Web Portal to Support Remote Island for Sightseeing and Disaster Management

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Abstract. The present study designed, developed and operated a web portal to support remote island for sightseeing and disaster management. The web portal is developed adopting web-geographic information systems (Web-GIS), and connecting with external Social Networking Services (SNS) and the watch over system. The web portal is operated in Tashirojima Island that is a small island in Ishinomaki City, Miyagi Prefecture in the eastern part of Japan.

The web portal enables to visualize the necessary information concerning sightseeing on the digital maps of Web-GIS. Using Twitter, it is also possible for users to share a variety of information transmitted from an islander in real time. Additionally, using the watch over system, users can usually watch over islanders from the outside of Tashirojima Island. When natural disasters suddenly occur, users can notice the serious situations, and rescue teams to quickly rescue islanders, and support for recovery and reconstruction of Tashirojima Island.

The web portal has been operated since February 22 in 2019, and it has been continuously accessed from the inside and outside of Japan until now. Additionally, users access to the web portal using various types of information terminals. Therefore, the further use of each function can be expected by the continuous operation of the web portal.

Keywords: Web Portal, Remote Islands, Sightseeing, Disaster Management, Web-Geographic Information Systems (Web-GIS), Social Media, Watch Over System

1 Introduction

According to the survey conducted by the Ministry of Land, Infrastructure, Transport and Tourism in 2019 [1], Japan is composed of 6,852 islands including Hokkaido, Honshu, Shikoku, Kyusyu and Okinawa islands. Excluding these large-scale islands, the numbers of remote islands, which are manned and unmanned, are respectively 416 and 6,432. The total area of remote islands is 5,323km^2 that is 1.41% of Japanese national land. Approximately 380 thousand people, which is equivalent to 0.30% of total Japanese population, live in the manned remote islands. Nevertheless, the remote islands

play an important role in the protection and increase of the profits for Japan and Japanese people in terms of its territory and exclusive economic zones, use of marine resources, succession of diverse cultures, conservation of nature environments, etc.

However, the populations of remote islands have been continually in the decrease since 1955. Additionally, in 2013, the aging rates (the percentage share of people aged 65 or older against the total population) of the whole Japan and underpopulation areas are respectively 22.7% and 33.0%, while that of remote islands is 35.0%. Thus, most remote islands have tremendously serious issues related to declining birth rate and aging population in particular. Though the main industry of the remote island is fishery, there has been lack of new blood and insufficient human resources to carry on such an occupation.

On the other hand, in recent years, more tourists visit remote islands. With the increase of the tourists visiting remote islands from the inside and outside of Japan, it is possible to promote the sustainable development and local revitalization in such islands. However, there are very few guidebooks and websites that introduce remote islands. Additionally, the islanders could hardly transmit sightseeing information concerning their islands by themselves. Therefore, it is difficult for tourists to obtain the information concerning the remote islands.

Furthermore, in addition to such issues related to declining birth rate and aging population, natural disasters such as typhoons, tsunami, heavy rain, strong wind and volcanic eruption frequently attack remote islands. Therefore, it is essential to watch over islander all the time from the outside of remote islands. As a countermeasure against such issues, Murayama et al. (2019, 2020) [2, 3] developed and operated a watch over system that will be particularly mentioned in section 3. Against such a backdrop, in order to support a remote island for sightseeing and disaster management, the present study aims to develop a web portal using web-geographic information systems (Web-GIS), and connecting with external Social Networking Services (SNS) and the watch over system developed and operated by Murayama et al. (2019, 2020) [2, 3]. Additionally, in the present study, as mentioned in section 5, Tashirojima Island in Ishinomaki City, Miyagi Prefecture in the eastern part of Japan was selected as the operation target area.

2 Related Work

The present study develops a unique system using Web-GIS and connecting with external SNS and the watch over system. Therefore, considering the characteristics of the system, the present study is related 2 study fields, namely, (1) studies concerning activity support system, and (2) studies concerning social media GIS. The following will introduce the major preceding studies of recent years in the above 2 study fields, and demonstrate the originality of the present study in comparison with the others.

In (1) studies concerning activity support system, Kurashima et al. (2011) [4] proposed a travel route recommendation method using the geotags of photo-sharing sites. Kurata (2012) [5] developed an automatic sightseeing route system using Web-GIS and genetic algorithms (GAs). Sasaki et al. (2013) [6] gathered the information concerning

regional resources and developed a system that offers travel support for each user. Fujitsuka et al. (2014) [7] used the pattern-mining method, which lists and extracts the chronological movement of those visiting sightseeing spots, to develop an outing plan recommendation system. Ueda et al. (2015) [8] generated posterior information from the movement of users while sightseeing, and developed a sightseeing support system that shares such information as prior information with other users.

Fujita et al. (2016) [9] developed a navigation system to support sightseeing activities during normal times and evacuation in case of a disaster integrating augmented reality (AR), Web-GIS, social media (Twitter and SNS) and recommendation system. Zhou et al. (2016) [10] develop a sightseeing spot recommendation system integrating AR, Web-GIS, SNS and recommendation system. Mizushima et al. (2017) [11] proposed a service data model in design support system for sightseeing tours, based on tourists' 3 types requests (geographical, time and meaning information). Naitou et al. (2018) [12] developed a navigation system to support users to select their suitable city walking courses in response to their health conditions, needs and preferences adopting Web-GIS and Twitter. With Fujita et al. (2016) [9] as a reference, Yamamoto (2018) [13] developed a sightseeing navigation system, using two-dimensional and three-dimensional digital maps of Web-GIS and just targeting foreign tourists. Abe et al. (2019) [14] developed a tourism information system with language-barrier-free interfaces, mainly targeting foreign tourists. Murayama et al. (2019, 2020) [2, 3] developed and operated a watch over system using cameras of mobile phones. Sasaki et al. (2019) [15] developed a system to provide guidance and information concerning sightseeing spots integrating location-based AR and object-recognition AR and using pictograms.

In (2) studies concerning social media GIS, Yanagisawa et al. (2012) [16] and Nakahara et al. (2012) [17] developed social media GIS to accumulate and share regional knowledge in local communities integrating Web-GIS, SNS and Wiki. Yamada et al. (2013) [18] developed a social media GIS for the information exchange between regions integrating Web-GIS, SNS and Twitter. Ikeda et al. (2014) [19] and Mizutani et al. (2018) [20] developed social recommendation media GIS to recommend sightseeing spots integrating social media GIS and recommendation system. Okuma et al. (2013) [21], Murakoshi et al. (2014) [22] and Yamamoto et al. (2015) [23] developed social media GIS to accumulate and utilize urban disaster information integrating Web-GIS, SNS and Twitter. Asukai et al. (2018) [24] developed a recommendation system for meeting places targeting groups integrating recommendation system as well as an accessibility database, and linking with external Web-GIS and SNS (Twitter and LINE).

Referring to the results of the preceding studies in the 2 fields as listed above, the present study demonstrates the first point of originality to support activities for both sightseeing and disaster management. Among the preceding studies, Fujita et al. (2016) [9] developed a navigation system to support sightseeing activities during normal times and evacuation in case of a disaster. Therefore, the present study develops a web portal to support a remote island for both sightseeing and disaster management with Fujita et al. (2016) [9] as a reference. The second point of originality is to target remote island and consider its specific conditions. As mentioned in section 1, in Japan, approximately 380 thousand people live in the manned remote islands that have issues related to declining birth rate and aging population. Accordingly, it is necessary to support islanders

from the outside of remote islands. The third point of originality is to develop a unique web portal to support islanders to transmit sightseeing information, and watch over them all the time from the outside of remote islands.

3 System Design

3.1 System Configuration

The web portal of the present study is developed by means of Web-GIS and the connection with external social media (Twitter) and the watch over system. Fig. 1 shows the system design of the web portal. The web portal was based on the result of Naitou et al. (2018) [12] that developed a navigation system to support users to select their suitable city walking courses for Japanese urban areas. Regarding the watch over system, the cameras of mobile phones, which are installed in some points of remote island, are used.

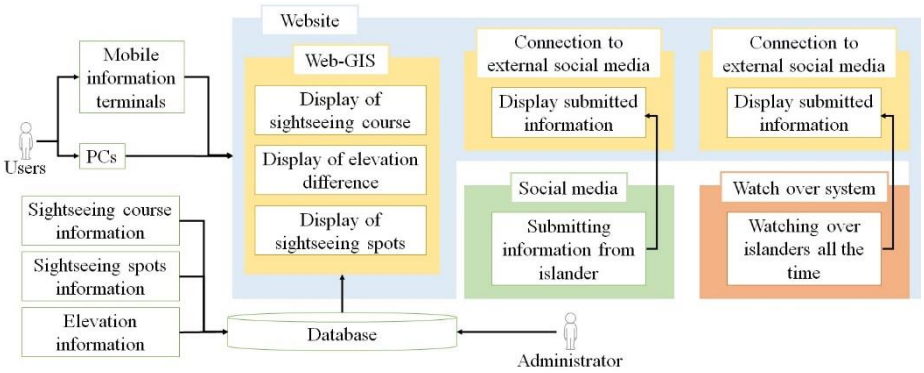

Fig. 1. System design

The web portal has the purpose to support remote island for sightseeing and disaster management. Specifically, it enables to visualize height, sightseeing spots and course on the digital maps, and accumulate the related information in the database of Web-GIS. Due to the connection of social media, it is possible for users to obtain the information submitted from an islander (one of main characters) using Twitter, and display her tweets on the screens of the web portal. Additionally, using the watch over system, as the moving images taken by the cameras of mobile phones are also displayed on the screens of the web portal, it is also possible to watch over islanders all the time from the outside of remote islands. Therefore, when natural disasters occur in remote islands, it is possible for rescue teams to quickly relieve islanders, and support for the recovery and reconstruction of their islands.

3.2 Target Information Terminals

Though the web portal is meant to be used from PCs or mobile information terminals, as there is no difference in functions on different information terminals, the same function can be used from any information terminal. PCs are assumed to be used indoors for gathering a variety of sightseeing information and watch over islanders from the outside of remote island. On the other hand, mobile information terminals are assumed to be used both indoors and outdoors to gather information concerning sightseeing spots, and watch over islanders from the inside and outside of remote island.

3.3 System Operation Environment

The web portal operates using the web server and the GIS server. For the web server, the Heroku, which is a Platform as a Service (PaaS) provided by the Salesforce Company, was used. On the other hand, for the GIS server, the ArcGIS Online was used. The web application developed with the web portal was implemented using PHP and JavaScript as main computer languages.

3.4 Design of Each System

3.4.1 Web-GIS.

In order to display a variety of information referring to the location information on the digital maps, it is essential to adopt Web-GIS into the web portal. However, as there are a variety of Web-GIS types, it is necessary to select the most suitable type according to the purpose of developing the web portal. In terms of convenience, the system should be used without having to download any special softwares, which would be inconvenient for users, and it would be desirable if it could be used by accessing the website on any PCs or mobile information terminals connected to the Internet. Therefore, a series of the GIS provided by the Environmental Systems Research Institute, Inc. (ESRI) were selected to develop Web-GIS in the present study.

Additionally, as most of the roads are very narrow in remote islands, these are not included into the base map provided by the ESRI. Therefore, Open Street Map, which includes minor streets as well as main roads, was used as the base map of the system. Additionally, it is possible for everyone who registered the system of Open Street Map to edit it.

3.4.2 Connection to External SNS

As the web portal is connected to Twitter, users can obtain the information submitted from an islander using Twitter. Among various kinds of social media, Twitter, which is provided by the twitter Japan Inc., was selected as social media for the web portal. Using Twitter publish, which is also provided by the twitter Japan Inc., the widget to display the timeline of tweets was created, and the URL related to a specific Twitter account was developed to be embedded in the web portal.

3.4.3. Connection to the Watch Over System

As the web portal is also connected to the watch over system developed and operated by Murayama [2, 3], users can usually watch over islanders. According to Murayama et al. [2, 3] and Saito et al. (2012) [25], the watch over system was developed, and it was applied for the damaged areas by the East Japan Earthquake (2011). Additionally, according to Sato, 2017 [26], the system was also applied for the campus of Tusda University to watch over handicapped people.

4 System Development

4.1 System Frontend

4.1.1 Overview of System Frontend

The web portal will implement 5 unique functions for users, which will be mentioned below, in response to the purpose of the present study as mentioned in Section 1. In order to implement these unique functions, the web portal was developed by means of Web-GIS, and was also connected with external social media and the watch over system. The viewing function of the moving images submitted by the watch over system is for disaster management, while the other 4 functions are for sightseeing.

In addition to these unique functions, all of the information concerning Tashirojima Island was consolidated into the web portal, and users can obtain their necessary information from the system. Specifically, the web portal includes the traffic information guide, the original walking map created by a former postmaster in Tashirojima Island, and the unique photo book of cats. Furthermore, the web portal links to a famous cartoonist's blog entitled "Cats Information from Tashirojima Island". Referring to these, users can efficiently and easily obtain their necessary information before, during and after their sightseeing in Tashirojima Island while enjoying.

4.1.2 Display Function of Sightseeing Course

Selecting "Sightseeing course" in the menu bar on the homepage, users can go to the page for the display function of the sightseeing course to confirm its outline on the digital map of Web-GIS (Fig. 2). The sightseeing course is clearly displayed by an orange line. A pink marker shows a sightseeing spot, a blue marker shows a cat area where tourists can meet a lot of cats, and a green marker shows an accommodation. Users can obtain the present location information by GPS of their mobile information terminals, and go to the next destination while grasping their present locations. Additionally, users can easily scale the size of the digital maps of Web-GIS as they like.

Fig. 2. Page for the display function of sightseeing course

4.1.3 Display Function of the Elevation Difference of Sightseeing Course

After confirming the outline of selected sightseeing course, by clicking its line on the digital map, users can go to the page for the display function of the elevation difference of sightseeing course (Fig. 3) to confirm the elevation difference. In the graph shown in Fig. 3, the vertical axis indicates elevation [m], and the horizontal axis indicates the distance [km]. By moving the cursor in the graph, the location corresponding to the sightseeing course is displayed by a blue circle.

Fig. 3. Page for the display function of the elevation difference of sightseeing course

4.1.4 Viewing Function of Sightseeing Spot Information

Selecting “Sightseeing spot” in the menu bar on the homepage, users can go to the page for the viewing function of the sightseeing spot information (location, explanation and image) on the digital map of Web-GIS (Fig. 4). The marker indicating the position of each sightseeing spot is displayed on the digital map. Specifically, as described in section 4.1.2, a pink marker shows a sightseeing spot, a blue marker shows a cat area where tourists can meet a lot of cats, and a green marker shows an accommodation.

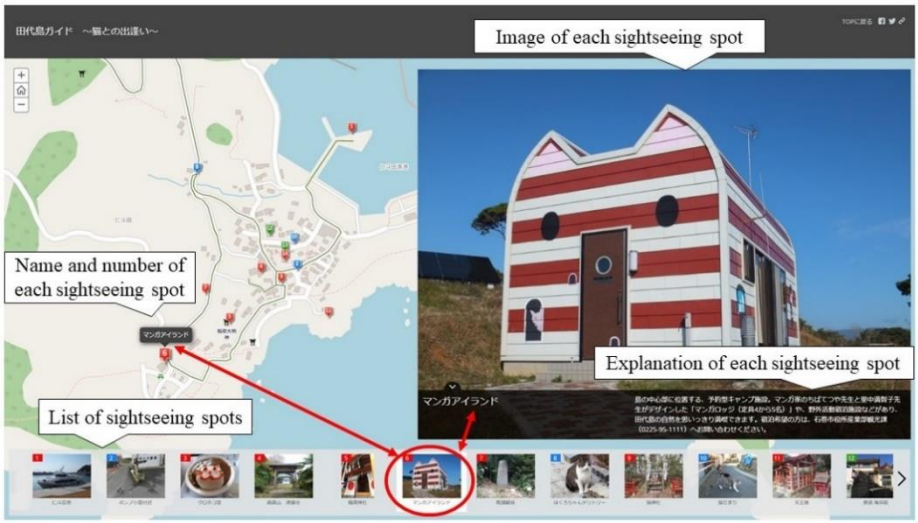

Fig. 4. Page for the viewing function of sightseeing spot information

4.1.5 Viewing Function of the information submitted by Twitter

Selecting “Twitter of the Kuroneko-do” in the menu bar on the homepage, users can go to the page for the viewing function of the information submitted by Twitter (Fig. 5). The Kuroneko-do is managed by an islander who is a main character, and it is an information transmission source on the internet in addition to a tourist information center in Tashirojima Island. Users can usually view her tweets, and obtain a variety of information concerning the cats, beautiful landscapes and events in Tashirojima Island. Additionally, users can also confirm the information concerning the weather report in northeastern Japan and the ferry service as a unique transportation means to Tashirojima Island. The ferry service is frequently suspended due to the bad weather especially in winter. Therefore, the above information is extremely important and useful for users to visit Tashirojima Island. If situations are changed, the above information is immediately updated by the islander. Furthermore, when users who have Twitter accounts hope to obtain accurate information in detail, they can keep in touch with the above islander and her followers using Twitter.

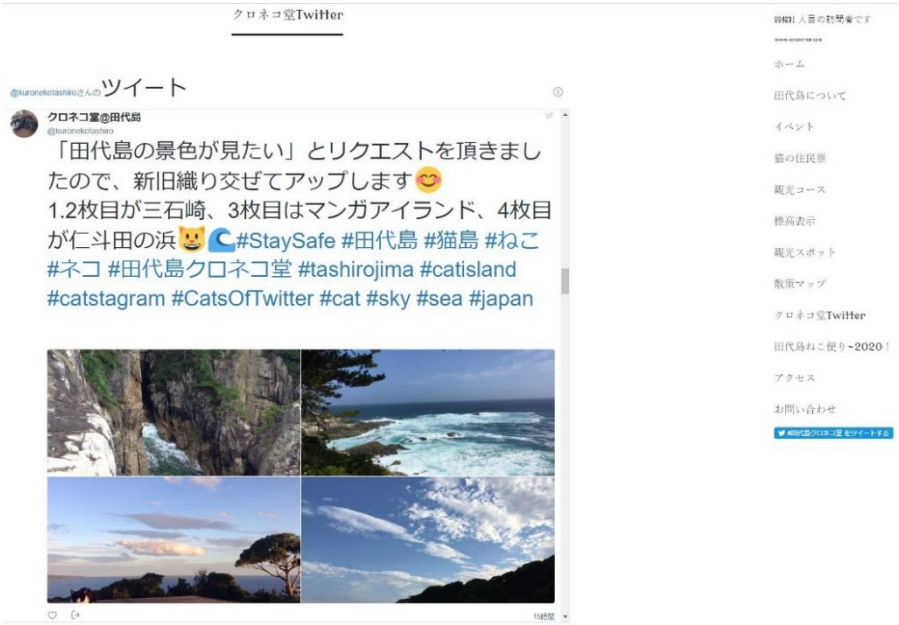

Fig. 5. Pages for the viewing function of the information submitted by Twitter

4.1.6. Viewing Function of the Moving Images Submitted by the Watch Over System

Selecting “Moving images” in the menu bar on the homepage, users can go to the page for the viewing function of the moving images submitted by the watch over system. Due to the function, users can usually watch over islanders. Additionally, when natural disasters occur in remote islands, rescue teams can quickly relieve islanders, and support for the recovery and reconstruction of their islands.

4.2 System Backend

4.2.1 Overview of System Backend

The following processes are implemented in the backend of the system, and have close connections with the functions for users in the frontend. Specifically, the first process is related to the display function of sightseeing course, the display function of the elevation difference of sightseeing course, and the viewing function of sightseeing spot information. The second process is related to the viewing function of the information submitted by Twitter.

4.2.2 Process to Display Information on the Digital Map of Web-GIS

Markers and lines respectively showing sightseeing spots and courses are included into the layers that connects to specific location information. Therefore, based on the location information, the layers are overlaid on the base map using GIS. Using GPS of

users' mobile information terminals, the web portal automatically can obtain their present locations to display it on the digital map of Web-GIS. Additionally, using the line information accumulated in layer, the web portal can grasp the elevation difference of the sightseeing course, and display it in the graph.

4.2.3 Process to Obtain the Information Submitted by Twitter

Using the widget to display timeline, the web portal can automatically obtain all of the information submitted from the specific Twitter account of an islander who manages the Kuroneko-do introduced in section 4.1.5.

4.3 System Interface

The interfaces are optimized according to the user's PC screens and mobile information terminal screens. The interface for PC screens has the layout with a menu bar allowing easy access to each function. As the menu bar is displayed on the right side of top page, the users who are new to the web portal can easily use it. Though the interface for mobile information terminal screens is basically the same as that of PC screens, by changing the layout and size of items according to the size of the screen, the operability of the web portal is made easy.

5 Operation

5.1 Operation Target Area

Among the remote islands in Japan, Tashirojima Island is selected as the target for the present study. It is a remote island in Ishinomaki City, Miyagi Prefecture in the northeastern part of Japan. The island is small, and the perimeter is approximately 11 kilometers. Approximately 80 islanders live in the island, and most of them are elder fishermen.

The Great East Japan Earthquake caused serious damages to the main ports of Tashirojima Island. However, though most of the islanders were elder people, they cooperated with each other to succeeded in the recovery and reconstruction of the island just by their own efforts. Other natural disasters such as heavy rain and strong wind frequently attack the island, these sometimes causes the interruption of electric service and the suspension of ferry service. Therefore, it is expected that the web portal will work as a disaster information system in addition to sightseeing information system. Because the web portal can watch over islanders from the outside of Tashirojima Island all the time, and users can notice that natural disasters suddenly occur.

At present, Tashirojima Island is well-known to all over the world as a "cat island". The islanders usually take care of cats as a god of promising success in fishing. They established a shrine for cats called "Cat Shrine" in the center of the island, and the number of cats are more than that of the islanders. The islanders and cats live together in harmony. Many people who love cats visit the island from all over the world, and

they frequently transmit the specific information concerning the island using social media. Additionally, most of them become the followers of an islander who manages the Kuroneko-do introduced in section 4.1.5 on Twitter, and exchange the information with her after leaving the island.

However, there are very few guidebooks that introduce Tashirojima Island in detail. Additionally, in the island, as most of the tourists take a day trip, and they have to efficiently visit sightseeing spots including cat areas. Therefore, it is also expected that the web portal designed and developed in the present study can appropriately support the tourists who do not have a good sense of locality in the island.

5.2 Overview of Operation

The web portal has been operated since February 22 in 2019. Whether inside or outside the operation target area, the operation of the web portal was advertised using the website, Twitter and Facebook of the authors' lab as well as Twitter of the Kuroneko-do. The web portal has been continuously accessed until now, and users access to the web portal using various types of information terminals. 94.6 % were from Japan, and 5.4% were from other countries such as the United State, Germany, China and Thailand. From these, it is evident that the web portal is well-known to not only Japanese but also foreigners. The web portal has approximately 4,600 users at the beginning of January in 2021.

6 Conclusion

The present study designed, developed and operated a web portal to support Tashirojima Island that is a remote island for sightseeing and disaster management. The web portal is developed adopting Web-GIS, and connecting with external SNS and the watch over system developed and operated by Murayama et al. [2, 3].

The web portal enables to visualize the information concerning sightseeing course, elevation difference of sightseeing course, and sightseeing spots on the digital maps of Web-GIS. Therefore, it is possible for users to efficiently obtain the necessary information concerning sightseeing. Using Twitter, it is also possible for users to share a variety of information transmitted from an islander who is a main character in real time. Additionally, using the watch over system, users can usually watch over islanders from the outside of Tashirojima Island. When natural disasters suddenly occur, users can immediately notice the tense critical situation, and rescue teams can quickly relieve islanders and support for the recovery and reconstruction of Tashirojima Island.

The web portal has been continuously accessed from the inside and outside of Japan until now, and users access to the web portal using various types of information terminals. Therefore, the further use of each function can be expected by the continuous operation of the web portal. However, it is necessary to conduct a web questionnaire survey to users in order to evaluate the web portal. Based on the evaluation result, it is also necessary to improve the web portal to raise the usability.

The future research is to expand and improve all of the functions, and to apply the web portal in other remote islands. Furthermore, referring to Saito et al. (2012) [25], Sato et al. (2017) [26] and Murayama et al. (2019) [2, 3], it is hopeful to particularly improve the viewing function of the moving images submitted by the watch over system. Because the function will support remote islands for disaster management, and it will be useful from the normal times to disaster outbreak times. Using the function, users can easily know the situation of Tashirojima Island whenever they like. Additionally, it is also expected that the function will play a role to watch over the elder islanders from the outside of the island during normal times.

At present, the coronavirus disease 2019 (COVIT-19) epidemic is expanding fast all over the world. Therefore, it is tremendously difficult for tourists to visit remote islands where most islander are elder people, and medical facility is not sufficiently arranged. Under these circumstances, it is possible that the viewing function of the moving images submitted by the watch over system will be effective to inform users of the changing situations of remote islands in real time.

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