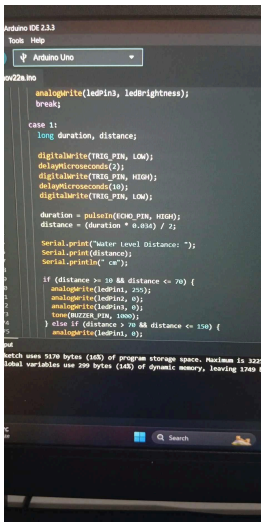
Chapter 3

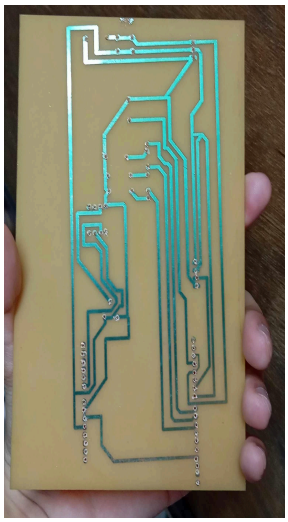
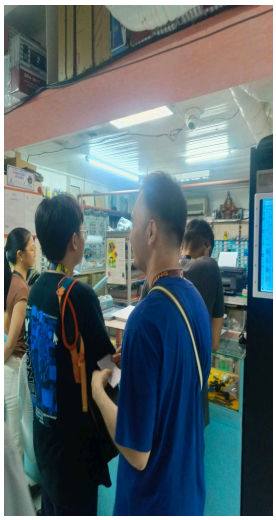
Data, Results, and Discussion

Combining a light dimmer, motion sensor, and water level sensor into one circuit using Arduino can serve various applications, such as home automation systems, smart irrigation, or water leakage detection with lighting control. Below is a discussion on how to integrate these sensors into a single system. Three LED lights are the main indicator for all three sensors. The device has all three modes, by clicking the button, you will be able to switch modes, with how the device works, Motion sensor detects motion, the LED lights will turn red when the motion is near, turns yellow when when the motion is at mid-length distance, and the LED light will turn green when it's at the farthest distance that the sensor can detect. Light motion adjusts the light brightness based on activity using PWM (for LEDs) or a TRIAC dimmer (for AC lights). Water Level Sensor monitors water levels to trigger alerts or controls a pump.

Pictures During Experiment

Result

Three functionalities of the project, light dimming, water level monitoring, and motion detection, were successfully integrated into a one Arduino based circuit. Independently each mode was tested, with a button to switch visiting to a mode that is seamless. In the water level monitoring mode, the HC-SR04 ultrasonic sensor was driven by Arduino trigger and the water levels were measured accurately. An auditory output allowed for real time feedback: different buzzer sounds for low, medium and high water levels. Testing showed consistent performance when the system reliably categorized water levels within predefined thresholds.

Led brightness could be adjusted by a potentiometer with the use of the light dimmer mode. Intensity of the LEDs was then modulated by the op-amp, processing the input voltage. Brightness was precisely controlled, and the system responded well to changes in the potentiometer setting. But at the darkest potentiometer setting, the LEDs were slightly of different brightness.

The motion detection mode of the PIR sensor was able to correctly detect movement which in turn caused a buzzer to be sounded for the sake of alerting. The sensor quickly responded and demonstrated reliable operation under stable environmental conditions. The addition of a mode switching button allowed for streamlined operation, while crafting the system to focus on one functionality at a time, with less power and resources than needed for two at once.

Discussion

Arduino is really capable of running all these sensors in a single circuit. The HC-SR04 sensor and buzzer in water level monitoring gave practical, real time feedback with distinct sounds for each level. While this approach is effective, environmental factors such as water turbulence could introduce error and consequently require noise reduction or improved sensors.

Led brightness was successfully controlled by the light dimmer mode using an op-amp, which exhibited a slow response at low settings. Uniformity could be refined using a rail to rail op amp or other resistors. In motion detection the PIR sensor reliably activated the buzzer but sometimes there was a false positive. It could improve performance by better placement or shielding.

Seamless transitions between functions were possible through the use of a button based mode switching system, however precise programming was necessary to make the touch of the buttons translate smoothly into functions. Overall, this project demonstrated feasibility of implementing them together, and potential for improvement in accuracy and function for practical applications ranging from home automation.

Chapter 4

Conclusion

Bringing together a light dimmer, motion sensor, and water level sensor in one Arduino-powered setup is a smart and practical way to automate your home and manage resources. This system can handle tasks like turning lights on or off based on movement, keeping track of water levels to avoid waste or flooding, and even adjusting light brightness as needed.

With Arduino's flexibility, you can build a setup that's affordable, energy-efficient, and customized to your needs. By ensuring good wiring, reliable power, and adding features like Wi-Fi for remote control, this project can make your home smarter, safer, and more sustainable.

Recommendation

Future studies could delve into incorporating a diverse array of additional sensors to significantly enhance the system's versatility and applicability. For instance:

- **Temperature Sensors**: These could enable the system to monitor and regulate environmental conditions, proving useful for applications such as climate control, food storage monitoring, and health-related use cases like fever detection.
- **Humidity Sensors**: Including these sensors could allow for precise monitoring of moisture levels, which is critical in agriculture, industrial drying processes, and maintaining optimal storage conditions for sensitive materials.
- **Gas Detectors**: These could be employed to detect harmful gases, ensuring safety in environments prone to gas leaks (e.g., industrial facilities, kitchens, or chemical labs) and improving air quality monitoring systems for urban environments or smart homes.
  Integrating such sensors would not only broaden the range of potential applications but also open doors to advanced implementations in home automation,
- **Enhance Sensor Accuracy:** Therefore, to increase the reliability of the HC-SR04 ultrasonic sensor on measuring water level particularly where the environment is disturbed by water turbulence, filtering algorithms or noise reduction techniques are implemented..
- **Optimize Circuit Design**: To correct brightness inconsistencies in the light dimmer mode, and to improve LED performance at lower potentiometer settings, replace the current op-amp with a rail to rail op-amp.
- **Improve Motion Detection:** Place the PIR sensor optimally to minimize false positives so that environmental shielding, like heat sinks or reduction of interference from temperature fluctuations or neighbors electronic devices, can be incorporated to reduce the false positive rate.

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