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APPLICATION OF SATELLITE NAVIGATION SYSTEM FOR EMERGENCY WARNING

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ABSTRACT

In the event of an emergency, one of the most important duties of any government is to convey and distribute safety information and warnings to the general population. New media, mobile technologies, and the associated expectations of personalized warnings to personal mobile devices are challenging the old paradigm of a government monopoly system providing warnings via a broadcast method. In the provision of emergency warnings, location-based emergency services and smartphone notifications are becoming more common. Several nations across the globe, including Australia, have embraced these innovative emergency service models. The Australian National Emergency Alert (EA), for example, is a phone-based service with location-based features. The idea of using global satellite navigation systems, such as the Japanese satellite system, in the area of emergency warning and alerting is introduced in this article. The Japanese satellite warning system may be customized to send real-time location-based emergency alerts to people's mobile devices without being limited by ground-based communication technology. The great resilience of satellite-based communication against communication network overload and loss of ground systems and network infrastructure during a catastrophe is a significant benefit. During disasters, this allows individuals to receive critical information from anyplace (outdoor) and at any time. A satellite-based warning system may potentially be utilized in conjunction with current warning systems as a complementing technology. This paper looks at the benefits and drawbacks of utilizing satellite navigation systems to provide emergency and disaster alerts and security messaging.

KEYWORDS: *System, Navigation, Alerting, Warning, Satellite.*

1. INTRODUCTION

Emergency and catastrophes have severe personal, economic, and environmental effects that are widely acknowledged. The Indian Ocean Tsunami, Victorian bushfire disaster in Australia, and the Tohku Earthquake and Tsunami in Japan are just a few examples of tragedies that highlighted the critical importance of preparedness, early detection, and warning communications in reducing losses of life, property, and environmental damage[1]. A 'warning system' is a method of gathering information about an approaching emergency, the nature of the threat, conveying that information to those who are likely to be impacted by it, and allowing those in risk to make educated choices and respond quickly. Functional warning systems have been proven in many studies to be a valuable tool for saving lives and minimizing property damage.In the emergency management process, the early warning and preparation phase is critical for achieving a sufficient degree of preparedness to respond to possible threats. Emergency plans are created in this phase to define processes such as evacuation and emergency escape routes, among other things. The United Nations International Strategy for Disaster Reduction specifies four interdependent components for early warnings, including information distribution through communication networks that provide timely and accurate warning signals (United Nations International Strategy for Disaster. Warning systems must be backed by dependable communication networks with good interactions between important stakeholders, decision-makers, and the general public in order to operate successfully. State emergency response agencies have traditionally relied on one-way, top-down communication channels to convey warnings[2]. Warnings and safety information are often delivered through technologies such as sirens, radio, and television. A recent re-examination of emergency warning systems, on the other hand, shows a steady progression toward incorporating two-way participatory approaches leveraging new technologies and collaborative information sharing tools, such as the powerful combination of the Internet, mobile, crowd-sourcing, and social networking technologies[3]. In a growing number of nations across the globe, including Australia, mobile location-based emergency services have become an established component of government plans[4]. This significant shift in communication roles from command to conversation reflects the rapid rate of change in modern communication patterns and information sharing technologies. Satellite navigation systems are a novel and developing technology.There hasn't been much study done to see whether it's possible or useful. In critical circumstances when ground-based communication channels are restricted or unavailable, the importance of coordinating emergency procedures with location-awareness exercises cannot be overstated. The Japanese and Australian governments officially agreed in mid-2014 to collaborate to promote the use of information and communications technology (ICT) and to enhance collaboration for the development of geospatial information projects utilizing the Japanese satellite navigation system. One example of a satellite-based navigation system is the Japanese Quasi-Zenith Satellite System (QZSS). While the satellite trajectory design was mainly designed for Japanese consumers, it also benefits neighboring East Asian nations including Australia[5]. The use of a satellite navigation system for emergency warning and alerting is discussed in this article. The suggested system may provide real-time warnings with location-based information, allowing users to adopt appropriate risk mitigation measures during disasters.

1.1 Warning Systems on the Mobile:

For the transmission of essential safety information and warning messages to individuals about imminent hazards and catastrophe risks, several, redundant communication channels are needed. Multiple communication channels improve the efficacy of emergency alerts by expanding their reach, allowing others to get through if one fails.Additionally, having several ways to convey emergency information may serve as a kind of confirmation reinforcement. People often seek confirmation from various sources when they hear surprising news.Traditional communication methods including door-to-door, signs, sirens, loudspeakers, radio, television, fixed phone network, and the internet have long been used to warn people of imminent hazards and distribute safety information[6]. Outdoor sirens and loudspeakers are effective in terms of attracting attention, but they are ineffective in terms of conveying information. Radio, television, and the Internet offer information on emergency situations to a broad audience. These, on the other hand, can only fulfil the information role of warnings and transmit them passively. The people must tune in to particular communication channels. Although door-to-door notification and a fixed phone network can actively notify and warn people of impending danger, their coverage is limited to a local scale, making them ineffective operationally. In different physical and social settings, these different methods of communicating warning and safety information are not equally effective at providing an alert.In the last decade, new media and communication technologies have emerged as effective means for disseminating warning messages and safety information. In today's culture, mobile telephony or cellular network technologies have grown widespread, and the proliferation of mobile phones offers the potential to deliver "personalized" lifeline information during crises and catastrophes. Several governments around the world have embraced and effectively used mobile telephone warning systems as a supplement to traditional well-established warning channels[7].

The common Short Message Service (SMS) and Cell Broadcast Services are maybe the two most practicable mobile telecommunication technologies that meet the criteria of mobile phone emergency alert information service (CBS). Uniform text messages are delivered point-to-area to all users within a specified geographic region defined by cell towers using CBS. It may also be transmitted to all cells in a carrier network and offers a wide range of channels for broadcasting various types of service messages (such as weather updates, public health advice etc). Users of CBS, on the other hand, must set their mobile phones to a particular channel in order to receive messages, exactly like they would with a radio broadcast. As a consequence, CBS is immune to network saturation. The Netherlands was the first country in the world to implement a national emergency warning system (Netherlands Government, 2012). Another example of CBS is the United States' Wireless Emergency Alert (WEA).

1.2 Proliferation of Smartphones and Location-Based Services:

Not just in terms of communication, but also in terms of information acquisition, Australian society is becoming more mobile. According to a 2013 study, the number of Australians using cellphones has increased. In comparison to the previous year, 88percent of respondents possessed a smartphone this year, up from 76 percent. Smartphone ownership is expected to rise to 93 percent by August 2014, based on purchase intentions of mobile phone users (Mackay 2013). Almost all smartphones now come with a built-in GPS receiver and maps that allow users to pinpoint their exact position. Indeed, with the widespread use of smartphones, geospatial

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technology usage has skyrocketed. Smartphones are being hailed as the modern-day digital "Swiss Army knives" of consumer electronics, capable of handling functions formerly reserved for specialist gear such as cameras, computers, and GPS receivers. People with active mobile devices who are situated within a specified geographic region of the disaster get notifications and pertinent safety information from location-based emergency warning systems. It may also be used to determine a mobile device's geographic position after the user has made an emergency phone call or sent a distress SMS seeking assistance. The Enhanced-911 (E911) location-based emergency call service in the United States is one example. For calls to 911, E911 requires telecommunications providers to identify a person and transmit the location of his or her mobile phone to the closest answering center. People in emergency situations may benefit from using location-based emergency warning systems. The Australian government enhanced EA in 2013, allowing location-based alerts to be broadcast based on the mobile handset's last known location at the time of the emergency as well as its registered address. Mobile phones with a registered address in the affected region, as well as users who are mobile but in the impacted area, will be informed of the emergency as a result of this improvement. A system like this is seen as a useful tool for rapidly delivering important information within a specified geographic region to the intended receivers of the messages. Mobile telecommunications services, on the other hand, are heavily reliant on network and underlying infrastructure, which may jeopardize their capacity and dependability. One drawback of such a system is that it loses effectiveness when a geographic region becomes bigger and/or in places where there is no mobile network. This method of communication works well in cities, but not so well in smaller rural areas where cell service is patchy or non-existent. Dareel, a Victorian village in the state's western region, was devastated by fire in 2013, destroying 16 houses and 18 structures. The emergency coordination operation during the fire was hampered by patchy cellphone service. The text message is delivered from point-to-point to a specified group of phone numbers using SMS. Unlike CBS, this channel is an individual addressable channel, which means that the messages are targeted to a specific person. However, if a large number of SMS messages and/or phone calls are sent at the same time, SMS is vulnerable to network congestion and message delivery failure. Delays may happen, and they might lead to delivery failure, particularly in an emergency. Despite this, SMS is a well-established and extensively used communication system. SMS offers the advantages of supporting delivery confirmation and having a ‘store and forward' method. The message is kept in the Short Message Service Centre (SMSC) network during periods of unavailability network coverage or temporary breakdown and sent when the recipients become accessible.

1.3 Navigation Satellite Warning System:

Another method of communication utilized by many nations and organizations across the globe to broadcast emergency alerts is satellite-based communication. J-Alert, a national warning system in Japan, is an example of how Superbird-B2 is used. Warning messages will be transmitted through a communication satellite. COSPASSARSAT International The GNSS receiver included in smartphones, which provides accurate location information, may be used to correlate safety information received from the satellite, making the information relevant to intended users at a particular moment and within a specified geographic region. Existing warning systems may be supplemented and improved using GNSS. With the launch of the ALIVE (Alert interface through EGNOS) Concept in 2005, Europe has been working on emergency messaging services utilizing the EGNOS and Galileo satellite navigation systems. Following up studies have looked at the technical and non-technical benefits, as well as the advantages, of using GNSS satellites for disaster warning. Another well-known satellite-based search and rescue program is the (SAR), System for detecting and disseminating distress alerts. The system is the most well-known name for it. that identifies and locates airplanes, ships, and backcountry emergency beacons hikers who are in trouble (COSPAS-SARSAT 2014).

In general, satellite communication services include resilient, and may be extended with geographic data to indicate which areas the system should be used in. The information is useful. The usage of a satellite phone, on the other hand, is not as popular as it once was. to cellular phones Furthermore, satellite communication service maintenance and Both service providers and users bear the costs of operation. The navigation satellite emergency system combines the advantages of both mobile and fixed systems. Satellite-based communication and communications services Satellites for Global Navigation The Global Navigation Satellite System (GNSS) is a generic name for satellite-based navigation systems, which include the GPS[8]. GPS in the United States, GLONASS in Russia, and many morenew and upcoming constellations, including as The Galileo and BeiDou systems in Europe and China, respectively. These technologies offer accurate positioning in the environment. Using radio navigation signals, three dimensions, time, and velocity may be achieved. GNSS stands for Global Navigation Satellite System[9]. The receivers receive the signals in a one-way system, with no engagement from the receivers. relating to satellites Regional navigation satellite systems and satellite-based navigation systems are also available. SBAS, such as the United States' WAAS a Europe's European Geostationary Orbital or The European Navigation Overlay Service (EGNOS) and India's GAGAN are two systems that seek to supplement GNSS. In addition to increasing efficiency and lowering operational costs, GNSS adoption Many new location-based services have benefited from technological advancements (ACIL)[10].

Another SBAS created by Japan Aerospace Exploration Agency is the Japanese Quasi-Zenith Satellite System (QZSS). When fully operational in 2018, three QZSS satellites in highly inclined elliptical orbits (HEO) and one geostationary satellite will provide 24-hour coverage. The QZSS satellites' orbit design offers continuous coverage at a high elevation angle, improving satellite navigation in regions of Japan where conventional GNSS satellite positioning capabilities are challenged, such as central metropolitan areas. While the orbit design is mainly aimed for Japanese consumers, it also benefits neighboring East Asian nations including Australia.

The footprint of the QZSS satellite is launched on September 11, 2010, the first QZSS satellite was launched. QZSS has a unique feature in that it may transmit brief emergency messages in addition to the usual GNSS navigation signals used for Position, Navigation, and Timing (PNT). A GNSS/GPS receiver integrated in mobile phones or in in-car navigation systems can receive the signals straight from the satellite. The data would be interpreted and displayed by application software or an app. Given the near-universal usage of mobile phones and in-car navigation systems by virtually everyone, the potential coverage and reach of alerts delivered to these personal devices is expected to be considerably higher than existing methods could accomplish.

Another aspect of the QZSS alert messaging system is that, in addition to the broad area coverage given by the satellite system, the receivers also transmit accurate location information through their integrated GNSS/GPS capabilities. This manner, based on the nature and content of the catastrophe information, alarm messages may be delivered to a particular region, and only those receivers inside that area will be triggered. Knowing the approximate location of a potential catastrophe, the targeted users might be informed, but those outside the disaster region would not be.In comparison to existing methods of delivering warnings through personal devices, the satellite-based system provides a number of benefits for real-time catastrophe notifications. The following are some of the benefits:

- In an emergency, GNSS with location-based information may be utilized. This allows high-priority and targeted messages to be sent to specific areas and groups;
- The service can cover a large area at once – for example, the entire country of Australia – due to its wide area broadcast footprint, and there is no limit to the number of people who can be warned at the same time within the broadcast area
- The messages can still be received even when terrestrial communications are disrupted. This provides redundancy
- Because the system is not reliant on mobile phone coverage, it can reach individuals wherever they are, regardless of whether or not they have access to a phone.

2. DISCUSSION

A satellite navigation system, often known as a satnav system, utilizes satellites to offer autonomous geospatial location. It uses time signals sent along a line of sight by satellites to enable tiny electronic receivers to calculate their position (longitude, latitude, and altitude/elevation) with great accuracy (within a few centimeters to metres). The system may be used to provide position, navigation, or track the location of anything that has a receiver attached to it (satellite tracking). The signals also enable the electronic receiver to determine the current local time to a high degree of accuracy, allowing for time synchronization. Positioning, Navigation, and Timing are the terms used to describe these functions (PNT). Satnav systems work without the need for a phone or internet connection, but these technologies may improve the accuracy of the location data.A global navigation satellite system is a satellite navigation system that has worldwide coverage (GNSS). The Global Positioning System (GPS) of the United States, Russia's Global Navigation Satellite System (GLONASS), China's BeiDou Navigation Satellite System (BDS) , and the European Union's Galileo are all fully functioning GNSSs as of September 2020. The Quasi-Zenith Satellite System (QZSS) is a (US) GPS satellite-based augmentation system designed to improve GPS accuracy, with satellite navigation independent of GPS expected to be operational by 2023. In the long run, the Indian Regional Navigation Satellite System (IRNSS) intends to grow to a worldwide version.

3. CONCLUSION

The government has a major operational and logistical difficulty in providing an emergency warning system that can communicate time-critical safety information ‘wherever to whoever it is required' during disasters due to Australia's enormous geography. It would require a significant financial investment in the network and supporting infrastructure, which may not be feasible. The provision of safety information through a GNSS-based system is possible because it combines the benefits of both mobile phone-based service and satellite communications while overcoming their shortcomings. The great resilience of satellite-based communication against communication network overload and collapse of ground systems and network infrastructure during a catastrophe is its main benefit. It also offers scalability of coverage for mass public warning, and its operation may be less expensive than existing warning systems. Despite the widespread availability of GNSS-based technology, the use of GNSS in emergency warning and alerting in Australia is still in its early stages. Research on the feasibility and implications of GNSS technology inside the national emergency warning system is, for the most part, sparse. This is due to the satellite-based warning technology's partial immaturity, which will soon change with the arrival of additional GNSS satellites and augmentation systems. Thinking beyond the immediate obstacles, defining technical and non-technical needs, and comprehending the operational environment in which the technology may be utilized as "added value" to current warning systems remains a problem.

The Japanese satellite system, known as QZSS, is capable of sending warning messages to people's mobile phones. The gadgets may be programmed to receive emergency alerts depending on their position at a particular time and within a defined geographical region. As a result, it has the potential to solve some of the limitations of conventional warning systems. Although a GNSS-based warning system is unlikely to replace current systems, it may supplement and enhance them by offering an independent method of transmitting location-based alerts. Building effective methods that develop over time by adopting newer technology is a continuous requirement. As other GNSS systems, such as Galileo and BeiDou, mature and gain emergency alert capability, Australia will have the opportunity to be an excellent test bed for GNSS-based emergency services and be the first to innovate with new tools and products due to the continent's geographical location relative to all of these global navigation satellite systems.

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