Intercultural Collaboration Support System Using Disaster Safety Map and Machine Translation

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Abstract. Natural Disaster Youth Summit (NDYS) is an intercultural collaboration project promoted by a NPO called JEARN (Japan Education And Resource Network). They are working on collaborative learning about disaster prevention by exchanging disaster safety maps created by students over the world and by discussing over BBS's and video conference systems on the Internet. Language barrier is the most difficult issue in this activity, and in order to communicate freely in their own native language, linguistic support, such as using machine translation systems, is necessary. We develop CoSMOS, an intercultural collaboration support system using disaster safety map and machine translation, and discuss collaboration supports using CoSMOS from four viewpoints; handling high-definition digital images, linking disaster safety maps to the world map, supporting collaborative learning, and supporting multiple languages.

Keywords: Intercultural collaboration, Machine translation.

1 Introduction

Collaboration is an interactive process where two or more people work together to achieve a common goal. The development and proliferation of the Internet technology enable us to communicate with people in distant places and have potential to facilitate intercultural collaboration where people in different culture and language collaborate with each other [1].

Natural Disaster Youth Summit (NDYS)[1] is an intercultural collaboration project run by JEARN(Japan Education And Resource Network). JEARN is the Japanese branch of iEARN which is the largest non-profit global education network in the world. The NDYS project tries to establish an education network where students and their teachers over the world can collaborate with each other to learn disaster prevention by creating and exchanging disaster safety maps on which dangerous places and shelters around school are located [2].

The project so far utilizes conventional BBS's (Bulletin Board Systems) and video conference systems to support the collaboration work over the Internet. These tools can facilitate communication among them in distant places, but the difference of language is a most formidable obstacle to hinder intimate collaboration among them in different

[1] http://ndys.jearn.jp/ja/index.html

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culture. At present, English is used as the common language for communication, however, all the participants, who are middle or high school students, are not good enough to speak fluently in English and their teachers have to assist them a lot. In order to assist the students and their teachers to communicate in their native language, multi-linguistic supports using machine translation are expected [3].

We are developing a new intercultural collaboration support system called CoSMOS (Collaborative Safety Maps on Open System), which supports collaborative work among students over the world on disaster safety maps utilizing the Internet and machine translation technologies.

In this paper, we show design goals of CoSMOS to support intercultural collaboration on disaster safety maps in Section 2. We discuss the implementation issues of CoSMOS in Section 3 and intercultural collaboration using CoSMOS in Section 4. We especially discuss and compare two ways of multilingual translation, which is a key technology to support intercultural collaboration, in Section 5. We describe related works and compare CoSMOS with them in Section 6. Finally, we summarize this paper with our future work in Section 7.

2 Design Goals of CoSMOS

We need to achieve design goals as follows to support intercultural collaboration in the NDYS project.

1. Handling high definition digital images
2. Linking disaster safety maps to the world map
3. Supporting collaborative learning
4. Supporting multiple languages

2.1 Handling High Definition Digital Images

The main purpose of creating disaster safety maps is to make students locate dangerous places, safe places, and shelters around school and to let them learn how to prevent disasters from happening. Currently, disaster safety maps are created as posters by students, so transforming the maps into digital images is required to upload them onto the Web system available on the Internet. The map is not just a picture to see but it contains various disaster information. The messages and symbols depicted on the map to show the disaster information should be clearly readable on Web browsers, so it is required to transform the maps into high definition digital images to be readable in detail. The system should assist the students to handle the images easily.

2.2 Linking Disaster Safety Maps to the World Map

One of the goals of the NDYS project is to create a “global” disaster safety map by students over the world collaborating with each other. We need to create it by linking individual disaster safety maps to a world map. The students can learn the geographical relation among the maps from the global map, and understand the cultural background of each disaster safety map.

2.3 Supporting Collaborative Learning

Photo sharing Web site such as Flickr may be satisfactory only to share disaster safety maps over the Internet. However, in order to support collaborative learning about disaster prevention, we need to provide a way for the students to discuss with each other over disaster safety maps. Consequently, we need to incorporate a function to post comments on the disaster safety maps. Some students post comments to a map and the others reply to them so that they can learn collaboratively.

2.4 Supporting Multiple Languages

The students from various countries, such as Japan, Taiwan, Canada, Turkey, and so on are participating in the NDYS project, and various languages are used in each school. If the students can communicate with others in their native language, it is comfortable for them to work together with others. To make it possible, the system should support multiple languages by using machine translation. It is requested that comments submitted by the students should be translated automatically into other languages.

3 Intercultural Collaboration Support System CoSMOS

We are developing an intercultural collaboration support system CoSMOS as a Web system in which the students in different countries collaborate with each other using a Web browser. CoSMOS is developed based on WordPress[2], which is an open source blog software that is written in PHP and uses MySQL database. Four design goals, which are mentioned in the previous section, are achieved by implementing four functions: handling disaster safety maps, linking disaster safety maps to the world map, posting comments on disaster safety maps, and translating comments into multiple languages.

3.1 Handling Disaster Safety Maps

Students in each school create a disaster safety map in their own poster format style, so the map is taken as a picture by a digital camera, and is uploaded onto CoSMOS. To consider the intent of the students who create the disaster safety map, not only the drawing and/or painting but also the messages in the map should be clearly readable. To this end, the picture is taken as a high definition digital image over 10M pixels. However, we have to deal with two problems in order to display the image.

1. Loading time:
   As the number of pixels increases, the file size of the image becomes large. It takes a long time to load the entire image on a browser.
2. Operability of image browsing:
   When the size of image is over 10M pixels, the image usually overflows the window size of Web browser. It is not easy for the students, who are novice users of computer, to handle a large image.

[2] http://ja.wordpress.org/

To cope with the first problem, we refer to how Google Maps[3] loads the map image onto a browser. In Google Maps, the entire map is divided into multiple images with different resolutions, each of which corresponds to a zoom level and a range, and are aligned as a grid in the database. When we view a map of a specific range and resolution on a Web browser, only the corresponding image depending on the resolution and the range is selectively loaded from the database. The loading time is much less than that of loading the entire image. Google Maps Image Cutter [7] is a software that divides an image into multiple ones complying with the Google Maps format and generates HTML codes to display the images through the Google Maps interface. We use it to display disaster safety maps on CoSMOS.

To cope with the second problem, we use the zooming and dragging functions which are compatible with those of Google Maps because disaster safety maps are displayed using the Google Maps interface. Students can easily zoom out/in to view the entire/detail part of a disaster safety map by using a mouse.

3.2 Linking Disaster Safety Maps to the World Map

One of the goals of the NDYS project is to create a "global" disaster safety map by students over the world collaborating with each other. We create such a global map by linking disaster safety maps to a world map. Each disaster safety map is uploaded on Cosmos as an individual page, and a link to the the world map is attached using the Google Maps API[4]. The reason why we choose the Google Maps API is because Google Maps covers the entire world, and it can be customized by utilizing its functions.

In order to embed the Google Maps in CoSMOS, we use the marker function to create a link from a disaster safety map to the world map. The metadata of the disaster safety map is stored in the Disaster Safety Map database, which is implemented by using MySQL, in the following format.

[ID], [Latitude], [Longitude], [Page ID]

"Latitude" and "Longitude" represent the coordinate of the disaster safety map on the world map. "Page ID" is the URL of the page on which the disaster safety map is uploaded.

3.3 Posting Comments on Disaster Safety Maps

CoSMOS has a function to paste a note on a disaster safety map to support collaborative learning over the maps.

Since a student can paste a note anywhere on the map, he/she can pinpoint a specific part of the map in which he/she has a comment or a question. The other student who created the map can reply to the pasted notes, so they can communicate with each other in a Q&A style.

We utilize the marker function of Google Maps to indicate the position of note on a disaster safety map by specifying the coordinate of the note on the map. Note data are stored in the Note database implemented by MySQL in the format below.

[3] http://www.google.co.jp/maps

[4] http://code.google.com/intl/en/apis/maps/

[Note ID], [Map name], [X-coordinate], [Y-coordinate], [Date posted], [Content], [Parent note ID], [Input language], [User ID]

X and Y coordinates are the latitude and the longitude on Google Maps to paste the note. A note and the replies create a thread and "Parent note ID" specifies the parent note of the note in the thread.

3.4 Translating Comments into Multiple Languages

CoSMOS supports five languages: Japanese, English, Turkish, French, and Chinese (Traditional), so students, who speak one of the languages, can use their language to collaborate with others.

A messages submitted to CoSMOS as a note is automatically translated into four languages by using machine translation services provided by the Language Grid [9], which is a platform where we can integrate a number of language services and resources to produce various multi-lingual applications on the Internet. When an original messages is written in a language but English, the message is translated into English first, and then translated into other languages. This means that English is used as an intermediate language in CoSMOS. Fig. 1 shows the translation flow and the actual translation services used in CoSMOS.

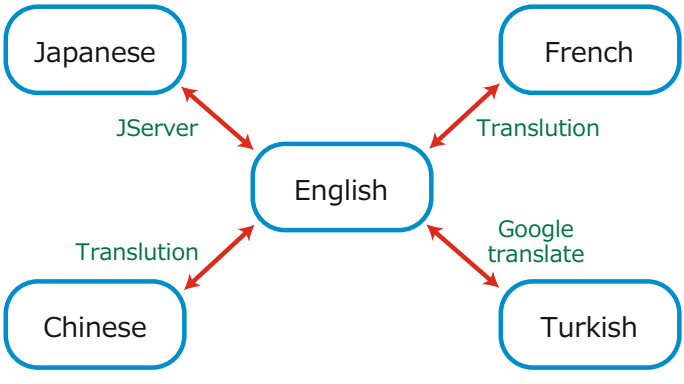


Fig. 1. Translation flow and the name of translation services

For example, when a Japanese message is translated into Chinese, the message is translated into English by using JServer and is translated again from English into Chinese by using Translution.

In addition, the Language Grid provides a Japanese-English glossary on natural disasters and dictionaries of academic terms, and an English-French glossary on natural disasters. When a translation service between these languages are activated, the system automatically consult the glossaries and dictionaries to improve the quality of translation.

A messages input from a student is translated into multiple languages, so multiple messages in different languages need to be stored. To this end, we utilize a qTranslate function[5], which is a plug-in of WordPress. We can handle multi-lingual messages by composing a message in the following format.

<!−−: Language code of language 1 −−>a message in language 1
<!−−:−−><!−−: Language code of language 2 −−>a message in language 2
<!−−:−−>c<!−−: Language code of language n −−>a message in language n
<!−−:−−>

For example, a message for greeting is stored as follows.

<!−−: en −−>Hello. <!−−:−−><!−−: ja −−>B <!−−:−−><!−−: fr −−>Bon jour. <!−−:−−>

When a message is displayed in CoSMOS, the specific message is extract from the multi-lingual one depending on the user language. If the code of the user language is French (fr), “Bon jour.” is extracted and shown on the page by using the qTranslate function.

As shown in Fig. 2, a note is actually displayed depending on the user language in CoSMOS.

Fig. 2. Note shown in multiple languages

Machine translation services often produce incorrect translations. To cope with this problem, the system displays back-translation [10], so the student can check the quality of translation, and fix his/her input message if necessary. Back-translation is to reversely translate the translated result in the target language into one in the input language. If the input text and its back-translation are similar in meaning, the translation is estimated to

[5] http://www.qianqin.de/qtranslate/

be correct. On the other hand, if the back-translation does not make sense, the translation is estimated to be incorrect. The student fixes his/her input until the input text and its back-translation look similar.

4 Intercultural Collaboration Support Using CoSMOS

CoSMOS[6] has been available on the Internet. Currently, 15 disaster safety maps from 12 countries are uploaded on CoSMOS. Anyone can view disaster safety maps, but only registered users can post notes to prevent from spams.

CoSMOS can display the contents in one of five languages; Japanese, English, Turkish, French, and Chinese (Traditional) and there are buttons to switch the user language on the top bar of CoSMOS.

Fig. 3. Top page of CoSMOS

4.1 Viewing Disaster Safety Maps

The top page of CoSMOS is the world map shown in Fig. 3. Individual disaster safety maps created by students over the world are linked from the world map.

A red marker indicates the location of a disaster safety map. When we move a mouse cursor over a marker, a balloon to describe a summary of the corresponding disaster

[6] http://www.kitamura-lab.jp/cosmos/

Fig. 4. Viewing an entire disaster safety map

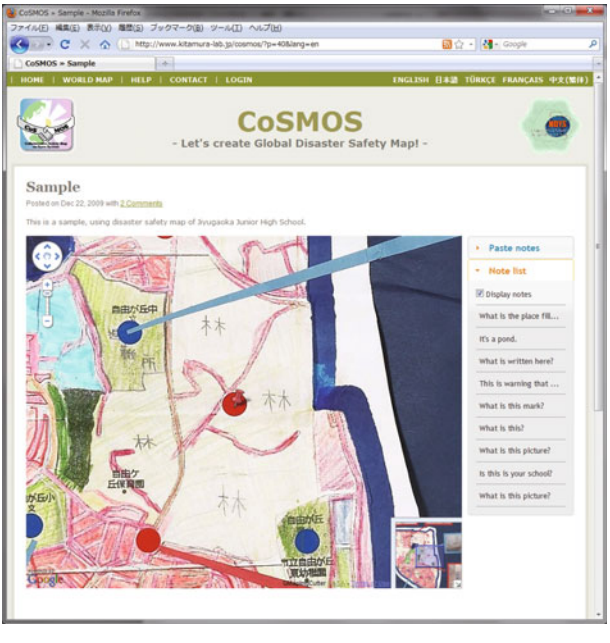


Fig. 5. Zooming in a disaster safety map

safety map appears with a link to the map. If we click the link, the corresponding map, which is embedded in the Google Map interface, appears as in Fig. 4.

We can use the Google Maps Controls to move around and zoom in/out the map. If we zoom in the map as shown in Fig. 5, we can read the detail of the map. A red pin represents the location of a note pasted on the map. If we put the mouse cursor over the red pin, the corresponding note pops up and we can read the comments posted to the map as shown in Fig. 2.

4.2 Pasting Notes to Disaster Safety Maps

As a style of collaborative learning, some students can paste a note on a disaster safety map and others can reply to the pasted note. Because a lot of information are contained in a disaster safety map, it is easy to understand what the message or question means by pasting a note at a specific point on the map. In addition, the note is translated into multiple languages.

In order to paste a note, we first press the “Paste notes” button on the left bar and point the location to paste a note. We then write a message in the dialog shown in Fig. 6 following the process below.

First, we select a language to write from a list of “Input language.” Second, we input a message in the “Message” text box, and press the “Translate” button. If the

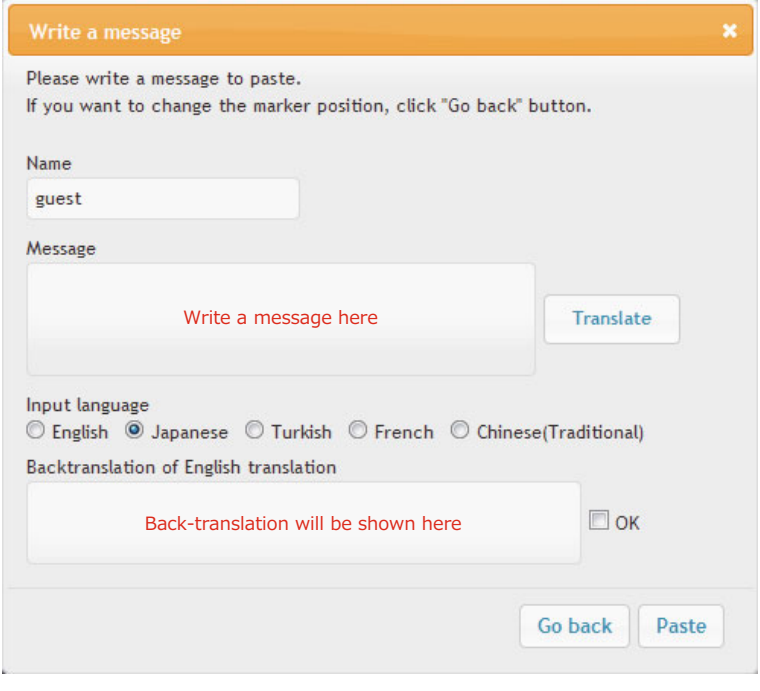


Fig. 6. Message input dialog

input language is not English, the back-translation of the input message is shown in the "Back-translation of English translation" text box. Comparing the original message and the back-translation, if they are similar in meaning, we check the "OK" check-box to confirm the translation.

However, if the back-translation does not make sense, we fix the original message and retranslate it until the back-translation makes sense. Finally, after confirming the back-translation, we press the "Paste" button. The message is translated into three languages except English and the input language, and the set of messages in five languages is pasted on the disaster safety map as a note, as mentioned in the previous section.

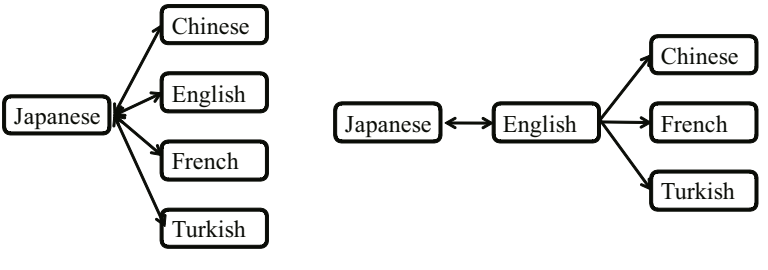
When we write a message in English, we just press the "Paste" button. The message is translated into four languages except English and is pasted on the map. In this case, there is no way to confirm the translation quality. Discussion on how to translate a message into multiple languages is given in the next section.

5 Multilingual Translation

When we initially designed the translation process of CoSMOS, we displayed the back-translation for four languages except the input language, so the user has to check the quality of translation in each language referring to the back-translation, as shown in Fig. 7(a). However, this method takes a long time to translate the input message and retrieve its back-translations. It needs 8 translations (one regular translation and one back-translation for each of 4 languages). In addition, if some back-translations are incorrect, the user has to repeat to fix and retranslate the message until the back-translations make sense. These process increases the burden of the user to post messages.

As a remedy to cope with this problem, we use only English to confirm the translation quality, as shown in Fig. 7(b). When the input message is not English, the system translates it into English once and back-translate the English translation to confirm the translation quality. If we confirm the quality, the English translation is further translated into the other languages with no confirmation.

This method takes a shorter time to translate a message than the initial method. It needs only 5 translations (four regular translations and one back-translation). To



(a) Direct translation (b) English-mediated translation

Fig. 7. Two methods of multilingual translation (from Japanese)

Table 1. Average processing time of translation (in sec.)

	All languages	English only
Sentence A (30 letters)	7.56	1.16
Sentence B (19 letters)	7.11	1.19
Sentence C (12 letters)	9.71	1.13
Sentence D (25 letters)	9.81	1.42
Sentence E (44 letters)	8.12	1.24
Overall average	8.46	1.23

evaluate an actual performance, we translated 5 Japanese sentences for 10 times, and measured the average processing time of each translation in both methods. Table 1 shows the result.

The processing time of the English-mediated translation is 1.23 seconds in average and that of the direct translation is 8.46 seconds in average. If the number of languages to be translated increases, the processing time increases significantly.

6 Related Works

We discuss the advantages of CoSMOS by comparing with conventional systems, as shown below, to support intercultural collaboration.

- TransBBS
  TransBBS[6] is a multilingual bulletin board system. The system is the most basic type of intercultural collaboration support system and supports text based collaborations. By using machine translation services, submitted messages are automatically translated into other languages on the BBS.
- AnnoChat
  AnnoChat[5] is a multilingual chat system. The system has an annotation function, in which an image or text message can be attached to a term as a note, to assist the users in different cultural background to understand the meaning of the term.
- Flickr
  Flickr[7] is a representative photo-sharing community system. The users can easily share photos on the Web system by uploading them. They can collaborate with each other by submitting comments to photos.
- Google Maps
  Google Maps[8] is a most widely used GIS (Geographical Information System) in the world. The system stores, manages, and presents various types of geographical

[7] http://www.flickr.com/
[8] http://maps.google.com/

and map data all over the world. The users can append messages on the map by using the My Maps function.

Table 2 shows how each system achieves four goals that are required to support the NDYS project, mentioned in Section 2. Only CoSMOS can achieve all the goals.

Table 2. Average processing time of translation (in sec.)

	High-definition image	Link to the world map	Collaborative learning	Multiple language support
TransBBS	No	No	Partly	Yes
AnnoChat	Partly	No	Partly	Yes
Flickr	Yes	No	Partly	No
Google Map	Yes	Yes	No	No
CoSMOS	Yes	Yes	Yes	Yes

6.1 Handling High Definition Digital Images

TransBBS cannot handle images at all. AnnoChat can attach an image, but it is difficult to attach a high-definition one to display a disaster safety map. An image in AnnoChat is just an annotation to explain the meaning of term. Flickr,Google Maps and CoSMOS can handle high definition images.

6.2 Linking Disaster Safety Maps to the World Map

There is no way to link disaster safety maps to the world map in TransBBS, AnnoChat and Flickr. Google Maps and CoSMOS can provide a world map to locate disaster safety maps.

6.3 Supporting Collaborative Learning

TransBBS and Flickr provide a BBS to support collaboration over a disaster safety map, but the function is limited because the users can submit a message to an entire map but not to a specific part of the map by pasting a note. In AnnoChat, an image is used as an annotation to a term and it is difficult for the users to collaborate with each other over a disaster safety map. Google Maps has no way to collaborate over the map. CoSMOS has a function to paste a note on a specific part of a disaster safety map.

6.4 Supporting Multiple Languages

TransBBS, AnnoChat, and CoSMOS utilize machine translation services, so messages are translated into multiple languages. Flickr and Google Maps support no machine translation, so the users have to collaborate with each other by using a specific language such as English.

7 Summary

We are developing a new intercultural collaboration support system CoSMOS, which uses disaster safety maps and machine translation to support the Natural Disaster Youth Summit project. High-definition image of disaster safety maps created by students are posted on CoSMOS, and students can view the map in detail on a Web browser. We create a global disaster safety map by linked individual maps to a world map. As a support for collaborative learning over disaster safety maps, we implemented a function to paste notes on the map. Students can post notes to the maps and reply to the notes. In addition, CoSMOS supports five languages by using machine translation services provided by the Language Grid and this makes the students collaborate with each other by using their native language.

We introduced CoSMOS at "NDYS Forum 2010," which was held in Kobe, Japan on January 24, 2010, and it has been available on the Internet. After gathering the log data, we are going to evaluate the system from the viewpoint of collaboration support and what kind of intercultural collaboration can be done over CoSMOS.

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