**PROFESSIONAL HIGH TECHNOLOGY HIGH SCHOOL**

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**GRADUATE PROJECT**

**Subject: JEWELRY BOX DESIGN, SOFTWARE**

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**Introduction**

In the modern world, where valuable objects are exposed to various dangers and the need for an effective system for their protection is of utmost importance. In this context, my thesis project aims to develop and implement an innovative security system specialized for keeping valuable objects.

1. **The purpose of the project**
   1. **Description:**

The goal of the project is to create an integrated security system that provides reliable protection for valuable items, such as jewelry, money, important documents, gold and other valuables for the user, through the use of laser and ultrasound technologies. The system must be efficient, easy to use and offer a high level of protection against various types of threats, such as intrusion attempts or theft.

1. **Expected results**
   1. **Development of a system with lasers:**

The project will involve the research, design and construction of a system of lasers that will be placed around the valuables. In the event of the lasers being crossed, a beeping signal will be generated until the laser stops being interrupted, which will alert the potential trespasser.

* 1. **Implementation of ultrasonic sensors:**

In addition to the lasers, the system will include ultrasonic sensors that will be located behind the lasers. In case of crossing the ultrasonic sensors, which can be interpreted as evil intentions, an alarm will be triggered with a light signal to attract the attention of those around.

By fulfilling these goals and objectives, the diploma project aims to contribute to the creation of a more secure environment for keeping valuable objects and to respond to the growing need for innovative solutions in the field of security.

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**Main part**

**What is the project?** - The project I am developing, 'Jewelry Storage Box', is an innovative security system that is fully integrated into an impressively crafted wooden box. To create the box, I used hand-cut wooden boards that provide strength and stability to the structure.

The ultrasonic sensors are located at the base of the box, which are used to detect movement in the environment. They are strategically positioned to provide comprehensive coverage of the entire area around the valuable. Thus, in case of illegal movement, the system quickly reacts and triggers the alarm.

Lasers and light sensors are integrated into the four columns of the box, with all cables hidden and carefully organized. This approach not only ensures the aesthetics and discretion of the device, but also facilitates its maintenance and management.

On the "ceiling" of the box are placed the Arduino and Breadboard, which control the entire system. They are discreetly integrated into the interior of the box, so as not to disturb its vision. In the lower part of the "ceiling", LED matrices are mounted, which provide a visual indicator of an activated alarm.

**How does the system work?**  - When the beam of light from one of the lasers to the receiver is interrupted, the buzzer signals a warning to the would-be thief. However, if he decides to run his hand over one of the many ultrasonic sensors in the middle of the box, it immediately activates the alarm. The alarm consists of an audible and visual signal, providing immediate warning of unauthorized access or danger. Thus, with its reliable functionality and intelligent functions, the project represents not only an effective security system, but also an elegant solution for protecting valuable objects.

**What parts have I used?** -In my project I have used laser modules, light sensor modules (light receivers), ultrasonic distance sensors, buzzer and 8x8 ice matrix.

I decided to choose the OKY3301 laser modules for my project because of a number of advantages they offer. First, their extremely high accuracy and precision make them ideal for applications requiring precise measurement or positioning, which is my case. In addition, they have compact dimensions, which makes them easy to embed in project columns.

Additionally, I included a light sensor module known as the TEMT6000 Ambient Light Sensor Module. The choice of these sensors was thought out, as they feature minimalistic dimensions and exceptional robustness. Their advantages also include accuracy and fast response time, which makes them suitable for my project.

To complement the functionality, I decided to also include ultrasonic sensors HS-RS04, which are distinguished by their exceptional ease of use and high accuracy. Their response time and sturdiness were also factors that swayed me towards them.

To provide audio and visual alerts in my project, I used a buzzer for an audio signal and an LED matrix for a light signal. These components complement the functionality of the project and give it greater versatility.

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All these components were integrated and connected to the Arduino Mega 2560, which gave me the ability to manage and control them through the microcontroller. Thus, I have successfully created a complex system that meets the requirements and goals of my project. Here is more information about all the parts used in the project:

1. **For laser modules I use: OKY3301**

(Image 1) (Image 2)

The OKY3301 laser module is a compact and multi-functional laser module that typically has a variety of applications including laser pointers, laser levels, barcode scanners, and distance measuring devices. Here is some more information about the OKY3301 laser module:

* 1. **Light source:**

The OKY3301 laser module is powered by a semiconductor laser diode that serves as the main light source. Semiconductor laser diodes are commonly used in laser modules due to their efficiency, compact size and reliability. Here is some additional information about semiconductor laser diodes and their role in the OKY3301 module:

* + 1. **Semiconductor laser diodes:**

These diodes are composed of semiconductor materials such as gallium arsenide (GaAs) or gallium nitride (GaN). When an electric current is applied to the diode, it stimulates the emission of photons, resulting in laser light. This process is known as stimulated emission.

* + 1. **Narrow beam emission:**

Semiconductor laser diodes emit a narrow and concentrated beam of light, thanks to the design of the diode and the properties of the semiconductor material. This focused beam is ideal for applications that require precision and accuracy, such as laser alignment, distance measurement and barcode scanning.

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* + 1. **Wavelength selection:**

Semiconductor laser diodes can emit light at different wavelengths depending on the particular semiconductor material used and the design of the diode. The OKY3301 laser module can offer different wavelength options to meet different application requirements, such as red, green or blue laser beams.

* + 1. **Effectiveness and Durability:**

Semiconductor laser diodes are known for their high efficiency and long service life. They require relatively low power to produce a bright laser beam, making them energy efficient. In addition, the semiconductor materials are strong and can withstand long-term use, ensuring the longevity of the laser module.

* + 1. **Universality:**

Due to their compact size and flexibility, semiconductor laser diodes are widely used in various devices and applications outside of laser modules. They can be found in laser printers, optical communication systems, medical devices and consumer electronics.

* + 1. **Summary:**

The semiconductor laser diode used in the OKY3301 laser module serves as an efficient and reliable light source, emitting a narrow and concentrated beam of light suitable for precision applications. Its compact size, energy efficiency and flexibility make it well suited for integration into various laser systems and devices.

* 1. **The wavelength:**

The laser wavelength of the OKY3301 module may vary depending on the specific model and application requirements. Common wavelengths for laser modules like the OKY3301 include red (about 650 nm), green (about 532 nm), and blue (about 450 nm).

The wavelength of the laser emitted by the OKY3301 module plays a crucial role in determining its characteristics and applications. Here is some additional information:

* + 1. **Red laser:**

Red lasers are among the most common types used in laser modules such as the OKY3301. They emit light with a wavelength of about 650 nanometers (nm), which corresponds to the red region of the visible spectrum. Red lasers are widely used in laser pointers, barcode scanners, and laser levels because of their visibility in a variety of lighting conditions.

* + 1. **Green laser:**

Green lasers emit light with a wavelength of about 532 nm, which falls in the green region of the visible spectrum. Green lasers are known for their higher visibility compared to red lasers, especially in bright environments. They are typically used in applications where increased visibility and precision are required, such as astronomy, alignment and some industrial applications.

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* + 1. **Blue laser:**

Blue lasers emit light with a wavelength of about 450 nm, which falls in the blue region of the visible spectrum. Blue lasers offer advantages such as higher energy density and finer focus compared to red and green lasers. They find applications in areas such as optical data storage, biomedical imaging, and high-resolution laser projection systems.

**1.2.4 Summary:**

The flexibility of the OKY3301 module in offering laser output at different wavelengths allows it to serve a wide range of applications in different industries, from basic pointing devices to advanced industrial and scientific instruments.

The choice of laser wavelength depends on the specific requirements of the application. For example, red lasers may be preferred for general purpose applications where visibility and cost effectiveness are key factors. Green lasers are often chosen for applications requiring improved visibility and precision. Blue lasers are used in applications where high energy density and fine focus are critical, albeit at a potentially higher cost.

* 1. **Power output:**

The output power of the OKY3301 laser module can also vary, with typical power levels ranging from a few milliwatts to several tens of milliwatts.

The output power of the OKY3301 laser module plays a crucial role in determining the brightness and visibility of the laser beam it emits. Here is some additional information:

* + 1. **Brightness:**

The output power directly affects the brightness of the laser beam. The higher output power results in a brighter beam, which can be an advantage in applications where visibility over long distances or in well-lit environments is essential. For example, in outdoor settings or brightly lit indoor environments, a higher power laser module such as the OKY3301 can provide better visibility of the laser beam.

* + 1. **Visibility:**

The visibility of the laser beam is also affected by its output power. A laser module with a higher output power will produce a beam that is more visible to the human eye, even in ambient light conditions. This is especially important in applications such as laser pointers or alignment tools, where visibility of the laser beam is critical for accurate work.

* + 1. **Range:**

The output power of the laser module also affects its effective range. A higher powered laser module can generally project a beam over greater distances than a lower powered module. This is important in applications such as laser rangefinders or distance measuring devices where the ability to accurately measure distances over extended ranges is required.

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**1.3.4 Summery:**

The output power of the OKY3301 laser module determines the brightness, visibility, range and potential safety hazards associated with the laser beam it emits. Understanding these factors is critical to selecting the appropriate laser module for a given application and ensuring safe and efficient operation.

* 1. **Operating voltage:**

The operating voltage of the OKY3301 module is typically in the range of 3V to 5V DC. This makes it compatible with a wide range of power sources, including batteries and DC supplies. Here's why:

* + 1. **Broad compatibility:**

With an operating voltage range spanning from 3V to 5V DC, the OKY3301 module can be powered by a wide range of power sources. This includes common options such as alkaline or rechargeable batteries, as well as DC power supplies commonly found in electronic devices and equipment.

* + 1. **Battery Powered Applications:**

The ability to operate in the 3V to 5V DC range makes the OKY3301 laser module suitable for battery-powered applications. For example, laser pointers and handheld devices often rely on batteries for portability and convenience. The module's compatibility with standard battery voltages ensures seamless integration into such devices without the need for additional voltage regulation.

* + 1. **DC Power Supplies:**

In addition to battery-powered applications, the OKY3301 module can also be powered by DC supplies. These power sources are generally used in stationary or fixed installations where a continuous and stable power source is required. The module's voltage range aligns well with the output of many DC power supplies, simplifying integration into various systems and equipment.

* + 1. **Flexibility in Design:**

The wide operating voltage range of the OKY3301 module provides designers and engineers with flexibility during the product design phase. They can choose power sources based on factors such as application requirements, cost considerations, and available infrastructure. This flexibility allows the module to be seamlessly integrated into a diverse range of devices and systems in various industries.

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**1.4.5 Summary:**

The operating voltage range of 3V to 5V DC makes the OKY3301 laser module very flexible and compatible with a variety of power sources, including batteries and DC supplies. This flexibility in power options enhances its suitability for a wide range of applications, from portable hand-held devices to stationary installations requiring continuous power.

* 1. **Beam characteristics:**

The OKY3301 laser module typically produces a collimated beam of light with a narrow deflection angle. This allows the laser beam to maintain its intensity over long distances, making it suitable for applications such as alignment and guidance.

Here is some additional information on the beam characteristics of the OKY3301 laser module:

The OKY3301 laser module is known for producing a highly collimated beam of light with a narrow deflection angle. "Collimated" refers to the fact that the light beams emitted by the laser module are parallel and do not diverge significantly as they move away from the source. This results in a laser beam that maintains its intensity over long distances, making it ideal for applications that require precise alignment and targeting.

The narrow deflection angle of the laser beam means that it spreads very little as it travels, which is crucial for applications where maintaining a concentrated beam of light is important. For example, in laser alignment applications such as in construction or manufacturing, a narrow beam provides precise alignment of components or structures over long distances.

Likewise, in targeting applications such as laser pointers or laser sights, the narrow beam deflection angle allows for precise targeting of objects or specific points of interest. This is especially useful in scenarios where accuracy is paramount, such as astronomy, surveying, or outdoor activities such as hiking or hunting.

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**1.5.4 Summary:**

The collimated beam and narrow deflection angle of the OKY3301 laser module make it well suited for a wide range of applications that require long-range visibility, precise alignment, and precise targeting capabilities. Its reliable performance and consistent beam quality make it a popular choice among professionals and hobbyists.

* 1. **Compact design:**

The design of the OKY3301 laser module is one of its notable features (15x24mm; 2.2g), which makes it very flexible and adaptable for integration into a wide range of devices and systems. Here is some additional information:

* + 1. **Portability:**

Thanks to its compact and lightweight design, the OKY3301 laser module is very portable, allowing it to be easily transported and installed in different locations as needed. This portability makes it an ideal choice for applications where mobility is essential, such as handheld laser devices or portable measuring instruments.

* + 1. **Flexibility of integration:**

The small size of the OKY3301 module allows seamless integration into various devices and systems, offering flexibility in design and layout. Its compact form factor allows for efficient use of space, making it suitable for applications where size constraints are a consideration.

* + 1. **Cylindrical body:**

The OKY3301 laser module usually comes in a cylindrical housing, which not only contributes to its compactness, but also provides durability and protection to the internal components. The cylindrical shape allows for easy operation and installation, while the robust construction ensures reliable operation even in demanding environments.

* + 1. **Threaded mounting holes:**

To further facilitate installation, the OKY3301 laser module is often equipped with threaded mounting holes on its housing. These holes facilitate secure attachment to mounting brackets, fixtures, or other mounting surfaces without the need for additional hardware. This feature simplifies the installation process and saves time during setup.

* + 1. **Many applications:**

The compact design of the OKY3301 laser module makes it suitable for a wide range of applications in various industries. Whether used in industrial alignment and positioning machines, in consumer electronics for laser pointers, or in scientific instruments for precision measurements, its compact form factor ensures compatibility with a variety of use cases.

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**1.6.6 Summary:**

The compact design of the OKY3301 laser module not only enhances its portability and integration capabilities, but also contributes to its flexibility and suitability for multiple applications. Whether incorporated into hand-held devices or integrated into larger systems, its compactness ensures seamless integration and reliable operation in any environment.

* 1. **Applications:**

The OKY3301 laser module finds use in a wide range of applications, including laser pointers for presentations and demonstrations, laser levels for construction and engineering, barcode scanners for retail and logistics, and distance measuring devices for surveying and mapping.

Here is additional information about the applications of the OKY3301 laser module:

* + 1. **Laser pointers:**

The OKY3301 laser module is commonly used in laser pointers for presentations, lectures and demonstrations. Its bright and focused laser beam makes it ideal for highlighting key points on screens or surfaces, allowing presenters to communicate effectively with their audience.

* + 1. **Laser levels:**

In construction and engineering, laser levels are essential tools for ensuring accurate alignment and leveling of surfaces. The OKY3301 laser module is often integrated into laser level devices to project highly visible laser lines or dots onto walls, floors or other surfaces, assisting with tasks such as framing, cladding and fixture installation.

* + 1. **Barcode Scanners:**

Barcode scanners are widely used in retail stores, warehouses and logistics facilities to quickly and accurately capture barcode information. The OKY3301 laser module is used in barcode scanners to emit a laser beam that scans through the barcodes, decodes the information and transmits it to a computer or database for inventory management, sales tracking and other purposes.

* + 1. **Distance measuring devices:**

The OKY3301 laser module is also used in distance measuring devices such as laser rangefinders and surveying instruments. These devices use the laser beam emitted by the module to accurately measure distances to objects or points of interest, making them valuable tools for surveying, mapping, building layout, and outdoor recreational activities such as golf and hunting.

* + 1. **Industrial Applications:**

In addition to the mentioned applications, the OKY3301 laser module finds application in a variety of industrial applications, including machine vision systems, alignment and positioning systems, and quality control processes. Its precise and reliable laser output makes it suitable for tasks that require accurate measurement, alignment and detection in industrial environments.

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* + 1. **Security Systems:**

Lasers can also be used in security systems, as I am doing in this project. Lasers would be very useful for detecting bad guys in someone's backyard, vault, or whatever.

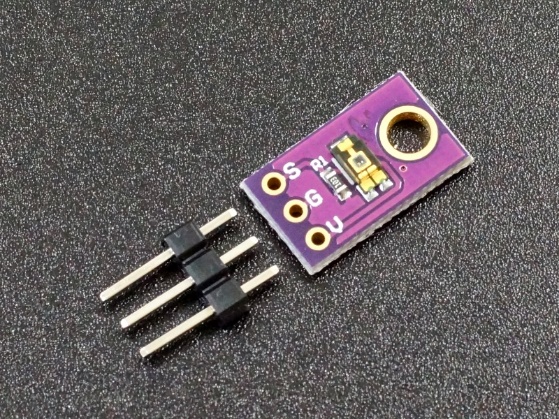
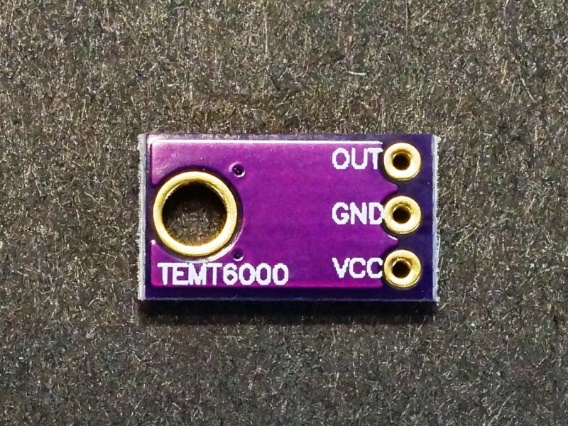
**1.7.7 Summary:**

The OKY3301 laser module plays a critical role in a variety of applications, providing reliable laser performance for tasks that require precision, visibility and efficiency across industries and sectors, as well as security.

**Conclusion:**

The OKY3301 laser module is a versatile and reliable component that offers precise laser performance for a variety of applications. Its compact design, adjustable output power and multi-wavelength compatibility make it suitable for integration into a wide range of devices and systems.

1. **For light sensor modules I use: TEMT6000 Ambient Light Sensor Module**

(Image 3) (Image. 4)

The TEMT6000 ambient light sensor module is a light sensor module based on the TEMT6000 ambient light sensor. This sensor is designed to measure the level of ambient light in its surroundings. Here is some information about the TEMT6000 ambient light sensor module:

* 1. **Use of phototransistor:**

The sensor works on the basic principle of converting light energy into electrical signals. At its core, the sensor uses a phototransistor to accomplish this conversion process. Here's a more detailed explanation of how it works:

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* + 1. **Operation of a phototransistor:**

A phototransistor is a semiconductor device that is sensitive to light. It consists of a semiconductor material, usually silicon, with base, emitter and collector regions. When photons of light strike the surface of a semiconductor material, they transfer energy to the electrons in the material.

* + 1. **Generation of electron-hole pairs:**

When light energy is absorbed by the semiconductor material of the phototransistor, it can create electron-hole pairs. These pairs consist of an electron, which is negatively charged, and a hole, which is a positively charged vacancy in the crystal lattice.

* + 1. **Induction of current flow:**

The presence of electron-hole pairs in a semiconductor material changes its conductivity. In the case of the phototransistor, light-induced electron-hole pairs can affect the flow of current between the emitter and collector regions. This change in conductivity effectively modulates the current flowing through the device.

* + 1. **Light intensity proportional response:**

The intensity of light falling on the surface of the phototransistor directly affects the number of electron-hole pairs generated in the semiconductor material. Therefore, the magnitude of the current flowing through the device is directly proportional to the intensity of the incident light. Higher light intensity results in larger currents, while lower light intensity results in smaller currents.

* + 1. **Output signal:**

The output signal of the TEMT6000 sensor is usually in the form of an analog voltage or current that reflects the light intensity detected by the phototransistor. This signal can be further processed by external circuits, such as analog-to-digital converters (ADCs) or microcontrollers, for interpretation and use in various applications.

* + 1. **Summary:**

By utilizing the phototransistor's ability to convert light energy into electrical signals, the TEMT6000 ambient light sensor provides a reliable and accurate means of measuring ambient light levels in a wide range of applications. Its simple yet effective design makes it a popular choice for automatic brightness control, environmental monitoring and other light-sensitive tasks.

* 1. **High sensitivity**:

The sensor's high sensitivity to light is one of its key features, making it particularly suitable for applications where precise measurement of ambient light levels is essential. Here are more details on its sensitivity:

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* + 1. **Wide dynamic range:**

The TEMT6000 sensor is capable of detecting a wide range of light levels, ranging from low light conditions such as indoor environments or twilight to intense brightness such as direct sunlight. This wide dynamic range allows the sensor to adapt to different lighting conditions without losing accuracy or responsiveness.

* + 1. **Flexibility:**

The sensor's ability to detect both low and high light levels makes it versatile for a range of applications. For example, in indoor lighting systems, the sensor can adjust the brightness of LED lights or displays according to ambient light levels, ensuring optimal visibility while saving energy. Likewise, in outdoor applications such as solar-powered devices, the sensor can accurately measure sunlight intensity to optimize energy harvesting or adjust device performance.

* + 1. **Accuracy:**

The high sensitivity of the TEMT6000 sensor enables precise measurement of ambient light levels, providing reliable data for decision making in automated systems. Whether it's controlling camera exposure settings in photography applications or adjusting the brightness of street lights based on ambient conditions, the sensor's sensitivity ensures accurate and consistent performance.

* + 1. **Response time:**

Despite its high sensitivity, the TEMT6000 sensor typically exhibits a fast response time, allowing it to quickly detect changes in ambient light levels and react accordingly. This fast response is crucial in applications where real-time corrections are required, such as in adaptive lighting systems or smart home automation.

* + 1. **Strength:**

Despite its sensitivity to light, the TEMT6000 sensor is designed to be robust and reliable, with good resistance to external factors such as temperature changes, humidity and electromagnetic interference. This ensures consistent performance and accuracy across a wide range of operating conditions, enhancing its suitability for a variety of applications in a variety of environments.

**2.2.6 Summary:**

The TEMT6000 sensor's high sensitivity to light, combined with its wide dynamic range and versatility, make it a valuable component in a variety of applications requiring precise measurement and control of ambient light levels. Whether used indoors or outdoors, in low-light conditions or bright sunlight, the sensor provides accurate data and enables effective automation and optimization of systems for improved performance and energy efficiency

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* 1. **Compact size:**

The size of the TEMT6000 ambient light sensor module is one of its main features, offering flexibility and ease of integration into electronic designs and devices. Here are more details on its compact design:

* + 1. **Space efficiency:**

The sensor module is designed to be small and light, occupying minimal space on a printed circuit board or in an electronic device. This compact size makes it suitable for applications where space is limited or where an elegant and unobtrusive design is desired.

* + 1. **Flexibility in Integration:**

Due to its small form factor, the TEMT6000 sensor module can be easily integrated into various electronic projects and devices. It can be mounted directly on a printed circuit board or connected to it by connectors or soldering, depending on the specific requirements of the application.

* + 1. **Distribution board design:**

In many cases, the TEMT6000 sensor is mounted on a breakout board, which is a small printed circuit board that provides additional components and functions to facilitate its use. A distribution board usually includes voltage regulators, pull-up resistors, filter capacitors, and other components necessary for proper operation and interaction with microcontrollers and other electronic circuits.

* + 1. **Ease of Interaction:**

The breakout board design simplifies the process of connecting the sensor module to external devices such as microcontrollers, Arduino boards, Raspberry Pi and other electronic circuits. It often includes standard connectors or connectors that allow easy connection using jumper wires or cables.

* + 1. **Modularity:**

The small size and breakout board design of the TEMT6000 sensor module contribute to its modularity, allowing it to be easily swapped out or replaced without requiring significant changes to the overall design or layout of the electronic system. This modularity improves flexibility and eases maintenance and upgradeability.

* + 1. **Flexibility of applications:**

The compact size and easy integration make the TEMT6000 ambient light sensor module suitable for a wide range of applications in various industries. From consumer electronics to industrial automation and environmental monitoring, the sensor module can be used wherever accurate measurement of ambient light levels is required.

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**2.3.7 Summary:**

The compact size of the TEMT6000 ambient light sensor module, combined with its breakout board design, offers flexibility, ease of integration and modularity, making it a valuable component for a diverse range of electronic projects and devices.

* 1. **Analog output:**

The TEMT6000 ambient light sensor module typically provides an analog output voltage proportional to the light intensity detected by the sensor. This analog output can be directly connected to analog-to-digital converters (ADCs) on microcontrollers for processing and further analysis.

The TEMT6000 ambient light sensor module's analog output function is one of its key features, making it versatile and easy to integrate into electronic projects. Here is a more detailed explanation of this feature:

* + 1. **Analog output voltage:**

The TEMT6000 sensor typically generates an analog output voltage that is directly proportional to the intensity of light falling on its surface. As the ambient light level changes, the output voltage of the sensor varies accordingly. Higher light intensity results in higher output voltage, while lower light intensity corresponds to lower output voltage.

* + 1. **Linear response:**

The analog output of the sensor demonstrates a linear response to changes in light intensity over the specified range. This means that the relationship between the input (light intensity) and the output (voltage) is linear, making interpretation of the sensor readings easy.

* + 1. **Interaction with microcontrollers:**

The analog output voltage from the TEMT6000 sensor can be easily connected to the analog-to-digital converter (ADC) inputs available on most microcontrollers. ADCs convert analog signals, such as voltage levels, into digital values ​​that can be processed by the microcontroller. By connecting the output of the TEMT6000 sensor to the ADC input pin of a microcontroller, light intensity readings can be precisely taken and processed digitally.

* + 1. **Calibration and Scaling:**

Depending on the specific application requirements, it may be necessary to calibrate and scale the analog output voltage to obtain meaningful light intensity measurements.

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Calibration involves establishing a relationship between the output voltage of the sensor and the actual light intensity in the environment. Scaling may involve applying mathematical transformations to the raw sensor readings to obtain values ​​in desired units or ranges.

* + 1. **Data Processing and Analysis:**

After the analog output voltage is digitized by the ADC, the microcontroller can perform further processing and analysis of the light intensity data. This may include averaging multiple readings to reduce noise, applying smoothing filtering techniques, or applying algorithms for adaptive brightness control or illuminance level monitoring.

* + 1. **Real-Time Feedback and Control:**

By continuously monitoring the analog output of the TEMT6000 sensor, the microcontroller can provide real-time feedback and control in response to changes in ambient light conditions. For example, in automatic brightness control applications, the microcontroller can dynamically adjust the brightness of the display or backlight based on the detected light intensity.

**2.4.7 Summary:**

The analog output function of the TEMT6000 ambient light sensor module enables seamless integration with microcontroller-based systems, enabling precise measurement, processing and control of ambient light levels in a variety of electronic applications.

* 1. **Wide range of applications:**

Thanks to its high sensitivity and compact size, the TEMT6000 ambient light sensor module finds applications in various fields such as:

* + 1. **Automatic brightness adjustment in displays and backlight systems:**

In display devices such as LCD monitors, televisions, and digital signage, the TEMT6000 sensor can be used to automatically adjust screen brightness based on ambient light conditions. This ensures an optimal viewing experience for users in various lighting environments, while saving energy by reducing the intensity of the backlight when not needed.

* + 1. **Environmental monitoring systems for plant growth and animal behavior:**

In agriculture and horticulture, the TEMT6000 sensor can be integrated into environmental monitoring systems to measure ambient light levels that are critical to plant growth and development. By monitoring light intensity, growers can optimize lighting conditions in greenhouses or indoor farming facilities to improve crop yield and quality. Similarly, in zoology and animal behavior research, the sensor can be used to monitor light levels in animal habitats or research enclosures. It helps researchers understand how light affects animal behavior and physiological responses, aiding in the design of optimal lighting environments for captive species.

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* + 1. **Various security systems, such as a system to detect changes in ambient light conditions:**

The TEMT6000 sensor can be used in security systems to detect changes in ambient light conditions, such as sudden drops or increases in light levels, which may indicate intrusion or tampering. By integrating the sensor into alarm systems or surveillance cameras, security personnel can be alerted to potential threats or unauthorized access attempts.

* + 1. **Consumer electronics devices for automatic regulation:**

In consumer electronics, the TEMT6000 sensor plays a crucial role in devices such as smartphones, tablets and digital cameras. These devices use the sensor to automatically adjust screen brightness and camera settings based on ambient light conditions. For example, smartphones and tablets use the sensor to adjust the brightness of the display screen to ensure optimal visibility in different lighting environments, thereby increasing user comfort and extending battery life. Likewise, digital cameras use the sensor to adjust exposure, white balance, and focus settings in different lighting conditions, allowing users to capture high-quality photos and videos without manual intervention.

**2.5.5 Summary:**

The TEMT6000 ambient light sensor module offers flexible functionality and can be integrated into a wide range of applications in various industries, providing precise measurements of ambient light levels and enabling automatic adjustments to improve productivity, efficiency and user experience.

* 1. **Ease of Use:**

The ease of use of the TEMT6000 ambient light sensor module is one of its main advantages, especially for hobbyists, students and professionals working on electronics projects. Here's more about its ease of use:

* + 1. **Compatibility with popular microcontrollers:**

The TEMT6000 sensor module can easily interface with popular microcontrollers such as Arduino and Raspberry Pi, which are widely used in the maker community and in educational environments. These microcontrollers offer a user-friendly development environment and extensive community support, making them ideal platforms for sensor integration into projects.

* + 1. **Simplified interface:**

The sensor module usually has a simple interface requiring only a few connections to the microcontroller, such as power, ground, and an analog output pin. This simplicity simplifies the wiring and setup process even for beginners with limited electronics experience.

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* + 1. **Abundance of Online Resources:**

Numerous online resources are available for integrating the TEMT6000 sensor module into projects. This includes tutorials, documentation, forums, and sample code shared by the community. These resources provide step-by-step guidance on connecting the sensor to microcontrollers, reading data from the sensor, and implementing various applications such as automatic brightness adjustment and light level monitoring.

* + 1. **Libraries and Sample Codes:**

Many libraries and sample codes specifically designed for the TEMT6000 sensor are freely available online. These libraries abstract away the low-level details of sensor interaction, allowing users to focus on their application logic rather than dealing with the intricacies of sensor communication. Using these libraries, developers can quickly and easily incorporate touch functionality into their projects with minimal effort.

* + 1. **Community Support:**

The community of electronics makers and enthusiasts is known for its cooperative nature and willingness to help others. If users encounter problems or have questions about using the TEMT6000 sensor module, they can often find help through online forums, social media groups, and dedicated platforms such as GitHub. This community support network ensures that users can overcome challenges and get the most out of the sensor's capabilities.

**2.6.6 Summary:**

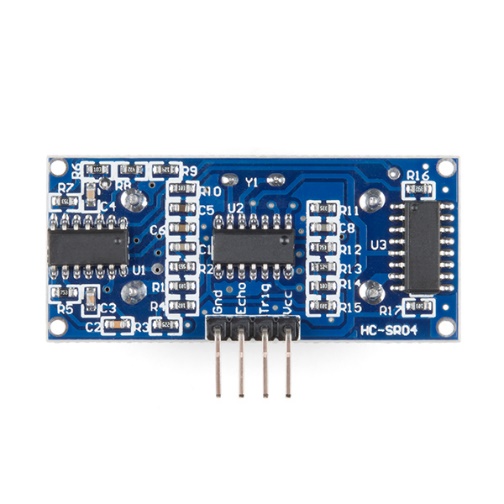
The combination of compatibility with popular microcontrollers, a simple interface, an abundance of online resources, the availability of libraries and sample codes, and strong community support makes the TEMT6000 ambient light sensor module extremely easy to use for a wide range of applications, from simple light sensing projects to more -complex automation and monitoring systems.

**Conclusion:**

Overall, the TEMT6000 ambient light sensor module is a versatile and reliable sensor solution for measuring ambient light levels in various applications, offering high sensitivity, compact size and easy integration.

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1. **For ultrasonic sensors I use: HC-RS04**

(Image 5) (Image 6)

The HC-SR04 ultrasonic sensor is a popular and widely used distance measurement sensor that works on the principle of ultrasonic waves. Here is some information about the HC-SR04 ultrasonic sensor:

* 1. **Principle of operation:**

The working principle of the HC-SR04 ultrasonic sensor revolves around the use of ultrasonic waves to measure distances. Here's a more detailed explanation:

* + 1. **Emission of ultrasonic waves:**

The HC-SR04 sensor contains an ultrasonic transmitter that emits short bursts of ultrasonic waves. These waves typically have a frequency of about 40 kHz, which is above the audible range for humans.

When triggered, the transmitter sends a series of ultrasonic pulses into the environment.

* + 1. **Wave reflection:**

When ultrasound waves encounter an object in their path, they are reflected back to the sensor.

The time it takes for the waves to travel from the sensor to the object and back is directly proportional to the distance between the sensor and the object.

* + 1. **Time calculation:**

The sensor contains an ultrasonic receiver that is sensitive to the echo of the emitted waves.

After transmitting the ultrasonic pulses, the sensor switches to receiving mode and waits for the echo to return.

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As soon as the receiver detects the returning ultrasound waves, it records the time at which the waves were received.

* + 1. **Distance calculation:**

Knowing the speed of sound in the medium (usually air) and the time it takes for the ultrasonic waves to return, the sensor can calculate the distance to the object.

The formula used to calculate the distance is:

**Distance = (Time Taken \* Speed ​​of Sound) / 2.**

Since ultrasonic waves travel at the speed of sound, the distance to the object is half the total distance traveled by the waves (to and from the object).

* + 1. **Result:**

The HC-SR04 sensor usually provides the calculated distance as an output signal that can be read by a microcontroller or other electronic device.

This distance information can then be used for various purposes, such as controlling the movement of a robot, triggering an alarm, or displaying distance measurements on a screen.

**3.1.6 Summary:**

The HC-SR04 ultrasonic sensor emits ultrasonic waves, listens for echoes bouncing off objects, measures the time it takes for the waves to return, and then calculates the distance to the object based on the time delay. This principle of operation makes it a versatile and widely used sensor in robotics, automation and distance measurement applications.

* 1. **Let's delve into the components of the HC-SR04 ultrasonic sensor:**
     1. **VCC (power supply):**

This pin is used to provide operating voltage to the sensor, typically 5V DC. It powers both the transmitter and receiver module of the sensor. It is important to connect this pin to the appropriate voltage source to ensure proper sensor operation.

* + 1. **Trig (Trigger):**

The Trig pin is used to trigger the sensor to start measuring distance. When a HIGH signal (typically a 10 microsecond pulse) is applied to this pin, the sensor emits a burst of ultrasonic waves from its transmitter module. This trigger signal initiates the measurement process.

* + 1. **Echo:**

The Echo pin is used to receive ultrasound waves that bounce off an object after being transmitted. When ultrasonic waves are received by the sensor's receiver module, this pin outputs a pulse whose duration is proportional to the time it takes for the ultrasonic waves to travel to the object and back. The duration of this pulse is directly related to the distance between the sensor and the object.

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* + 1. **GND (ground):**

The GND pin is connected to the reference ground of the circuit. It serves as a common ground for the sensor and other components in the circuit. Proper grounding is essential to the stability and reliability of sensor operation.

* + 1. **Ultrasonic transmitter and receiver module:**

The HC-SR04 sensor contains both an ultrasonic transmitter and receiver module housed in the same package. The transmitter module is responsible for generating ultrasonic waves, usually with a frequency of 40 kHz, and radiating them into the environment. The receiver module captures the ultrasonic waves that are reflected back from objects in the sensor's field of view. These modules work in tandem to facilitate distance measurement based on the time-of-flight principle.

**3.2.6 Summary:**

The integration of these components allows the HC-SR04 ultrasonic sensor to accurately measure distances by emitting ultrasonic waves and detecting their reflections. By using the Trigger and Echo pins along with appropriate timing calculations, users can interact with the sensor to obtain precise distance measurements for a variety of applications ranging from robotics and automation to object detection and proximity sensing.

* 1. **HC-SR04 Ultrasonic Sensor Specifications:**
     1. **Operating voltage:**

The HC-SR04 ultrasonic sensor operates with a supply voltage of 5 volts DC. This makes it compatible with most microcontrollers, such as Arduino boards, which typically run on 5V.

* + 1. **Operating current:**

The operating current of the HC-SR04 sensor is less than 15mA. This low power consumption makes it suitable for battery-powered applications and reduces the overall power requirements of the system in which it is used.

* + 1. **Measurement range:**

The HC-SR04 sensor has a wide measurement range spanning from 2 centimeters to 400 centimeters (or approximately 0.78 inches to 157.5 inches). This extensive range allows it to be used in a variety of applications, from proximity sensing to long distance distance measurement.

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* + 1. **Resolution:**

The resolution of the HC-SR04 sensor is 0.3 centimeters. This indicates the smallest change in distance that the sensor can detect and reliably measure. With a resolution of 0.3 cm, the sensor can provide precise distance measurements, making it suitable for applications where accuracy is critical.

* + 1. **Accuracy:**

The HC-SR04 sensor offers high accuracy, with a tolerance of ±3 millimeters. This means that the measured distance can deviate from the actual distance by up to 3 millimeters. Strict accuracy specifications ensure that the sensor provides reliable and consistent distance measurements in a variety of environmental conditions.

* + 1. **Operating frequency:**

The operating frequency of the HC-SR04 sensor is 40kHz. This frequency determines the rate at which the sensor emits ultrasonic pulses and monitors their reflections. A frequency of 40 kHz is commonly used in ultrasonic sensors due to the balance between range, resolution and power consumption.

**3.3.7 Summary:**

The HC-SR04 ultrasonic sensor offers a combination of wide operating range, high resolution and accuracy, making it suitable for a wide range of distance sensing and measurement applications. Its low power consumption and compatibility with common microcontrollers make it a popular choice among hobbyists, educators, and engineers alike.

* 1. **Let's look at the working principle of the HC-SR04 ultrasonic sensor:**
     1. **Operation of the ultrasonic transmitter:**

A short pulse is applied to the Trig pin of the HC-SR04 sensor to initiate distance measurement. This pulse usually lasts 10 microseconds.

When the Trig pin receives this pulse, it triggers the ultrasonic transmitter in the sensor to emit a series of ultrasonic pulses. These pulses travel through the air in a cone-like shape away from the sensor.

* + 1. **Waiting for echo signal:**

After triggering the transmitter, the sensor enters a standby state during which it listens for returning ultrasound pulses.

The sensor's echo pin initially remains low. However, once the ultrasound waves hit an object and bounce back to the sensor, the Echo pin goes high.

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* + 1. **Time Interval Measurement:**

When the Echo pin goes high, it indicates that the ultrasound waves have been transmitted and reflected back to the sensor.

The sensor measures the exact time interval between the transmission of the ultrasonic pulses (trigger) and the reception of the reflected pulses (detected by the Echo pin). This time interval is usually measured in microseconds.

* + 1. **Distance calculation:**

Using the measured time interval and the known speed of sound in air (approximately 343 meters per second at room temperature), the sensor calculates the round-trip time of the ultrasonic waves.

Since ultrasound waves travel at the speed of sound, the distance traveled by the waves can be calculated by dividing the total round trip time by two (since the distance is measured from the sensor to the object and back).

The calculated distance represents the time it takes for the ultrasonic waves to travel from the sensor to the object and back, providing an accurate estimate of the distance between the sensor and the object.

* + 1. **Reporting the distance measurement:**

The calculated distance value can be obtained by reading the Echo pin of the sensor. The duration for which the Echo pin remains high corresponds to the measured time interval, which is directly proportional to the distance to the detected object.

This distance value can then be used by the system's microcontroller or processor to perform additional actions or make decisions based on the object's proximity.

**3.4.6 Summary:**

In summary, the HC-SR04 ultrasonic sensor works by emitting ultrasonic pulses, detecting their reflections from nearby objects, measuring the time required for this process, and using this time measurement to calculate the distance to the object in front of the sensor. This principle forms the basis for its accurate and reliable distance sensing capabilities in a variety of applications.

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* 1. **Applications:**
     1. **Distance sensing and measurement in robotics and automation projects:**

In robotics and automation projects, accurate sensing and distance measurement are critical for tasks such as navigation, object detection, and collision avoidance. The HC-SR04 ultrasonic sensor provides an affordable and reliable real-time distance measurement solution. Robots can use this sensor to detect obstacles in their path, determine the distance to objects or walls, and adjust their movements accordingly. Additionally, in industrial automation settings, the sensor can be integrated into machines for precise positioning and monitoring of objects along production lines.

* + 1. **Obstacle Avoidance in Autonomous Vehicles and Drones:**

Autonomous vehicles, including cars, drones, and unmanned aerial vehicles (UAVs), rely on sensors to detect and avoid obstacles in their environment. The HC-SR04 ultrasonic sensor plays a vital role in obstacle avoidance systems by providing accurate distance measurements to objects in the vehicle's path. By continuously scanning the surrounding environment, the sensor enables autonomous vehicles to navigate safely, avoid collisions and maintain a clear path of travel. In drones and UAVs, the sensor helps maintain a safe distance from obstacles during flight and perform complex maneuvers in confined spaces.

* + 1. **Detection of liquid level in tanks and reservoirs:**

Liquid level detection is essential in a variety of industrial and agricultural applications, including monitoring fuel levels in tanks, controlling water levels in tanks, and managing chemical storage containers. The HC-SR04 ultrasonic sensor can be used to accurately measure the distance from the sensor to the liquid surface, enabling precise monitoring of liquid levels. By integrating multiple sensors at different heights, it is possible to create a reliable system to track changes in fluid levels over time, trigger warnings for refill or drain operations, and prevent overflow or underflow conditions.

* + 1. **Proximity detection to activate devices or trigger events:**

Proximity detection involves detecting the presence or absence of objects within a certain range of the sensor. The HC-SR04 ultrasonic sensor can be used for proximity sensing applications in a variety of contexts, such as activating electronic devices, triggering events based on object detection, and implementing contactless interfaces. For example, in home automation systems, a sensor can detect when a person approaches a door and automatically unlock it. In public spaces, it can control the operation of automatic doors, hand sanitizing stations or lighting systems based on the presence of people.

**Conclusion:**

Overall, the HC-SR04 ultrasonic sensor offers versatile capabilities that make it suitable for a wide range of applications, from robotics and automation to environmental monitoring and consumer electronics. Its affordability, accuracy and ease of use make it a popular choice among hobbyists, engineers and professionals.

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1. **For sound effects (alarm) I use: Buzzer 12V**



(Image 7)

A buzzer is an electronic device that produces audible beeps when an electrical current is applied to it. Here is some information:

* 1. **Voltage Requirement:**

As the name suggests, a 12V buzzer operates on a voltage of 12 volts DC (direct current). This means that a 12 volt DC power supply is required to function properly.

* 1. **Sound output:**

Buzzers usually make a loud beeping sound when activated. The sound frequency may vary depending on the design and purpose of the buzzer. Some buzzers may emit a continuous tone, while others may emit intermittent or pulsating sounds.

* 1. **Applications:**

Buzzers are commonly used in various applications where audible signals or alarms are required. Some common applications include:

* + 1. **Automobiles:**

In vehicles, buzzers can be used for a variety of purposes such as indicating low fuel levels, seat belt reminders, door ajar warnings, and other vehicle warnings.

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* + 1. **Security Systems:**

They are often used in security and alarm systems to alert users of intrusions, breaches, or other security-related events.

* + 1. **Industrial equipment:**

Buzzers find applications in industrial equipment and machinery to indicate operating status, faults or safety warnings.

* + 1. **Electronic projects:**

Hobbyists and DIY enthusiasts often use buzzers in electronic projects and prototypes to generate beeps or feedback.

* 1. **Types:**

Various types of buzzers are available, including electromechanical buzzers and piezoelectric buzzers. Electromechanical buzzers generally use an electromagnetic coil to produce sound, while piezoelectric buzzers generate sound using the piezoelectric effect.

* 1. **Installation Options:**

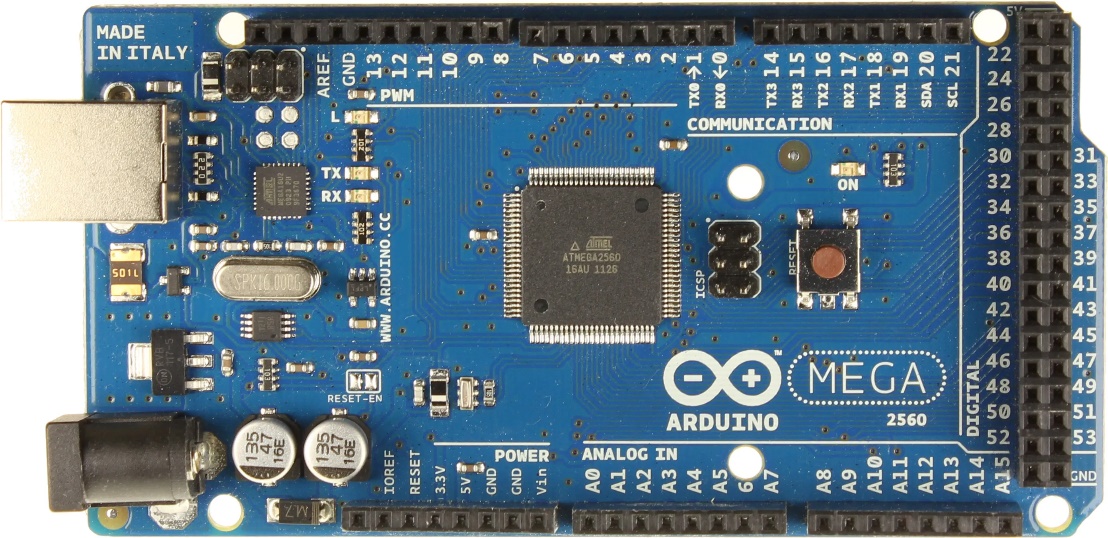
Buzzers can be offered in a variety of mounting options, such as panel mounting, surface mounting, or through-hole mounting, depending on the intended application and mounting requirements.

**Conclusion:**

In general, buzzers are versatile and widely used components that provide effective sound signaling in a variety of applications, from automotive and industrial to security and electronic projects.

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1. **For microcontroller board I use: Arduino Mega 2560**

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(Image 7)

The Arduino Mega is a microcontroller board based on the ATmega2560. There are 54 digital input/output pins (of which 15 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP connector, and a power button. reset.

* 1. **Main features of the Arduino Mega:**
     1. **Large number of pins:**

With 54 digital I/O pins and 16 analog inputs, the Arduino Mega provides a large number of I/O options, making it suitable for projects requiring multiple sensors, actuators and other peripherals.

* + 1. **Multiple Serial Ports:**

The Mega features four hardware UARTs (Serial1, Serial2, Serial3 and Serial) allowing simultaneous communication with multiple serial devices. This is useful for projects requiring communication with multiple external modules or devices.

* + 1. **Compatibility:**

The Arduino Mega is compatible with most shields designed for the Arduino Uno, allowing users to easily expand its capabilities with additional hardware modules and sensors.

* + 1. **Increased memory and processing power:**

The Mega's ATmega2560 microcontroller has 256 KB of flash memory for storing code (8 times more than the Uno) and 8 KB of SRAM, providing plenty of room for complex programs and data storage.

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* + 1. **USB connectivity:**

The Mega can be connected to a PC via USB for programming and serial communication. It uses the standard USB-to-serial converter found on most Arduino boards, making it easy to interface with different operating systems and programming environments.

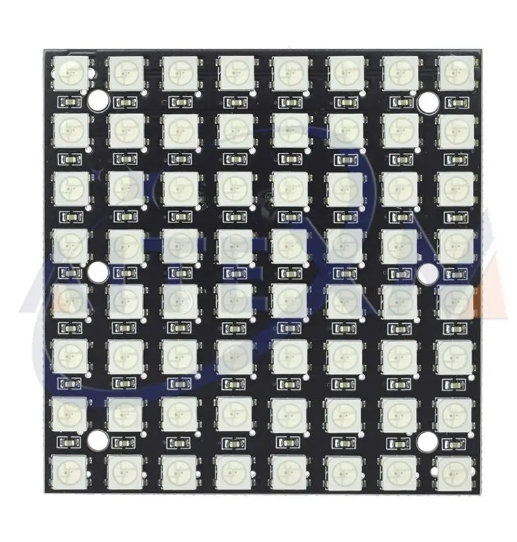
* + 1. **Wide range of applications:**

Thanks to its extensive I/O capabilities and processing power, the Arduino Mega is suitable for a wide range of applications, including robotics, home automation, data logging, 3D printing, and more.

**Conclusion:**

Overall, the Arduino Mega is a powerful development platform that offers advanced capabilities compared to the standard Arduino Uno, making it ideal for complex projects requiring a large number of I/Os, multiple serial communication channels, and increased memory and processing power.

1. **For light signal I use: WS2812 LED MATRIX Module**

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(Image 9)

WS2812 LED RGB 8x8 64-bit LED MATRIX module is a popular LED display module that integrates 64 individually addressable RGB LEDs arranged in an 8x8 grid. Each LED of the module is WS2812B, which is a type of intelligent control LED integrated with control circuit and RGB chip in one package. This allows each LED to be controlled individually using a single data line, making it easy to create colorful and dynamic lighting effects.

Here are some key features and information about the WS2812 LED RGB 8x8 64-bit LED MATRIX module:

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* 1. **Individually addressable LEDs:**

Each LED in the 8x8 matrix can be controlled individually, allowing a high degree of customization and flexibility in creating patterns, animations and effects.

* 1. **WS2812B LED chip:**

The WS2812B LED chip is integrated into each LED, combining the RGB LED and the control circuit into one package. This simplifies the wiring and control of the LEDs as they can be daisy-chained together and controlled using a single data line.

* 1. **High brightness and color accuracy:**

WS2812 LEDs offer high brightness and color accuracy, providing vibrant and vivid lighting effects.

* 1. **Easy to manage:**

Controlling the WS2812 LED matrix module is relatively easy. Data is sent to the module using a simple serial communication protocol, with each LED's color and brightness determined individually.

* 1. **Compact form factor:**

The module is designed to be compact and easy to integrate into different projects. Its 8x8 size makes it suitable for creating small displays, indicators, decorative lighting and more.

* 1. **Wide range of applications:**

The WS2812 LED Matrix module is widely used in a variety of applications, including DIY electronics projects, art installations, stage lighting, portable technology, and decorative lighting for events and festivals.

* 1. **Compatibility:**

The module is compatible with popular microcontrollers and development platforms including Arduino, Raspberry Pi and more. There are also code libraries and examples available online to make programming and controlling LEDs easier.

**Conclusion:**

Overall, the WS2812 LED RGB 8x8 64-bit LED matrix module offers a flexible and adaptable solution for creating colorful and dynamic LED displays and lighting effects in a wide range of applications. Its ease of use, compact form factor and individually addressable LEDs make it a popular choice among hobbyists, makers, artists and designers.

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**The code**

After familiarizing ourselves with the project and going through all the parts used in it, it's time to focus on the code without which nothing would make sense, it should be built so that all the different components work in harmony and synchronize as one with another. This stage is essential because the successful synchronization of the different parts of the project is the key to achieving the final result.

* I am adding the library for the LED lights.

#include <FastLED.h>

* I set the number of LEDs on the LED strips that will light up.

#define NUM\_LEDS 64

* I define the pins to which I have connected the two LED strips on the arduino.

#define DATA\_PIN1 24

#define DATA\_PIN2 25

* I define an array of the colors I use in the LED strips.

CRGB leds1[NUM\_LEDS];

CRGB leds2[NUM\_LEDS];

* I define the pins to which I have connected the lasers on the arduino.

#define laser1 2

#define laser2 3

#define laser3 4

#define laser4 5

#define laser5 6

#define laser6 7

#define laser7 8

#define laser8 9

#define laser9 10

#define laser10 11

#define laser11 12

#define laser12 13

#define laser13 22

#define laser14 23

#define laser15 24

#define laser16 25

* I define the pins to which I have connected the receivers on the arduino.

#define receiver1 A0

#define receiver2 A1

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#define receiver3 A2

#define receiver4 A3

#define receiver5 A4

#define receiver6 A5

#define receiver7 A6

#define receiver8 A7

#define receiver9 A8

#define receiver10 A9

#define receiver11 A10

#define receiver12 A11

#define receiver13 A12

#define receiver14 A13

#define receiver15 A14

#define receiver16 A15

* I am defining the buzzer pin on the arduino.

#define buzzer 53

* I define the trig and echo pins on the arduino, with the trig pins used to send the ultrasonic signal and the echo pins to capture it.

#define TrigPin1 26

#define EchoPin1 27

#define TrigPin2 28

#define EchoPin2 29

#define TrigPin3 30

#define EchoPin3 31

#define TrigPin4 32

#define EchoPin4 33

#define TrigPin5 34

#define EchoPin5 35

#define TrigPin6 36

#define EchoPin6 37

#define TrigPin7 38

#define EchoPin7 39

#define TrigPin8 40

#define EchoPin8 41

#define TrigPin9 42

#define EchoPin9 43

#define TrigPin10 44

#define EchoPin10 45

* I initialize a constant variable of type int that keeps the minimum length that the ultrasonic sensors should measure, anything below that is a violation signal and the alarm is triggered.

const int DISTANCE\_THRESHOLD = 14;

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* I initialize variables of type float to keep the durability of the signals of the ultrasound sensors.

float duration1;

float duration2;

float duration3;

float duration4;

float duration5;

float duration6;

float duration7;

float duration8;

float duration9;

float duration10;

* I initialize float type variables to keep the measured distance from the ultrasound sensors.

float distance1;

float distance2;

float distance3;

float distance4;

float distance5;

float distance6;

float distance7;

float distance8;

float distance9;

float distance10;

* FastLED is the library we use, and addles<brand, LED strip pin>(array with the colors we're running, number of LEDs) adds control over the strips.

FastLED.addLeds<NEOPIXEL, DATA\_PIN1>(leds1, NUM\_LEDS);

FastLED.addLeds<NEOPIXEL, DATA\_PIN2>(leds2, NUM\_LEDS);

* I set the brightness level of the LED strips.

FastLED.setBrightness(5);

* I set the pins of the lasers as output on the arduino.

pinMode(laser1, OUTPUT);

pinMode(laser2, OUTPUT);

pinMode(laser3, OUTPUT);

pinMode(laser4, OUTPUT);

pinMode(laser5, OUTPUT);

pinMode(laser6, OUTPUT);

pinMode(laser7, OUTPUT);

pinMode(laser8, OUTPUT);

pinMode(laser9, OUTPUT);

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pinMode(laser10, OUTPUT);

pinMode(laser11, OUTPUT);

pinMode(laser12, OUTPUT);

pinMode(laser13, OUTPUT);

pinMode(laser14, OUTPUT);

pinMode(laser15, OUTPUT);

pinMode(laser16, OUTPUT);

* I'm turning on the lasers.

digitalWrite(laser1, HIGH);

digitalWrite(laser2, HIGH);

digitalWrite(laser3, HIGH);

digitalWrite(laser4, HIGH);

digitalWrite(laser5, HIGH);

digitalWrite(laser6, HIGH);

digitalWrite(laser7, HIGH);

digitalWrite(laser8, HIGH);

digitalWrite(laser9, HIGH);

digitalWrite(laser10, HIGH);

digitalWrite(laser11, HIGH);

digitalWrite(laser12, HIGH);

digitalWrite(laser13, HIGH);

digitalWrite(laser14, HIGH);

digitalWrite(laser15, HIGH);

digitalWrite(laser16, HIGH);

* I set the pins of the receivers as inputs on the arduino.

pinMode(receiver1, INPUT);

pinMode(receiver2, INPUT);

pinMode(receiver3, INPUT);

pinMode(receiver4, INPUT);

pinMode(receiver5, INPUT);

pinMode(receiver6, INPUT);

pinMode(receiver7, INPUT);

pinMode(receiver8, INPUT);

pinMode(receiver9, INPUT);

pinMode(receiver10, INPUT);

pinMode(receiver11, INPUT);

pinMode(receiver12, INPUT);

pinMode(receiver13, INPUT);

pinMode(receiver14, INPUT);

pinMode(receiver15, INPUT);

pinMode(receiver16, INPUT);

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* I set the pin of the buzzer as the output of the arduino.

pinMode(buzzer, OUTPUT);

* I set the Trig pins of the ultrasound sensors as outputs on the arduino.
* I set the Echo pins of the ultrasound sensors as inputs on the arduino.

pinMode(TrigPin1, OUTPUT);

pinMode(EchoPin1, INPUT);

pinMode(TrigPin2, OUTPUT);

pinMode(EchoPin2, INPUT);

pinMode(TrigPin3, OUTPUT);

pinMode(EchoPin3, INPUT);

pinMode(TrigPin4, OUTPUT);

pinMode(EchoPin4, INPUT);

pinMode(TrigPin5, OUTPUT);

pinMode(EchoPin5, INPUT);

pinMode(TrigPin6, OUTPUT);

pinMode(EchoPin6, INPUT);

pinMode(TrigPin7, OUTPUT);

pinMode(EchoPin7, INPUT);

pinMode(TrigPin8, OUTPUT);

pinMode(EchoPin8, INPUT);

pinMode(TrigPin9, OUTPUT);

pinMode(EchoPin9, INPUT);

pinMode(TrigPin10, OUTPUT);

pinMode(EchoPin10, INPUT);

* I check if any of the light sensors stop receiving one and save the result to a boolean variable (true/false).

bool isReceiver1Blocked = digitalRead(receiver1) == LOW;

bool isReceiver2Blocked = digitalRead(receiver2) == LOW;

bool isReceiver3Blocked = digitalRead(receiver3) == LOW;

bool isReceiver4Blocked = digitalRead(receiver4) == LOW;

bool isReceiver5Blocked = digitalRead(receiver5) == LOW;

bool isReceiver6Blocked = digitalRead(receiver6) == LOW;

bool isReceiver7Blocked = digitalRead(receiver7) == LOW;

bool isReceiver8Blocked = digitalRead(receiver8) == LOW;

bool isReceiver9Blocked = digitalRead(receiver9) == LOW;

bool isReceiver10Blocked = digitalRead(receiver10) == LOW;

bool isReceiver11Blocked = digitalRead(receiver11) == LOW;

bool isReceiver12Blocked = digitalRead(receiver12) == LOW;

bool isReceiver13Blocked = digitalRead(receiver13) == LOW;

bool isReceiver14Blocked = digitalRead(receiver14) == LOW;

bool isReceiver15Blocked = digitalRead(receiver15) == LOW;

bool isReceiver16Blocked = digitalRead(receiver16) == LOW;

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* And I'm checking if any of the variables get true, we'll go into the if statement and execute the buzzer trigger code that's inside, if not we'll turn off the buzzer.

if (isReceiver1Blocked || isReceiver2Blocked || isReceiver3Blocked || isReceiver4Blocked || isReceiver5Blocked || isReceiver6Blocked || isReceiver7Blocked || isReceiver8Blocked || isReceiver9Blocked || isReceiver10Blocked || isReceiver11Blocked || isReceiver12Blocked || isReceiver13Blocked || isReceiver14Blocked || isReceiver15Blocked || isReceiver16Blocked)

{

activateBuzzer();

}

else

{

turnBuzzerOFF();

}

* I check if any of the first to fourth laser inclusive is interrupted, then we will look if the distance measured by ultrasonic sensor number four is less than the set (14cm) and if it is less, an alarm is activated.

if (isReceiver1Blocked || isReceiver2Blocked || isReceiver3Blocked || isReceiver4Blocked)

{

digitalWrite(TrigPin4, LOW);

delayMicroseconds(2);

digitalWrite(TrigPin4, HIGH);

delayMicroseconds(10);

digitalWrite(TrigPin4, LOW);

duration4 = pulseIn(EchoPin4, HIGH);

distance4 = duration4 \* 0.017;

if (distance4 < DISTANCE\_THRESHOLD)

{

activateAlarm();

}

}

* I check if any of the fifth to eighth laser inclusive is interrupted, then we will look to see if the distance measured by the ultrasonic sensors number one, two, three and five is less than the set (14cm) and if it is less, an alarm is activated.

if (isReceiver5Blocked || isReceiver6Blocked || isReceiver7Blocked || isReceiver8Blocked)

{

digitalWrite(TrigPin1, LOW);

delayMicroseconds(2);

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digitalWrite(TrigPin1, HIGH);

delayMicroseconds(10);

digitalWrite(TrigPin1, LOW);

duration1 = pulseIn(EchoPin1, HIGH);

distance1 = duration1 \* 0.017;

digitalWrite(TrigPin2, LOW);

delayMicroseconds(2);

digitalWrite(TrigPin2, HIGH);

delayMicroseconds(10);

digitalWrite(TrigPin2, LOW);

duration2 = pulseIn(EchoPin2, HIGH);

distance2 = duration2 \* 0.017;

   digitalWrite(TrigPin3, LOW);

delayMicroseconds(2);

digitalWrite(TrigPin3, HIGH);

delayMicroseconds(10);

digitalWrite(TrigPin3, LOW);

duration3 = pulseIn(EchoPin3, HIGH);

distance3 = duration3 \* 0.017;

   digitalWrite(TrigPin5, LOW);

delayMicroseconds(2);

digitalWrite(TrigPin5, HIGH);

delayMicroseconds(10);

digitalWrite(TrigPin5, LOW);

duration5 = pulseIn(EchoPin5, HIGH);

distance5 = duration5 \* 0.017;

if (distance1 < DISTANCE\_THRESHOLD || distance2 < DISTANCE\_THRESHOLD || distance3 < DISTANCE\_THRESHOLD || distance5 < DISTANCE\_THRESHOLD)

{

activateAlarm();

}

}

* I am checking if any of the ninth to twelfth laser inclusive is interrupted, then we will look for whether the distance measured by the ultrasonic sensor number ten is less than the set (14 cm) and if it is less, an alarm is activated.

if (isReceiver9Blocked || isReceiver10Blocked || isReceiver11Blocked || isReceiver12Blocked)

{

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digitalWrite(TrigPin10, LOW);

delayMicroseconds(2);

digitalWrite(TrigPin10, HIGH);

delayMicroseconds(10);

digitalWrite(TrigPin10, LOW);

duration10 = pulseIn(EchoPin10, HIGH);

distance10 = duration10 \* 0.017;

if (distance10 < DISTANCE\_THRESHOLD)

{

activateAlarm();

}

}

* I check if any of the thirteenth to sixteenth laser inclusive is interrupted, then we will look for whether the distance measured by the ultrasonic sensors number six, seven, eight and nine is less than the set (14cm) and if it is less, an alarm is activated.

if (isReceiver13Blocked || isReceiver14Blocked || isReceiver15Blocked || isReceiver16Blocked)

{

digitalWrite(TrigPin6, LOW);

delayMicroseconds(2);

   digitalWrite(TrigPin6, HIGH);

   delayMicroseconds(10);

  digitalWrite(TrigPin6, LOW);

  duration6 = pulseIn(EchoPin6, HIGH);

  distance6 = duration6 \* 0.017;

  digitalWrite(TrigPin7, LOW);

  delayMicroseconds(2);

  digitalWrite(TrigPin7, HIGH);

  delayMicroseconds(10);

  digitalWrite(TrigPin7, LOW);

  duration7 = pulseIn(EchoPin7, HIGH);

  distance7 = duration7 \* 0.017;

digitalWrite(TrigPin8, LOW);

delayMicroseconds(2);

  digitalWrite(TrigPin8, HIGH);

   delayMicroseconds(10);

   digitalWrite(TrigPin8, LOW);

   duration8 = pulseIn(EchoPin8, HIGH);

   distance8 = duration8 \* 0.017;

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digitalWrite(TrigPin9, LOW);

delayMicroseconds(2);

digitalWrite(TrigPin9, HIGH);

delayMicroseconds(10);

digitalWrite(TrigPin9, LOW);

duration9 = pulseIn(EchoPin9, HIGH);

distance9 = duration9 \* 0.017;

if (distance6 < DISTANCE\_THRESHOLD || distance7 < DISTANCE\_THRESHOLD || distance8 < DISTANCE\_THRESHOLD || distance9 < DISTANCE\_THRESHOLD)

{

activateAlarm();

}

}

* A function that turns on the buzzer.

void activateBuzzer()

{

digitalWrite(buzzer, HIGH);

}

* A function that turns off the buzzer.

void turnBuzzerOFF()

{

digitalWrite(buzzer, LOW);

}

* Function that turns on the lights and buzzer. In a for loop, we fire the buzzer, fire the lights red, then wait 250 milliseconds, turn off the buzzer and turn off the lights, wait 250 milliseconds again, giving us the alarm effect of flashing the lights and beeping at a very short interval.

void activateAlarm()

{

for (int i = 0; i < 5000; i++)

{

activateBuzzer();

for (int i = 0; i < NUM\_LEDS; i++)

{

leds1[i] = CRGB::Red;

leds2[i] = CRGB::Red;

}

FastLED.show();

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delay(250);

turnBuzzerOFF();

    for (int i = 0; i < NUM\_LEDS; i++)

{

leds1[i] = CRGB::Purple;

leds2[i] = CRGB::Purple;

    }

FastLED.show();

delay(250);

}

}

**Conclusion**

The diploma project represents a significant undertaking in the field of security, combining innovative technologies to protect valuable objects. The designed system, based on laser and ultrasonic sensors, provides reliable protection and warning of potential dangers, such as theft or unauthorized access. In this concluding section, we will look at the possibilities for further development of the project and the various applications it may have in the future.

1. **Further development of the project**
   1. **Integration of additional sensors**

The integration of additional sensors is a key element in improving the functionality and efficiency of the security system. The implementation of infrared sensors to detect heat sources or sensors to detect vibrations provides additional opportunities to monitor and respond to potential threats. Here are some of the main aspects of their introduction:

* + 1. **Infrared sensors for detection of heat sources:**

These sensors can be used to detect the movement of people or animals that emit heat. They are especially useful for monitoring open spaces or perimeter sites where normal video cameras may have difficulty due to lighting or other factors. Infrared sensors can complement the functionality of the system by warning of the presence of unwanted persons or movements in the surveillance area.

* + 1. **Vibration detection sensors:**

These sensors are designed to detect vibrations or unusual movements in structures such as doors, windows or walls. They can be used for early warning of unauthorized building entry attempts. When a vibration sensor is activated, the system can react immediately by triggering an alarm or taking other protective measures.

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The integration of these additional sensors would increase the reach of the security system and make it more adaptable to different types of threats. This would improve the system's ability to respond to various hazard scenarios and provide greater protection for valuable items and objects. At the same time, the integration of these sensors would increase the level of trust in the system, as users would be assured that they are subject to reliable protection against various types of threats.

* 1. **Use of Data Analytics**

Using data analytics in a security system can be a significant improvement, adding additional intelligence and functionality to the system. The implementation of analytical tools enables better use of information collected from sensors and other system components, leading to more effective detection and response to potential threats. Here are some of the possible ways in which data analytics can be used:

* + 1. **Predicting potential threats:**

By analyzing data from past events and trends, the system can use machine learning methods to predict the likelihood of potential threats occurring. For example, if the system detects certain unusual patterns in people's behavior around valuable objects, it can warn of risks and suggest preventive measures.

* + 1. **Optimization of anomaly detection algorithms:**

By analyzing data from sensors and other sources, the system can refine anomaly detection algorithms that identify unusual or irregular events. This includes automatically improving the algorithms through feedback from real events and refining their parameters to better adapt to different situations.

* + 1. **Data Analysis for Response Optimization:**

The system can use data analysis to optimize its response to different situations. For example, by analyzing data on the duration and frequency of different types of threats, the system can determine the most effective response strategies and tailor its response procedures to specific conditions.

* + 1. **Identification of new threats:**

Data analytics can help identify new or previously unseen threats by analyzing unusual or unexpected events that are not captured by existing anomaly detection algorithms.

The use of data analytics in the security system provides an opportunity for smarter and more effective risk management by offering real-time analysis and response to potential threats. This not only increases the security of the targets, but also reduces the likelihood of the need for manual control or intervention, improving the overall responsiveness and reliability of the system.

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* 1. **Mobile Application Development**

The creation of a mobile application represents an important step in the development of the security system, providing convenience and easy access for users to the functionalities of the system. Here are some of the key aspects and benefits of the mobile app:

* + 1. **Remote Control:**

The mobile application will allow users to manage the security system from anywhere in the world where they have access to the Internet. They will be able to activate or deactivate the system, control various parameters and settings, and perform other actions to manage the protection of their valuables.

* + 1. **Receiving Event Notifications:**

The mobile application will provide an opportunity to receive notifications and warnings about various events and situations related to system security. For example, users will receive notifications when an alarm is activated, when an intrusion is attempted, or when other important events require their attention.

* + 1. **Visualization of system status:**

Through the mobile application, users will have the opportunity to visualize the current state of the security system, including the activation of sensors, the presence of potential threats and other important parameters. This will give them greater transparency and control over the protection of their valuables.

* + 1. **Custom Settings and Profiles:**

The mobile application may offer the possibility of customized settings and profiles for different users or usage scenarios. Thus, users will be able to adapt the system to their individual needs and preferences.

Ultimately, the development of a mobile application for managing and monitoring the security system represents an important milestone in the development of the project, providing significant benefits to users and facilitating their daily interaction with the system to protect their valuables.

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1. **Application possibilities**
   1. **Home Security**

Home security is essential to protect our family and property. The use of innovative security technologies, such as those presented in the thesis project, can offer reliable and effective protection against various threats that can affect our home or apartment.

Here's how a security system based on lasers and ultrasonic sensors can be applied to home security:

* + 1. **Preventing Unauthorized Access:**

The system can be installed around the front doors and windows of the home, creating an invisible barrier of lasers. In the event of crossing these lasers, an alarm signal is generated to alert owners of a potentially dangerous scenario.

* + 1. **Traffic monitoring:**

Ultrasonic sensors can be placed inside the home to detect the movement of people or animals. In case of unexpected movement, the system can activate an alarm signal and warn the owners of a potential threat.

* + 1. **External lighting:**

The system can be integrated with outdoor lighting to be activated automatically when motion is detected around the home. This not only provides additional protection against potential intruders, but also offers better lighting for the safety of residents.

* + 1. **Remote Control:**

The system can be connected to a mobile application that allows owners to control and manage home security even remotely. This includes the ability to arm and disarm the system, receive event notifications and view CCTV footage.

Using these innovative home security technologies can offer homeowners greater peace of mind and confidence in the safety of their home and family. These solutions not only offer protection against theft and unauthorized access, but also enable smarter and more efficient security management in the home environment.

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* 1. **Business Security**

In today's business environment, the security of commercial sites plays a critical role in the success of enterprises. The use of innovative security systems, such as the one developed in the thesis project, can have significant positive consequences for the business sector. Here are some of the important aspects where the project can be applied for business security:

* + 1. **Asset Protection:**

Business facilities such as stores, warehouses and offices often contain valuable materials, goods and equipment. Installing a security system based on lasers and ultrasonic sensors can provide a high level of protection against theft or unauthorized access to these assets.

* + 1. **Loss Prevention:**

The project can help prevent losses due to theft or vandalism by providing early warning of potential threats and taking necessary security measures.

* + 1. **Monitoring and Management:**

The security system can offer the ability to monitor and manage important objects from a remote location. This allows business owners or managers to monitor and control the security of their sites even when they are not on site.

* + 1. **Improving overall efficiency and productivity**:

Increased business site security can contribute to greater peace of mind for staff and customers, which can ultimately improve the overall work atmosphere and productivity of the enterprise.

* + 1. **Regulatory Compliance:**

Many sectors of business are subject to regulatory requirements for security and data protection. Installing advanced security systems can help businesses meet these requirements and maintain compliance with legislation.

In summary, the project offers significant potential for improving business security through the use of innovative technologies and protection systems. It can provide businesses with greater security, control and confidence in the protection of their assets and sites.

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* 1. **Bank Security**

In banking, security is critical to protect bank deposits and customers' valuables. The use of innovative security systems, such as the one developed in the diploma project, can provide additional guarantees for the security of customers and the bank as a whole. Here are some of the ways the system can be implemented in the banking environment:

* + 1. **Protection of bank vaults:**

The system can be installed around bank tellers where large sums of money and valuables are stored. Using laser and ultrasonic sensors, the system can prevent unauthorized access to cash registers and warn of attempted thefts.

* + 1. **Monitoring of bank facilities:**

The system can be integrated with the video surveillance in the banking facilities, providing additional data and alerts on events in real time. This would allow bank security to respond quickly and effectively in the event of a threat.

* + 1. **Protection of bank safes:**

Bank safes are designed to store customers' valuables, such as jewellery, documents or cash. The security system can be used to protect safes by preventing unauthorized access and warning of attempted break-ins or break-ins.

* + 1. **Protection of bank terminals:**

In today's banking environment, where more and more operations are carried out through bank terminals and online platforms, the protection of these devices is essential. The security system can be implemented to protect bank terminals by preventing physical attacks or hacking attempts.

Through the application of the security system in the banking sphere, banks can increase the level of protection of their customers and create a more secure environment for storing bank deposits and valuables. This not only increases customers' trust in the bank, but also reduces the risk of financial losses and negative consequences for the institution's image.

**2.4 Museums and galleries:**

In museums and galleries, the security of valuable exhibits and collections is critical. These institutions possess valuable cultural objects that are often unique and of great historical and cultural importance. Therefore, in order to preserve their value and integrity, it is essential to provide effective protection against various types of threats.

The project, based on laser and ultrasound technologies, can be extremely useful in this area. Here's how:

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* + 1. **Preventing unauthorized access:**

Laser sensors can be located around the exhibits or along the perimeter of the room that contains them. In the event of unauthorized access to the exhibit, the crossing of the lasers will activate the alarm, alerting staff to a potential threat.

* + 1. **Damage prevention:**

Ultrasonic sensors can be used to detect vibrations or movements near the exhibit. This can prevent accidental damage, such as attempts at vandalism or overloading of exhibits.

* + 1. **Environmental monitoring:**

In addition to protecting against physical threats, the system can also be set to analyze the environment in which cultural objects are located. For example, by using humidity and temperature sensors, conditions that could lead to exhibit damage, such as excessive humidity or temperature shocks, can be detected.

* + 1. **Remote monitoring and management:**

The system can be connected to a central monitoring and management system, which allows personnel to monitor the state of security and react quickly in the event of a threat, even remotely.

With united efforts, technology and cultural heritage can be enriched simultaneously. The project offers an innovative and reliable way to protect valuable cultural objects, which contributes to preserving their value and accessibility for future generations.

Ultimately, the thesis project represents a significant undertaking that not only offers innovative solutions for the security of valuable objects, but also opens doors to a variety of applications in various fields. With the development and application of new technologies, the project has the potential to change the way valuable assets are protected and contribute to a more secure society.

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**Reference list**

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