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APPLICATION OF GEOFENCING TECHNIQUE IN THE DESIGN OF PHYSICAL PROTECTION SYSTEMS FOR A NUCLEAR FACILITY

Introduction

Nuclear material has always been an object of interest for terrorist organizations because of the high cost of nuclear material and the ability to use it to create an explosive device. When designing a physical protection system, it's necessary to consider the possibility of gaining access through the vulnerabilities of this protection [1]. Physical protection systems (PPS) are the combination of systems used to protect valuable facilities or entities from theft, sabotage or any malicious human activities. These valuable facilities may include nuclear power plants, airports, military installations, banks and other related facilities. Garcia [2] defines PPS more succinctly as" A physical protection system (PPS) integrates people, procedures, and equipment for the protection of assets or facilities against theft, sabotage, or other malevolent human attacks". The primary functions of PPS are detection of a malicious attack, delay of the malicious attack and response to the malicious attack. The PPS requires some elements to carry out these functions: fence, walls, lock and key, sensors, alarm, detectors, response guide or force, lights, cameras, thermocouples, and the rest [3]. These elements have to be appropriately integrated with a laydown procedure to achieve the required objectives of the PPS, and the procedures include the design of the PPS. The PPS design describes the elements' arrangement, composition, alignment, and interconnectivity see figure 1, while the design evaluation or analysis measures the effectiveness or efficiency of the design all in a given geographical area [4].

Geofencing is a location-based technology that uses GPS, cellular data, or radio-frequency identification (RFID) to create a virtual boundary around a real-world geographic area (figure 2). The concept of geofencing was developed in the early 2000s by a company called Mobot, which was later acquired by Qualcomm. The first patent for geofencing technology was filed in 2003 by Timothy W. Fong, the founder of Mobot [5]. The patent, titled "System and method for monitoring and reporting the geographic location of a mobile device," described a system that would use GPS technology to track a mobile device's location and trigger an alert when it crossed a predetermined boundary. Since then, geofencing technology has evolved and become widely

adopted in various industries, including retail, transportation, and security [6], [7]. Today, there are many geofencing software providers, including companies like Foursquare, Esri, and Google.

Some Applications of Geofencing Technique

The geofencing techniques are applied in several ways mostly in the commercial and security sphere. This includes the followings:

IoT Integration: Geofencing can be used to integrate Internet of Things (IoT) devices, such as smart locks, cameras, and sensors, by creating geofences around the home. This allows homeowners to monitor the status and health of devices in real-time, reducing the risk of issues and improving the efficiency of operations.

Autonomous-based services: Geofencing can be used to designate autonomous vehicle-only zones, such as airports, ports, and industrial parks. This allows autonomous vehicles to operate without interference from human-driven vehicles and can improve traffic flow and reduce the risk of accidents.

Geolocation-based Services: Geofencing can be used to offer location-based services, such as navigation, weather information, and traffic updates, to passengers in autonomous vehicles. Passengers can receive real-time information about the vehicle's location, destination, and estimated time of arrival, as well as information about the surrounding area, such as traffic conditions, weather, and points of interest[8], [9].

Emergency Response: Geofencing can be used to support emergency response efforts by creating geofences around accident scenes and other emergency locations. Autonomous vehicles can be deployed to the location to provide immediate assistance, such as transporting medical supplies, equipment, and personnel.

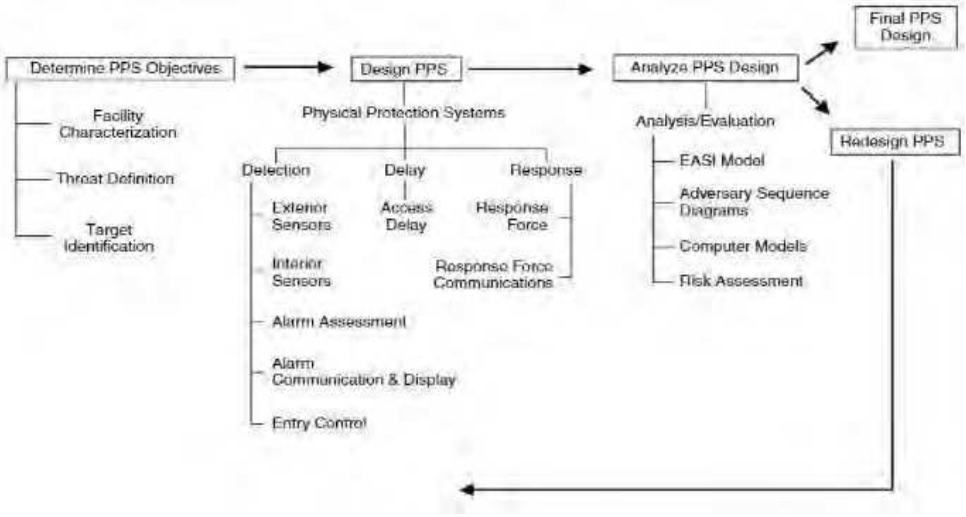

Fig. 1. PPS design cycle

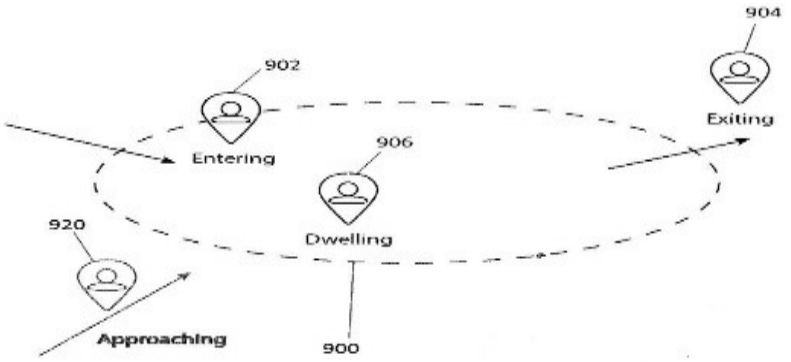

Fig. 2. Simplified Geofencing Diagram

Applying Geofencing to PPS design

Here are some general steps to use geofencing techniques to design a physical protection system:

1. Conduct a security assessment: Before implementing a geofencing system, it is important to conduct a comprehensive security assessment of the facility to identify potential security threats and vulnerabilities.
2. Define the geofenced area: The next step is to define the geofenced area, which will create a virtual perimeter around the facility. This should be done based on the results of the security assessment and in consultation with security experts.
3. Choose the right geofencing technology: There are different types of geofencing technologies available, such as GPS, Wi-Fi, and cellular data. It is important to choose the technology that best suits the specific needs of the facility [10].
4. Install the geofencing system: Once the technology has been chosen, the geofencing system can be installed. This will involve installing the necessary hardware, software, and infrastructure.
5. Integrate the geofencing system with other security measures: Geofencing technology should be integrated with other physical security measures, such as access control systems, surveillance cameras, and intrusion detection systems.
6. Test and refine the system: Once the geofencing system has been installed and integrated with other security measures, it should be thoroughly tested to ensure that it is working correctly. Any issues or problems should be addressed and the system refined as needed.

7. Train security personnel: Security personnel should be trained on how to use the geofencing system, including how to respond to alerts and notifications.
8. Regularly review and update the system: The geofencing system should be regularly reviewed and updated to ensure that it remains effective in responding to new security threats and changes in the facility.

By following these steps, a geofencing system can be effectively used to design a physical protection system for a nuclear power plant or other sensitive facilities. It is important to consult with security experts and take a comprehensive approach to security to ensure that the system provides the necessary protection.

Application of geofencing to PPS Entry and Exit Control Systems

To apply geofencing techniques to entry and exit control systems, you can follow these general steps: Geofencing techniques can be applied to both entry and exit control systems to improve security and control access to specific areas. To apply geofencing techniques to entry and exit control systems, you can follow these general steps:

1. Define the geofence boundaries: Determine the physical boundaries of the area you want to geofence. This could be the perimeter of a building or a restricted area within a larger space.
2. Choose a geofencing technology: Decide on the type of geofencing technology that will be used to track individuals or assets within the geofence. This could include GPS, Bluetooth beacons, or RFID.
3. Install the geofencing technology: Install the necessary hardware and software to create and manage the geofence. This may include sensors, gateways, and a cloud-based management system.
4. Set up the entry and exit control system: Configure the entry and exit control system to trigger an alert or action when an individual or asset attempts to enter or exit the geofenced area. This could include sounding an alarm, sending a notification to security personnel, or activating security cameras.
5. Define access policies: Define access policies that specify who is allowed to enter or exit the geofenced area and under what conditions. This could include requiring a valid ID card or biometric authentication.
6. Monitor and control access: Monitor and control access to the geofenced area using the entry and exit control system. Review access logs and audit trails to identify any unauthorized access attempts.
7. Test and refine the system: Test the geofencing and entry and exit control system to ensure that it is functioning correctly and accurately detecting when individuals or assets are attempting to enter or exit the

geofenced area. Refine the system as necessary to improve its accuracy and effectiveness.

By following these steps, you can apply geofencing techniques to entry and exit control systems to improve security and control access to restricted areas.

Benefits of Geofencing in PPS Designing

Geofencing techniques can provide several advantages in the design of a physical protection system for a nuclear power plant:

1. Increased security: Geofencing technology can enhance the security of a nuclear power plant by creating a virtual perimeter around the facility. This can help to prevent unauthorized access to sensitive areas and detect potential security breaches.
2. Real-time monitoring: Geofencing systems can provide real-time monitoring of the location of individuals or assets within the geofenced area. This can allow security personnel to quickly identify any potential security threats and take appropriate action.
3. Enhanced access control: Geofencing technology can be used to control access to specific areas within the geofenced perimeter, ensuring that only authorized personnel are allowed to enter sensitive areas.
4. Reduced costs: Geofencing technology can be more cost-effective than other physical security measures such as manned guards or physical barriers. It can also reduce the need for multiple security layers, which can reduce costs further.
5. Improved response times: Geofencing technology can help to improve response times to potential security threats by providing real-time alerts and notifications to security personnel.
6. Scalability: Geofencing technology can be scaled up or down depending on the size and complexity of the nuclear power plant. This means that it can be adapted to the specific needs of the facility, making it a versatile and customizable security solution.

Overall, geofencing technology can provide a range of benefits for the design of a physical protection system for a nuclear power plant, helping to enhance security, reduce costs, and improve response times.

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Limitations of Geofencing in PPS Designing

While geofencing techniques can be useful in the design of physical protection systems for nuclear power plants, there are also several potential disadvantages to consider:

1. False positives: Geofencing relies on precise location tracking, which can sometimes result in false positives when an individual or asset is mistakenly identified as being outside the geofenced area. This can lead

to unnecessary alarms and disruptions, which can be particularly problematic in a high-security environment like a nuclear power plant.

2. Inaccuracy: Geofencing technology can be affected by various factors such as weather conditions, environmental factors, and technological issues which can result in inaccuracies in the geofencing system. This can lead to false negatives, where an individual or asset is incorrectly identified as being inside the geofenced area, and unauthorized access may go undetected.
3. Vulnerability to hacking: Geofencing systems can be vulnerable to hacking, which could allow unauthorized access to the geofenced area. A cyber-attack on the system could potentially disable or manipulate the geofencing technology, allowing an intruder to enter the restricted area undetected.
4. Cost: Implementing geofencing technology can be costly, particularly in large-scale applications such as nuclear power plants. There may be costs associated with hardware, software, and ongoing maintenance and support.
5. Limited range: Geofencing technology has a limited range and may not be effective in detecting threats that occur beyond the geofenced area. This means that other physical security measures may be required in addition to geofencing technology to ensure comprehensive protection.
6. Privacy concerns: The use of geofencing technology can raise privacy concerns, particularly if it is used to track the movements of individuals. This may require additional measures to ensure that data is collected, stored, and used in a way that respects individuals' privacy rights.

These potential disadvantages of geofencing techniques should be carefully considered when designing a physical protection system for a nuclear power plant, and appropriate measures should be taken to mitigate these risks.

Conclusion

In summary, geofencing technology can be a valuable tool for designing physical protection systems for nuclear power plants. It allows for more precise and efficient monitoring of critical areas, helping to prevent potential security breaches. However, it's important to implement geofencing strategically and keep in mind the potential limitations and challenges of the technology.

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GLOBAL CRISES MILESTONES: ANALYSIS OF THE CAUSES

Financial and economic crises are not a new phenomenon in the global economy. Rather, they existed and succeeded in various economic systems, and their frequency and size increased in recent decades until they reached their climax recently. In this article, the most important financial crises faced