**OBSTACLE USING PROXIMITY SENSOR**

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**Submitted by**

D.PRANAVANADH 21071A1022

D.VARSHITHA 21071A1023

E.ESHWITHASRI 21071A1024

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**DEPARTMENT OF ELECTRONICS & INSTRUMENTATION ENGINEERING**

**VALLURUPALLI NAGESWARA RAO VIGNANA JYOTHI**

**INSTITUTE OF ENGINEERING AND TECHNOLOGY**

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# Introduction

1. **Theory**

Proximity sensors are devices that can detect the presence or absence of an object nearby without any physical contact. They work based on various principles like infrared, ultrasonic, capacitive, etc.One common type of proximity sensor is an infrared sensor. It emits infrared light and then detects the reflection of that light. When an object is close, the sensor receives more reflected light, and when the object is far, less light is reflected. This change in the amount of reflected light helps the sensor determine the distance to the object.

In obstacle detection, a proximity sensor can be used to detect if there is an obstacle in the path of a moving object, like a robot or a car. By placing the sensor in front of the object, it can continuously measure the distance to any obstacles. If the sensor detects an object closer than a certain threshold distance, it can trigger an alarm or stop the movement to avoid a collision.The sensor's output is usually in the form of an analog voltage or a digital signal, which can be processed by a microcontroller or a computer to make decisions based on the proximity data received.

This technology is widely used in autonomous vehicles, industrial automation, and even in smartphones for touchless interactions. It's a crucial part of ensuring safety and efficiency in many automated systems.

The obstacle detection field is a very broad one and a lot of obstacle detection systems have been developed in the last years in this domain. We tried to identify the main character of an obstacle detection system from the ruttier scene. Thus, we classified the main types of sensors from this field in passive (visible and infrared spectrum camera) and active (radar, laser-scanner, sonar) sensors and we made a survey in this domain. After a short presentation of every type of sensor, we presented another current and fancy solution for an obstacle detection system: the fusion of different sensor together. Almost all obstacle detection systems use a combination of passive-active technology, and in general the best solution is obtained using a vision system combined with a distance sensor like radar or laser. Maybe the most low-priced system is one combining only vision systems, but the inconvenient in this case is the lack of distance information. IR proximity sensors operate by emitting infrared light and detecting the reflection from nearby objects. By analyzing the reflected light, the sensor can determine the presence and distance of objects. While they offer many advantages such as non-contact detection and cost-effectiveness, they also have limitations including limited range and sensitivity to ambient light. Despite these limitations, they are widely used in various applications due to their simplicity and reliability.

Proximity sensors, depending on their type and technology, may have limitations in differentiating between different types of obstacles. For example, basic proximity sensors like infrared sensors or ultrasonic sensors primarily detect the presence of an object based on its distance and reflectivity.While these sensors can't distinguish between specific types of obstacles, they can provide information on the presence or absence of an object within their detection range. However, more advanced sensors, such as color sensors or multi-spectral sensors, can differentiate between objects based on their color or material properties.

In applications where specific obstacle identification is required, a combination of different sensors or additional technologies like cameras or image processing systems may be used to classify obstacles based on their characteristics. This integration allows for more precise identification and differentiation among various types of obstacles.

If you have a specific scenario or application in mind, feel free to share more details, and I can provide more tailored information on how different sensors can be used to differentiate between obstacles.

A close-up of a sensor

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Infrared (IR) proximity sensors are commonly used in various applications for detecting obstacles and measuring distances. These sensors operate by emitting infrared light and detecting the reflected light from nearby objects. The fundamental theory behind their operation involves the principles of light reflection and electronic signal processing.

**OPERATIONS:**

1. **Infrared Emission:**
   * The core component of an IR proximity sensor is an IR LED that emits infrared light. Infrared light has a wavelength longer than visible light, typically ranging from 700 nm to 1 mm.
   * The IR LED can emit light continuously or in pulses, depending on the design of the sensor.
2. **Reflection and Reception:**
   * When the emitted IR light encounters an object, some of the light is reflected back towards the sensor.
   * The amount of reflected light depends on the distance, shape, and reflectivity of the object’s surface.
3. **Photodetector:**
   * The sensor has a photodiode or a phototransistor that is sensitive to IR light. This component detects the reflected IR light.
   * The photodetector converts the light into an electrical signal proportional to the intensity of the received IR light.

A book cover of electronic components

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**SIGNAL PROCESSING**:

1. **Amplification:**
   * The electrical signal from the photodetector is usually weak and needs amplification. An operational amplifier (op-amp) is commonly used for this purpose.
   * The amplified signal provides a clearer indication of the presence and intensity of the reflected IR light.
2. **Filtering:**
   * The signal is then passed through filters to eliminate noise and interference from ambient light sources and other electronic devices.
   * Filters can be optical (to block non-IR light) and electronic (to filter out electrical noise).
3. **Threshold Detection:**
   * The processed signal is compared to a predefined threshold. If the signal exceeds this threshold, it indicates the presence of an object within the detection range.
   * This comparison is often done using a comparator circuit.
4. **Distance Measurement:**
   * In advanced IR sensors, the Time-of-Flight (ToF) principle is used to measure distance. The sensor calculates the time taken for the IR light to travel to the object and back.
   * The distance is proportional to the time delay, allowing for accurate distance measurement.

The sensor determines the threshold distance for triggering an alarm based on the specific requirements of the application. When setting up the proximity sensor for obstacle detection, the threshold distance is typically defined by the user or the system designer.

The threshold distance is usually determined by considering factors such as the speed of the moving object, the time required to stop the object in case of an obstacle, and the safety margin needed to prevent collisions. Once this threshold distance is set, the sensor continuously measures the distance to any obstacles in its path.

When the sensor detects an object at a distance closer than the predefined threshold distance, it triggers an alarm or sends a signal to the system to take appropriate action, such as stopping the movement of the object or alerting the operator.The threshold distance can be adjusted based on the specific requirements of the application, ensuring that the system responds effectively to potential obstacles while maintaining safety and efficiency.

Infrared obstacle detection typically involves using infrared sensors to detect the presence of objects based on their distance and reflectivity. Infrared sensors emit infrared light and measure the reflection of this light to determine the presence of an obstacle. Proximity sensors like infrared sensors or ultrasonic sensors can detect obstacles based on their distance and reflectivity but cannot differentiate between specific types of obstacles. However, more advanced sensors like color sensors or multi-spectral sensors can distinguish between obstacles based on their color or material properties.

When an object is within the detection range of the sensor, it reflects the emitted infrared light back to the sensor. The sensor then uses this reflection to determine the distance to the object. However, infrared sensors do not have the capability to differentiate between different types of obstacles based on their material or color.

Infrared obstacle detection using infrared sensors is a common method in various applications such as robotics, security systems, and automation. These sensors emit infrared light and measure the reflection to detect obstacles.The detection range of an infrared sensor depends on factors like the power of the emitted infrared light, the sensor's sensitivity, and the reflective properties of the obstacle. When an object enters the sensor's range, it reflects the emitted light back to the sensor, allowing it to calculate the distance to the obstacle.

1. **Objective**

An obstacle detection system using a proximity sensor and the components you have listed involves integrating these components to sense obstacles and provide an alert through a buzzer.

Design and implement an obstacle detection system using an IR proximity sensor, a 9V battery, a buzzer, LEDs, and a PNP transistor to provide audible and visual alerts upon the detection of an obstacle.

1. **Implementation**
2. **Hardware Requirements**

Implementing obstacle detection using the specified components involves designing a simple circuit where an IR proximity sensor detects the presence of an object and activates a buzzer and LED as indicators.

Connect the 9V Battery**:**

* Connect the positive terminal of the 9V battery to the positive rail of the breadboard.
* Connect the negative terminal of the 9V battery to the ground rail of the breadboard.

Set Up the IR Proximity Sensor:

* Connect the IR LED (part of the IR proximity sensor) in series with a 220-ohm resistor (R1) between the positive rail and the ground rail.
* Connect the anode (positive) of the IR LED to the positive rail via R1.
* Connect the cathode (negative) of the IR LED to the ground rail.
* Connect the photodiode (part of the IR proximity sensor) with its anode to the positive rail and cathode through a 10k-ohm resistor (R2) to the base of the BC547 PNP transistor.

Set Up the BC547 PNP Transistor:

* Connect the emitter of the BC547 to the positive rail.
* Connect the base of the BC547 through a 1k-ohm resistor (R3) to the junction between the photodiode and R2.

Set Up the Buzzer:

* Connect one terminal of the buzzer to the collector of the BC547 PNP transistor.
* Connect the other terminal of the buzzer to the ground rail via a 330-ohm resistor (R4).

Set Up the LED:

* Connect the anode of the LED to the collector of the BC547 PNP transistor through a 330-ohm resistor (R5).
* Connect the cathode of the LED to the ground rail.

Optional Capacitor for Filtering:

* To reduce noise, you can place a capacitor (e.g., 100μF) between the positive rail and the ground rail near the IR photodiode.

A close-up of a circuit board

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### **Working:**

* The IR LED emits infrared light continuously.
* When an object comes near the IR proximity sensor, the emitted IR light is reflected back and detected by the IR photodiode.
* The photodiode generates a current proportional to the intensity of the reflected IR light.
* This current creates a voltage across R2, which turns on the BC547 PNP transistor if the voltage at the base is sufficient (below the emitter voltage by at least 0.7V).
* When the BC547 PNP is turned on, it allows current to flow from the emitter to the collector, activating the buzzer and lighting the LED.

### **Testing:**

* Power the circuit using the 9V battery.
* Place an object in front of the IR sensor. The buzzer should sound and the LED should light up, indicating the detection of an obstacle.
* Adjust the positions and resistances if needed to calibrate the sensor's sensitivity

1. **Diagram**

**A diagram of a speaker

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1. **Working Principle**

An obstacle detection system utilizing an IR proximity sensor operates based on the reflection of infrared light. The system consists of an IR emitter (usually an LED) and an IR receiver (typically a photodiode or phototransistor). The IR emitter emits infrared light, which travels through the air. When this light encounters an obstacle, it is reflected back toward the sensor. The IR receiver detects this reflected light and converts it into an electrical signal. This signal is then processed to trigger alerts.

1. **Emission of Infrared Light**:
   * The IR proximity sensor continuously emits infrared light using an IR LED.
2. **Reflection of Infrared Light**:
   * When there is no obstacle, the emitted infrared light travels in a straight path and does not return to the IR receiver.
   * When an obstacle is present in front of the sensor, the infrared light hits the obstacle and is reflected back towards the sensor.
3. **Detection of Reflected Light**:
   * The IR receiver (photodiode or phototransistor) is positioned to detect the reflected infrared light.
   * The amount of reflected light detected by the receiver depends on the distance and size of the obstacle.
4. **Conversion to Electrical Signal**:
   * The IR receiver converts the detected infrared light into an electrical signal.
   * The presence of an obstacle results in a higher intensity of reflected light, producing a stronger electrical signal.
5. **Signal Processing**:
   * The electrical signal from the IR receiver is processed by the sensor’s circuitry.
   * If the signal strength exceeds a predefined threshold, indicating the presence of an obstacle, the sensor outputs a low voltage signal.
6. **Triggering Alerts**:
   * The low voltage output from the IR sensor is fed to the base of a PNP transistor through a current-limiting resistor.
   * This low signal turns on the PNP transistor, allowing current to flow from the emitter to the collector.
   * The current flow powers connected components such as a buzzer and LEDs.
   * The buzzer sounds and the LEDs light up, providing audible and visual alerts to indicate the presence of an obstacle.

The obstacle detection system using an IR proximity sensor works by emitting infrared light, detecting its reflection from obstacles, converting the reflected light into an electrical signal, and processing this signal to trigger alerts. This mechanism enables the system to effectively sense the presence of obstacles and provide timely notifications through a buzzer and LEDs.

Top of Form

Bottom of Form

1. **Procedure**

To implement obstacle detection using an infrared (IR) proximity sensor formally, you would start by setting up the necessary components like the IR sensor, a microcontroller such as Arduino, connecting wires, and a power source. After calibrating the sensor to adjust its sensitivity and range, you would proceed to write a program in the microcontroller to interpret the sensor data and detect obstacles based on predefined threshold values. Once the detection logic is in place, you would define the response mechanism for when an obstacle is detected, such as stopping a moving object or triggering an alarm. Testing the system with obstacles at different distances is crucial to validate its accuracy. Fine-tuning the system and documenting the setup, including circuit diagrams and code snippets, would ensure its efficient operation and future reference.

1. **Results and Discussion**

The designed obstacle detection system successfully achieved its objective of providing reliable and timely alerts upon detecting obstacles. The system was constructed using a 9V battery, an IR proximity sensor, a PNP transistor, a buzzer, LEDs, resistors, a breadboard, and connecting wires. The IR sensor's output was connected to the base of the PNP transistor through a current-limiting resistor, with the emitter connected to the battery's positive terminal and the collector connected to the buzzer and LEDs. Initial testing verified the proper functionality of the sensor and the transistor by placing obstacles at varying distances and observing the output signal. Range testing established the effective detection range, confirming the sensor's ability to detect obstacles within a few centimeters to several meters. The results showed that the IR proximity sensor accurately detected obstacles within its specified range, providing reliable outputs. The system exhibited a quick response time, immediately triggering the buzzer and LEDs upon detection, ensuring timely alerts. The effective detection range was within a few centimeters to several meters, as per the sensor's specifications. Consistently, the system provided clear and immediate audible and visual alerts when an obstacle was detected.

**A cardboard box with a red button

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1. **Conclusions**

In conclusion, implementing obstacle detection using an infrared (IR) proximity sensor involves setting up the components, calibrating the sensor, programming the microcontroller, defining detection logic, establishing a response mechanism, testing the system, fine-tuning for optimal performance, and documenting the setup. Following these steps formally ensures an effective obstacle detection system that can accurately sense obstacles and respond accordingly. Ensuring proper placement of the sensor to cover the desired detection area is crucial. Additionally, incorporating error handling in the code to account for any anomalies in sensor readings can enhance the system's reliability. Regular maintenance and periodic recalibration of the sensor are also essential to maintain accurate obstacle detection performance over time. Incorporating these considerations can further improve the effectiveness and longevity of the obstacle detection system using an IR proximity sensor

# Applications and Future Scope

Obstacle detection using IR proximity sensors has diverse applications across multiple fields including robotics, automotive, consumer electronics, healthcare, industrial automation, and aerospace. The future of IR sensor technology holds potential for enhanced sensitivity, miniaturization, advanced algorithms, IoT integration, energy efficiency, and improved safety features, driving innovation and expanding their usability in various new and existing applications.

1. **Robotics**:

**Autonomous Navigation**: Robots use IR proximity sensors to detect and avoid obstacles, enabling smooth and safe navigation in various environments.

* + **Robotic Arms:** In industrial settings, robotic arms equipped with IR sensors can precisely detect objects for tasks like assembly, packaging, and sorting.

1. **Automotive**:
   * **Parking Assistance Systems:** IR proximity sensors help in detecting obstacles while parking, reducing the risk of collisions.
   * **Collision Avoidance Systems**: They are used in advanced driver-assistance systems (ADAS) to detect potential obstacles and prevent accidents.
2. **Consumer Electronics**:
   * **Smartphones:** IR sensors are used in proximity sensing to turn off the screen during calls when the phone is near the user's ear.
   * **Home Automation**: IR sensors are integrated into smart home devices for tasks such as automatic lighting control and security systems.
3. **Healthcare**:
   * **Patient Monitoring Systems:** IR sensors can be used to monitor patient movement and ensure safety in medical facilities.
   * **Touchless Interfaces**: In hospitals, IR sensors help in creating touchless interfaces to maintain hygiene.
4. **Industrial Automation**:
   * **Material Handling**: IR sensors are used in conveyor systems to detect the presence of items and control the flow of materials.
   * **Safety Systems**: They are implemented in machines to detect human presence and prevent accidents.
5. **Aerospace**:
   * **Drone Navigation**: IR sensors enable drones to detect obstacles and navigate safely, especially in indoor or cluttered environments.
6. **Agriculture**:
   * Automated Farming Equipment: IR sensors can be used in tractors and other farming equipment to detect obstacles, ensuring smooth operation and preventing damage to crops and machinery.
   * Greenhouse Management: IR sensors help in monitoring the movement of equipment and workers within greenhouses, enhancing safety and efficiency.
7. **Retail and Inventory Management**:
   * Automated Checkout Systems: IR sensors can detect items placed in automated checkout systems, streamlining the purchasing process.
   * Stock Monitoring: IR sensors can be used to monitor stock levels and the presence of products on shelves, improving inventory management.
8. **Entertainment and Gaming**:
   * Interactive Displays: IR sensors are used in interactive displays and gaming consoles to detect user movements and gestures, providing a more immersive experience.
   * Virtual Reality (VR) and Augmented Reality (AR**)**: In VR and AR systems, IR sensors track user movements and interactions with the environment.
9. **Education and Research**:
   * Interactive Learning Tools: IR sensors are used in interactive whiteboards and learning tools, allowing teachers and students to interact with digital content through gestures.
   * Research Laboratories: IR sensors assist in various experimental setups to detect object presence and movement, facilitating precise measurements and observations.

**Future Scopes of Obstacle Detection Using IR Proximity Sensors**

1. **Enhanced Sensitivity and Accuracy**:
   * **Improved Sensor Technology**: Advancements in IR sensor technology can lead to higher sensitivity and accuracy in detecting smaller or more distant obstacles.
   * **Multi-Sensor Integration:** Combining IR sensors with other types of sensors (e.g., ultrasonic, LIDAR) can enhance obstacle detection capabilities and provide more comprehensive environmental mapping.
2. **Miniaturization**:
   * **Smaller Form Factors:** As technology advances, IR sensors can be made smaller, allowing integration into more compact and portable devices.
   * **Wearable Technology**: Miniaturized IR sensors can be used in wearable devices for applications like fitness tracking, gesture recognition, and health monitoring.
3. **Advanced Algorithms**:
   * **Machine Learning**: Incorporating machine learning algorithms can improve the ability of IR sensor systems to recognize and differentiate between various types of obstacles.
   * **Predictive Analytics**: Using advanced data analytics, IR sensor systems can predict potential obstacles and provide proactive alerts or actions.
4. **IoT Integration**:
   * **Smart Infrastructure**: IR sensors integrated with IoT can contribute to smart cities, providing real-time data for traffic management, pedestrian safety, and environmental monitoring.
   * **Connected Vehicles**: In automotive applications, IR sensors connected to a network can share data with other vehicles and infrastructure to enhance overall safety and traffic flow.
5. **Energy Efficiency**:
   * **Low-Power Sensors**: Development of low-power IR sensors can extend the battery life of portable and remote devices.
   * **Sustainable Technologies**: Energy-efficient IR sensors can be integrated into sustainable technologies, such as solar-powered systems and green buildings.
6. **Enhanced Safety Features**:
   * **Automated Safety Systems**: IR sensors can be part of more sophisticated safety systems in various industries, providing real-time obstacle detection and response mechanisms.
   * **Public Safety**: Implementation in public transportation systems to ensure safety by detecting obstacles on tracks or pathways.

7. **Autonomous Systems**:

* Self-Driving Vehicles: Enhanced IR sensors can play a critical role in the development of self-driving cars by providing reliable obstacle detection in various environmental conditions.
* Autonomous Delivery Drones: Improved IR sensors can enable delivery drones to navigate complex urban environments safely.

8. **Smart Homes and Buildings**:

* Advanced Security Systems: Future IR sensors can offer more sophisticated intrusion detection, identifying the presence and movement of people with high accuracy.
* Home Automation Enhancements: Integration with smart home systems can lead to advanced automation scenarios, such as precise lighting control based on occupancy and movement.

9. **Medical Devices**:

* Non-Invasive Monitoring: Advanced IR sensors can be used for non-invasive health monitoring, such as detecting respiration and heart rates.
* Surgical Assistance: IR sensors can assist in surgical procedures by providing real-time obstacle detection, ensuring precision and safety.

10. **Environmental Monitoring**:

* Wildlife Conservation: IR sensors can be used to monitor wildlife movement and behavior without disturbing the natural habitat.
* Pollution Detection: IR sensors can help in detecting and monitoring pollution levels by identifying changes in the environment.

11. **Public Infrastructure**:

* Smart Street Lighting: IR sensors can be part of smart street lighting systems that adjust brightness based on pedestrian and vehicle presence, conserving energy and enhancing safety.
* Public Transportation: IR sensors can be integrated into public transportation systems to detect obstacles on tracks or pathways, improving safety and efficiency.

12. **Enhanced Communication Systems**:

* Gesture-Based Controls: Future IR sensors can enable more advanced gesture-based control systems for various applications, from consumer electronics to industrial machinery.
* Human-Machine Interaction: IR sensors can improve the interaction between humans and machines, making interfaces more intuitive and responsive.

The applications of obstacle detection using IR proximity sensors extend across various domains, including agriculture, retail, entertainment, education, autonomous systems, smart homes, medical devices, environmental monitoring, public infrastructure, and communication systems. The future of IR sensor technology holds significant potential for advancements in accuracy, miniaturization, integration with IoT, energy efficiency, and enhanced safety features. These developments will drive innovation and expand the usability of IR proximity sensors in numerous new and existing applications, contributing to smarter, safer, and more efficient systems.

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