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Machine Translation in a Multilingual Electronic Meeting

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ABSTRACT

Electronic meetings can be more efficient and effective than traditional, oral discussions, but until only recently, groups with no common language could not benefit from machine translation. Although it is possible for linguists or other staff members using machines to translate comments during a multilingual discussion, the research presented here shows that this is not feasible for large groups speaking many languages. As a solution, we propose a fully automated multilingual meeting system, and an example of its use in a meeting with Chinese, Korean, and English comments shows its potential to reduce multinational communication barriers.

INTRODUCTION

As global trade and travel continually increase, there is a growing need to support communication among people from different countries. However, human interpreters are difficult to schedule and expensive, and as a result, only a small percentage of spoken encounters are interpreted (Fügen, Waibel, & Kolss, 2007).

In a multilingual setting, group members can try to use a common language (e.g., English) or use interpreters to speak the equivalent comment in other participants' languages. Alternatively, group members can participate in an electronic meeting (e.g., an electronic chat room) that provides participants with a means of sharing comments anonymously and simultaneously (Hung, Tang, & Shu, 2008). These electronic meetings have been shown to be superior to traditional, oral discussions in many cases (Chen, Ramano, & Nunamaker, 2006; Dennis & Valacich, 1993), and there is a demand for multilingual support in these settings (Lim & Yang, 2008). Using such a system, group members can type comments in their own native language and use an interpreter or machine translation (MT) to understand others' comments, type comments and have staff members provide the translations, or type comments and have completely automated translation, as this paper proposes. After a case study showing the problems encountered with staff supported translations, this paper describes a new, locally developed multilingual electronic meeting system that provides automatic translation among 41 languages. Early results show that for many languages, the system will provide highly comprehensible translations.

INTERPRETATION AND TRANSLATION IN MULTILINGUAL MEETINGS

The vast majority of multilingual meetings are interpreted, that is, a human hears spoken words in one language and speaks them again in one or more other languages (Nolan, 2005).

Interpretations can be whispered to a few participants if the majority of a group shares a language and a small number do not speak it. Alternatively, sound-proof booths can be set up that allow linguists to listen to a speaker and interpret into a microphone for the target audience.

Electronic meetings are often more productive than traditional, oral meetings when eight or more people need to share ideas anonymously (Gallupe, Dennis, Cooper, Valacich, Bastianutti, & Nunamaker, 1992; Fjermestad, 2004; Kępuska, Gurbuz, Rodriguez, Fiore, Carstens, Converse, & Metcalf, 2008), and in a multilingual setting, machines can assist with online, interactive translation (O'Hagan & Ashworth, 2002). Some researchers believe that MT can already deliver satisfactory accuracy in an electronic meeting, and even if not perfect, human real-time performance has probably reached its peak, leaving room for MT to catch up with or even surpass that of linguists (Fügen et al., 2007; Strong, Ghosh, & Conlon, 2008). Even if not correct, perhaps most of the key words in a foreign comment can be translated accurately enough for a basic understanding of its meaning (Sprung, 2000), and a group member can use the gist of the text to determine if an idea should be ignored or pursued further (Somers, 2003). Finally, translation in an electronic meeting might be more accurate than interpretation in an oral discussion because in the latter, group members might speak too softly, slur words, or otherwise be difficult to understand.

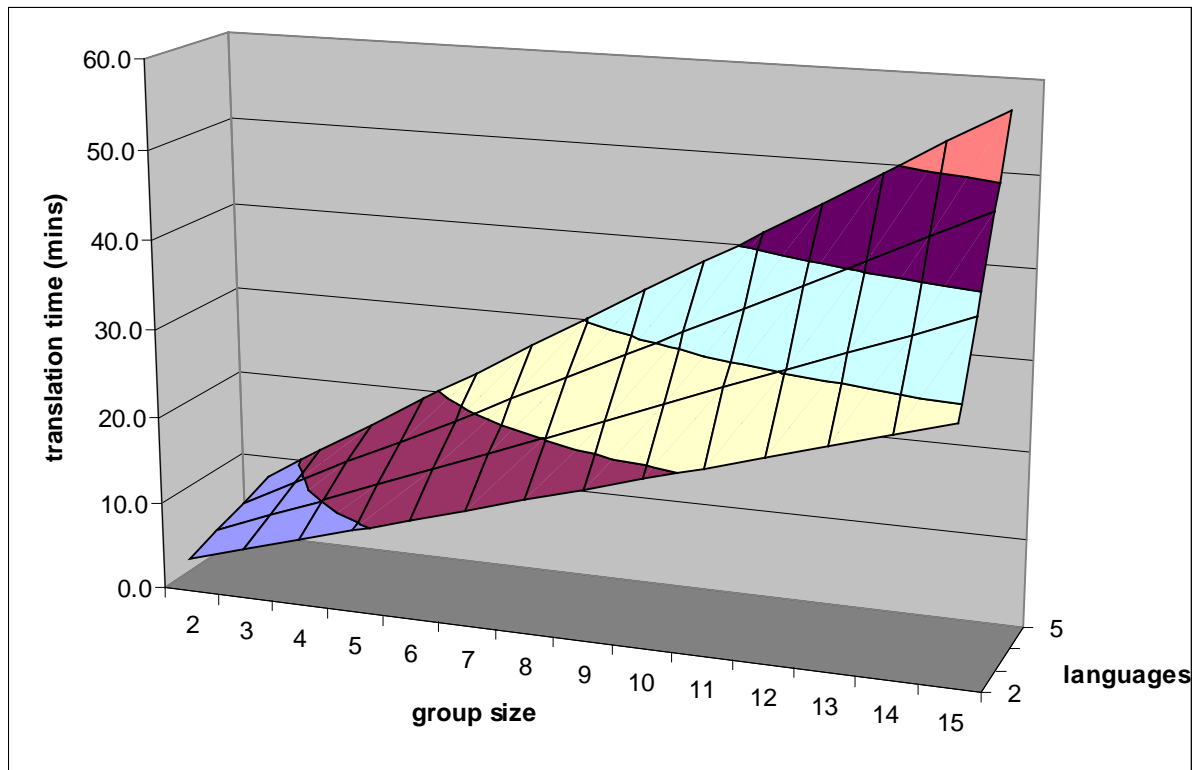
One way of providing interactive translation in an electronic meeting is with a linguist reading online comments while dictating to a typist. However, once there are more than five or six participants with two or three languages, the human translator will likely be overwhelmed, even with the assistance of MT (O'Hagan & Ashworth, 2002). This maximum group size that one translator can support is likely to be even smaller when languages such as Japanese and Chinese are used because of the delay experienced entering the characters through a standard QWERTY keyboard.

An analysis of seven electronic meeting studies showed that on average, group members might be expected to contribute 0.38 comments in English per person per minute (Aiken & Vanjani, 2002), and another study (Ablanedo, Aiken, & Vanjani, 2007) showed that a person using a Web-based MT service can translate a 100-word comment in 1.89 seconds, up to 195 times faster than a human translator without computer assistance. Allowing twice this time to copy and paste the result to the online discussion as the absolute minimum necessary, in a 10-minute meeting, a staff member would take longer translating comments than the entire meeting's duration when the group reached a size of 8 with 2 languages or a size of 6 with 3 languages, as shown in Table 1 and Figure 1. Even in a meeting with two languages, half the time would be needed for translation, leading to serious delays in posting comments in the target language.

**Table 1: Minimum Time Needed for Staff Member to Translate Comments
(using MT, in minutes, 10-minute meeting).**

size	Number of languages				
	2	3	4	5	6
2	2.5	3.8	5.0	6.3	7.6
3	3.8	5.7	7.6	9.5	11.3
4	5.0	7.6	10.1	12.6	15.1
5	6.3	9.5	12.6	15.8	18.9
6	7.6	11.3	15.1	18.9	22.7
7	8.8	13.2	17.6	22.1	26.5
8	10.1	15.1	20.2	25.2	30.2
9	11.3	17.0	22.7	28.4	34.0
10	12.6	18.9	25.2	31.5	37.8
11	13.9	20.8	27.7	34.7	41.6
12	15.1	22.7	30.2	37.8	45.4
13	16.4	24.6	32.8	41.0	49.1
14	17.6	26.5	35.3	44.1	52.9
15	18.9	28.4	37.8	47.3	56.7

Additional linguists can be added in an oral meeting where only one comment at a time is spoken (Boisard et al., 1998), but in an electronic meeting, it becomes extremely difficult to coordinate translations when several new messages are arriving at the same time. Meeting translations must maintain the discussion thread in the same order as in the source, and they must be delivered within seconds to preserve the coherence of the original comments (Flanagan, 1997).

Figure 1: Time Needed for Comment Translation in a 10-minute Meeting.

A FACILITATED MULTILINGUAL MEETING EXPERIMENT

We are not aware of any experiments that have used large multilingual electronic meetings with MT to test the facilitator's burden. Therefore, a study was designed to see how well a staff member could provide translations for groups using multiple languages.

Subjects

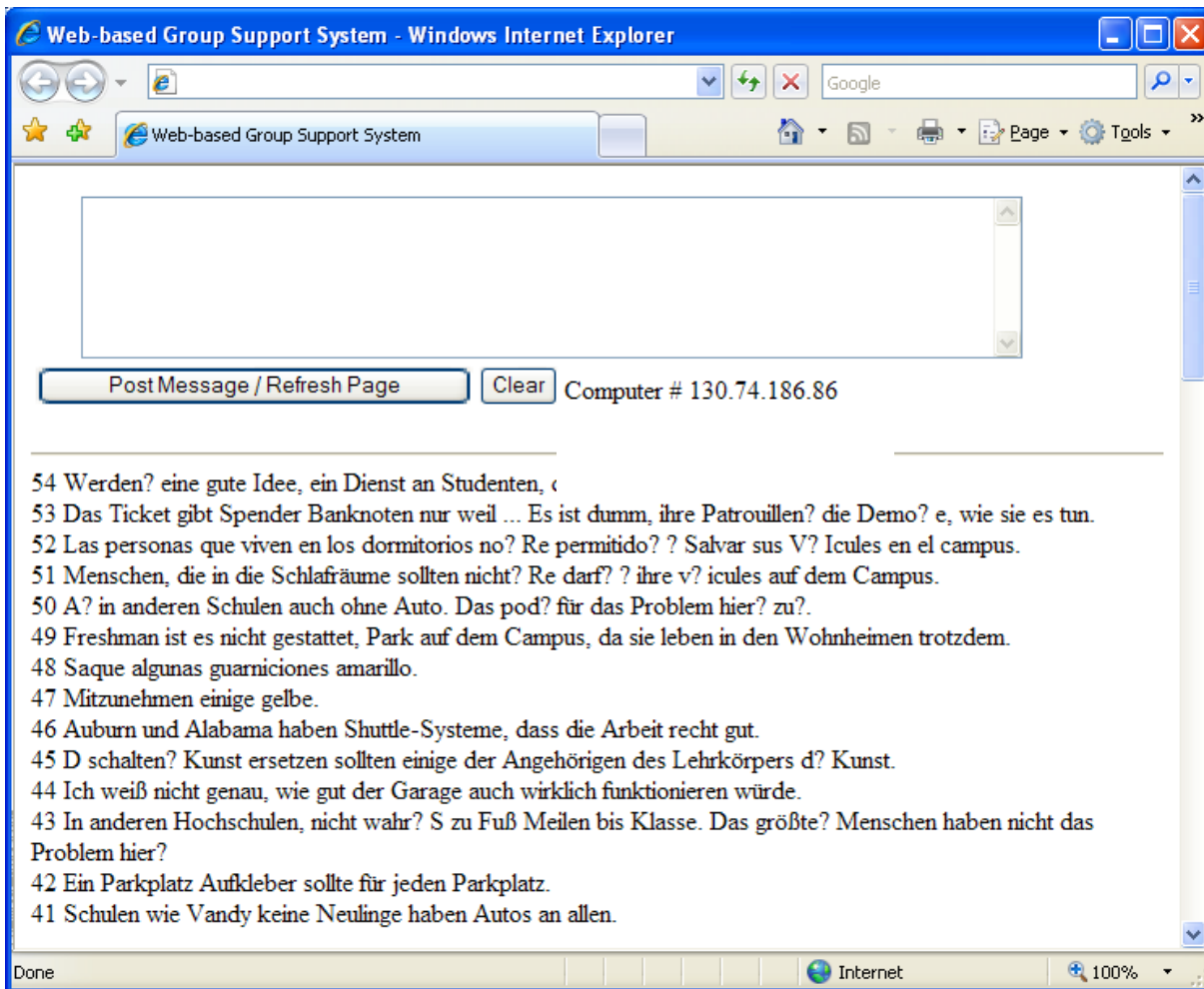
We asked 40 undergraduate students in a required introductory Information Systems class at a university in the southern United States to participate in the study. Students were randomly assigned into one of three sub-groups, French (N=13), German (N=14), and Spanish (N=13), forming one large, trilingual group.

Task and Procedures

We obtained English comments from historical electronic meeting transcripts focusing on the parking problem on campus and translated each to French, German, or Spanish using *Google Translate* (a popular Web-based translation service found at <http://translate.google.com/>). Each participant was given a Microsoft Word document with three comments that were written in the foreign language corresponding to his or her group. Each of the 120 comments was unique, and students were asked to insert the provided foreign comments into an online discussion using a locally developed group support system (GSS). They were told to simulate a real meeting by

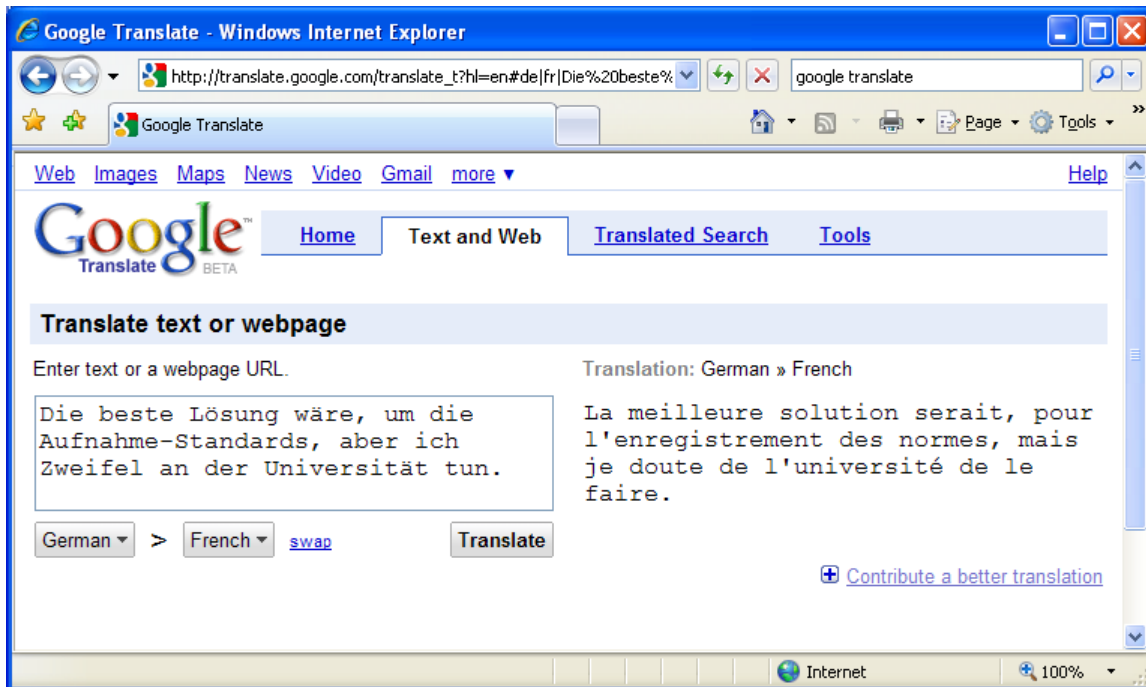
inserting the given comments at random intervals throughout the 10-minute meeting rather than posting them all at once. See Figure 2 for an example of a German user's screen.

Figure 2: German User's Screen Shot.



During the meeting, an experienced group support system facilitator attempted to interactively translate comments from one language into the other two using *Google Translate* (see Figure 3).

Figure 3: Using *Google Translate* for Converting German to French.



Experimental Results

The facilitator attempted to monitor the discussion closely to determine when a new comment was posted. When she saw a new comment, for example, text written in French, she had to translate the text to German, post that translation into the German discussion, translate the text to Spanish, and post that comment to the Spanish discussion. For greater efficiency, she opened 6 instances of the *Google Translate* page (a 3 x 2 combination) in one Web browser and 3 instances of the group support system in another browser. However, it was still a little difficult for her to find the appropriate language translation interface or the correct GSS language discussion group under the pressure of the meeting.

Within one minute after the discussion began, the participants posted more than 20 comments in each language group (21 French, 24 German, and 21 Spanish). Thus, very soon after the meeting began, the facilitator had more than 60 comments to translate into two different foreign languages.

After the first rotation of translating, it was difficult for the facilitator to identify which comments were translated and posted to the other groups, and which were not. The facilitator also had a problem remembering which comment she had herself posted. Because she was so overwhelmed, she managed to completely translate and post only 6 (2 comments from each language group), leaving more than 100 comments untouched (36 French, 39 German, and 38 Spanish). Because of this burden, a few mistakes were made. For example, a translation into Spanish was posted in the German interface (see comment 52 in Figure 2).

On average, it took about 30 seconds for the facilitator to translate from one language to another and to post the resulting text to the appropriate discussion. For the first comment, however, it took almost 70 seconds for the Spanish group members to receive a translated message from the French group (see Table 2). The last Spanish comment was translated and posted to the German group over 8 minutes after it had been originally posted.

Table 2: Comments Translated from Participants Based on Time.

Participants				Facilitator (translation and distribution)			
Gp	ID #	Language	Comment	Entered Time			
1	14	French	Faire du corps professoral et des étudiants départs arrivées de ratio comparable à la population appropriée.	9:44:28	to German 9:45:06	to Spanish 9:45:38	to English 9:46:01
2	2	German	Zerstörung unserer schrecklichen Union an und schalten Sie ihn in eine riesige, multi-level Parkhaus.	9:44:30	to French 9:46:37	to Spanish 9:47:02	to English 9:47:24
3	13	Spanish	En otras universidades, los niños tienen que caminar millas para la clase. La mayoría de las personas no tienen ese problema aquí.	9:44:33	to French 9:47:54	to German 9:48:26	to English 9:48:49
1	3	French	Commuter départs devraient remplacer certains des plus proches du corps professoral départs.	9:44:30	to German 9:49:18	to Spanish 9:49:56	to English 9:50:34
2	11	German	Die beste Lösung wäre, um die Aufnahme-Standards, aber ich Zweifel an der Universität tun.	9:44:31	to French 9:51:03	to Spanish 9:51:57	to English 9:52:22
3	8	Spanish	Auburn y Alabama lanzadera tienen sistemas que funcionan bastante bien.	9:44:35	to French 9:53:02	to German 9:53:24	to English 9:53:47

AN AUTOMATED MULTILINGUAL MEETING

Because staff-facilitated translation of a multilingual electronic meeting is so difficult, a purely automated approach may be best. We have developed a prototype group support system that automatically provides translations among 41 languages through the *Google Translate* application programming interface (API). For example, a meeting participant could submit a comment in Chinese and equivalent text will be shown on the other group members’ screens in their chosen languages without any staff intervention, in approximately 2 seconds (see Figures 4 – 6).

Figure 4: Chinese Speaker's View of a Completely Automated Multilingual Meeting.

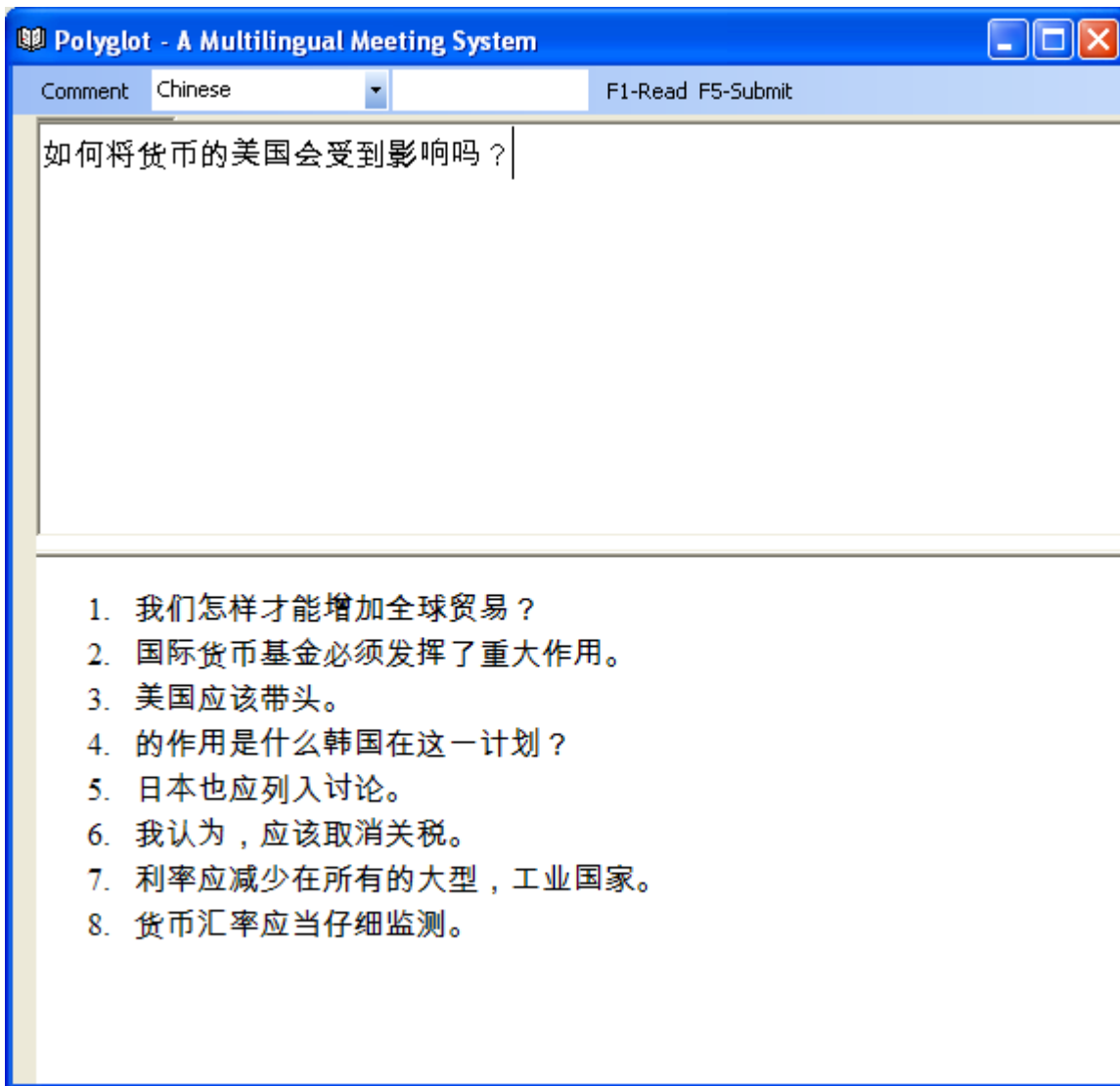


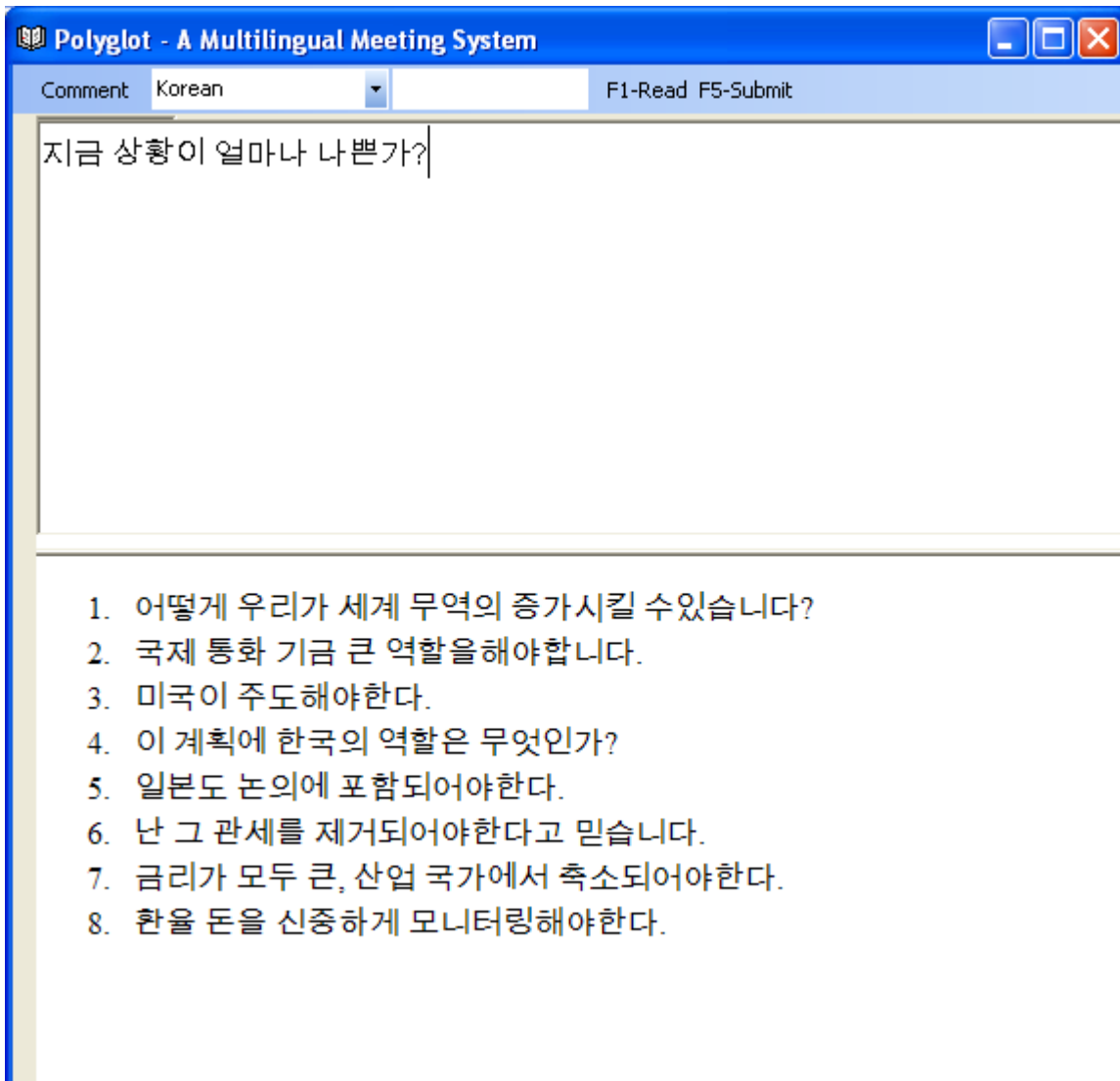
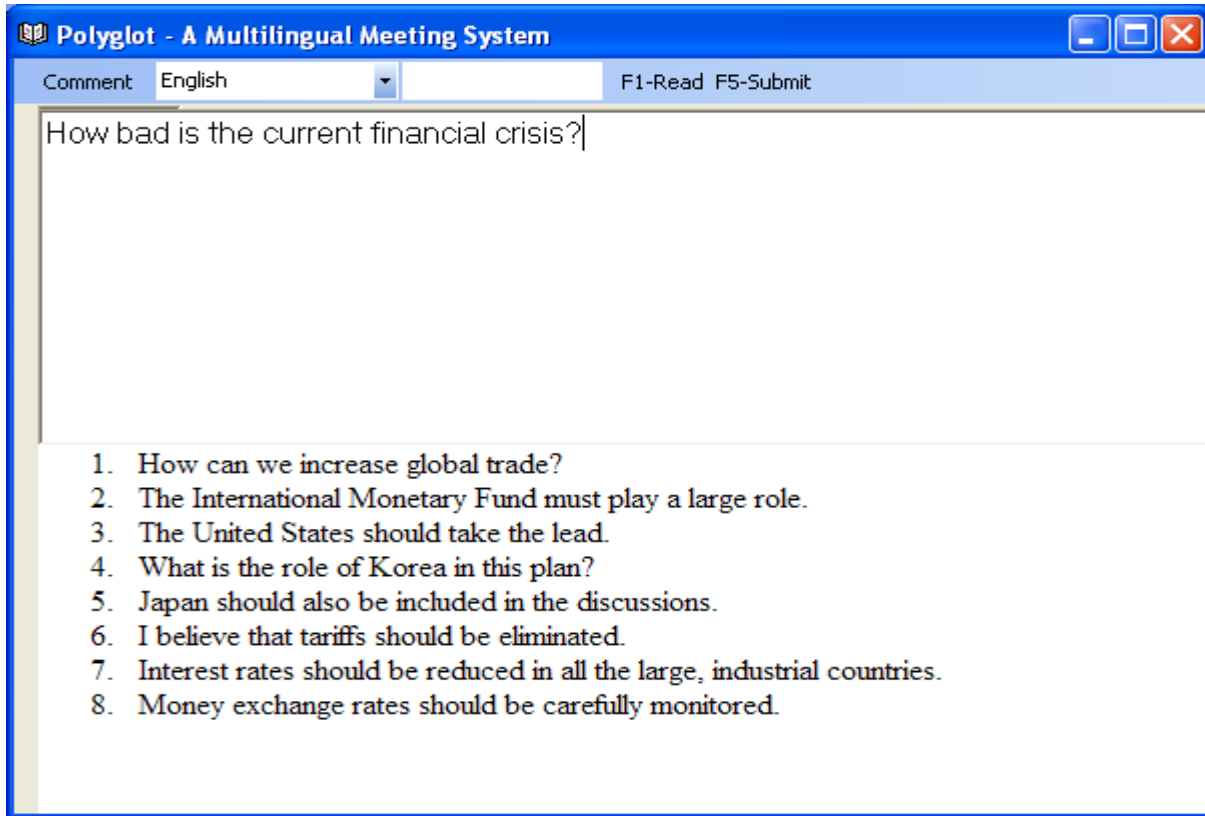
Figure 5: Korean Speaker's View of a Completely Automated Multilingual Meeting

Figure 6: English speaker's View of a Multilingual Meeting.



However, the results from online translation services vary in accuracy by sentence and vocabulary complexity and by language. In an attempt to judge the performance of the prototype, two objective evaluators with a high inter-rater reliability (0.85) ranked the 40 non-English languages based on the scales provided by Guyon (2003):

Comprehension

1. The text is clear, easy to understand and grammatically correct and does not require any corrections.
2. The text contains minor errors such as incorrect prepositions or articles, but is otherwise impeccable.
3. The text is a mixture of minor errors and incorrect terms, but the meaning is still understandable.
4. The text is a mixture of minor errors and incorrect terms, and it takes a definite effort to understand the meaning.
5. The text is incomprehensible gibberish.

Acceptability

1. The text is perfectly acceptable.
2. The reader notices slight anomalies in the text.
3. The reader feels somewhat uncomfortable reading the text.
4. The reader has the impression that the text is not very serious.

5. The reader feels insulted to have been presented with such a text.

Meaning

1. The translation conveys the meaning of the original exactly.
2. Minor nuances are missing.
3. The translation more or less conveys the meaning of the original.
4. The translation does not convey the meaning of the original very accurately.
5. The translation does not convey the meaning of the original at all.

The equivalents for the five English comments below were obtained for each of the 40 languages from <http://www.omniglot.com/language/phrases/index.htm> and translated back to English with *Google Translate*.

1. Pleased to meet you.
2. My hovercraft is full of eels.
3. One language is never enough.
4. I don't understand.
5. I love you.

Table 3: Ranking of 40 Non-English Languages Supported by Google Translate (lower score better).

Language	Comprehension		Acceptability		Meaning	
	Rank	Score	Rank	Score	Rank	Score
Dutch	1	1.3	1	1.3	3	1.5
Hungarian	1	1.3	1	1.3	3	1.5
Czech	3	1.4	3	1.4	1	1.4
Estonian	3	1.4	3	1.4	1	1.4
Chinese	5	1.5	5	1.5	9	1.8
Italian	5	1.5	5	1.5	9	1.8
Korean	5	1.5	5	1.5	3	1.5
Portuguese	5	1.5	5	1.5	3	1.5
French	9	1.7	9	1.7	9	1.8
German	9	1.7	9	1.7	19	2.0
Russian	9	1.7	9	1.7	7	1.7
Slovak	9	1.7	9	1.7	9	1.8
Slovenian	9	1.7	9	1.7	7	1.7
Danish	14	1.8	14	1.8	9	1.8
Norwegian	14	1.8	14	1.8	9	1.8
Spanish	14	1.8	14	1.8	9	1.8
Bulgarian	17	1.9	17	1.9	16	1.9
Finnish	17	1.9	17	1.9	16	1.9
Polish	17	1.9	17	1.9	16	1.9
Filipino	20	2.0	20	2.0	21	2.2
Hebrew	20	2.0	20	2.0	19	2.0
Swedish	20	2.0	20	2.0	21	2.2
Turkish	20	2.0	20	2.0	21	2.2
Croatian	24	2.2	24	2.2	28	2.5
Catalan	25	2.3	25	2.3	28	2.5
Japanese	25	2.3	25	2.3	24	2.3

Maltese	25	2.3	25	2.3	25	2.4
Serbian	28	2.4	28	2.4	25	2.4
Ukrainian	28	2.4	28	2.4	25	2.4
Vietnamese	28	2.4	28	2.4	30	2.6
Greek	31	2.5	31	2.5	30	2.6
Indonesian	31	2.5	31	2.5	30	2.6
Romanian	33	2.6	33	2.6	33	2.7
Albanian	34	2.7	34	2.7	34	2.8
Thai	35	2.8	35	2.8	35	3.1
Latvian	36	3.1	36	3.1	35	3.1
Hindi	37	3.2	37	3.2	39	3.6
Arabic	38	3.4	38	3.4	37	3.4
Lithuanian	38	3.4	38	3.4	37	3.4
Galician	40	3.5	40	3.5	40	3.8

Table 3 shows that for these relatively simple sentences, the evaluators were able to understand 35 of the languages' English translations fairly well, despite minor errors (comprehension scores ≤ 3). Future research will investigate the accuracy of more complex sentence translations as well as how the prototype performs in actual multilingual meetings.

CONCLUSIONS

This study shows that for all but the smallest groups, staff support for multilingual electronic meetings is not feasible. The case study of an extreme situation with a 40-member tri-lingual group showed a significant time delay between the entry of comments and the comment translation and posting. Further, at least one translation was posted incorrectly, and many of the comments were not translated at all.

In order to support groups of more than five people using more than three languages, a completely automated multilingual meeting system is necessary. The prototype described here supports 41 languages via a link with *Google Translate* and a preliminary study ranking the languages indicates the potential for high comprehension.

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