Invited paper

INTERNATIONAL DISTANCE EDUCATION AT TOKYO TECH

Akinori Nishihara[1]

[1]Center for Research and Development of Educational Technology, Tokyo Institute of Technology, Tokyo, Japan, Tel: +81 3 5734 3232, e-mail: aki@cradle.titech.ac.jp

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Abstract

This paper introduces distance education activities at Tokyo Institute of Technology. The Center for Research and Development of Educational Technology (CRADLE), being its key player, has been using commercial satellite, testbed network, and normal internet connections for international distance education. We have been conducting formal higher education at graduate level, and accumulated knowledge to improve the effectiveness of distance education, if not compatible to face-to-face education. Information and communication technology can further improve distance education by transmitting better quality video or by assisting teachers and learners using a learning management system and other useful tools.

Keywords: Distance education, Educational technology, International collaboration, Internet, satellite communication

Introduction

Mobility of university students across country borders is very important for students to have rich experiences and for universities to have diversity. So many universities encourage their students to study abroad and accept foreign students. To study abroad, however, you need a lot of preparation including scholarships and it is not possible for everybody. International distance education can be an option to study from overseas professors while you are in your home country. Information and communication technology can suitably help conducting international distance education.

Tokyo Tech (Tokyo Institute of Technology) started distance education between Ookayama campus in Tokyo and Nagatsuda (now it is called Suzukakedai) campus in Yokohama in 1981. Two campuses are separated by 26.4km, but could suitably connected using single-mode optical fibers along Tokyu railway lines, thanks to NTT Corporation and Tokyu Corporation for their supports. In 1996 ANDES (Academic Network for Distance Education by Satellite) was installed, and used for recurrent education for workplace engineers. The ANDES system first used analog format, but we introduced a digital format compatible with DVB standard in 1998. We first targeted Japanese domestic people only, but in 2002 we started international distance education in collaboration with Asian Institute of Technology (AIT), Bangkok, Thailand, and King Mongkut's Institute of Technology Ladkrabang (KMITL), Bangkok, Thailand. The internet has been rapidly growing, and now we also use internet for international distance education. Satellite and internet have their own advantages and disadvantages, and we have to choose them according to the needs and budget.

Tokyo Institute of Technology

Established in 1881 as Tokyo Vocational School, Tokyo Tech celebrates its 130th anniversary this year. The number of foreign students has been increasing, and at present about 13% of the total 10,000 students are from abroad. Tokyo Tech started International Graduate Program in 1993, in which students can take entrance examinations, lecture courses, and seminars in English. Students are enrolled in October, unlike regular enrollment in April. More than 100 courses are currently taught in English. The program now makes it possible for qualified students with little or no knowledge of Japanese language to pursue a full degree-course of advanced study in this country.

Tokyo Tech has overseas offices in Bangkok, Manila, and Beijing, and promote collaboration with those areas. Since May 2002 we have been transmitting real-time graduate courses using satellite communication. Although face-to-face lectures are basic in education, technology support is necessary to overcome the physical distance, and support by local lecturers and teaching assistants is also important. Course lecturers are encouraged to visit at least once in a term to have a face-to-face session to improve students' motivation.

Tokyo Tech provides free access to course materials for users around the world aiming at releasing the Tokyo Tech's high-level educational resources on science and technology as the world's public property. Tokyo Tech OCW is one of the core materials of the Web-based electronic knowledge system. Starting in May 2005, Tokyo Tech OCW covers 3,500 undergraduate and graduate courses, for which course outlines are shown. Lecture materials are shown for more than 920 courses at this moment, and we will cover almost all the courses in the future.[1]

ANDES System

In addition to inter-campus distance education, CRADLE set up the ANDES system in 1996, for the use in lecture deliveries via commercial communication satellite. The ANDES system was used for lecture exchange with Hitotsubashi University, a top national university in social science, open lecture delivery to workplace engineers, and high-School university collaboration in which undergraduate lecture courses are transmitted to high-school students all over Japan who are interested in science and technology. Since 2002 some of the courses taught in English in the International Graduate Program are transmitted to Thailand using ANDES system [2]. We use 3Mbps or 6Mbps MPEG2-DVB for video transmission to guarantee good video quality, while internet was used for Q and A. The lectures were received by National Science and Technology Development Agency (NSTDA), AIT, and KMITL. Figure 1 shows ANDES antenna.

Figure 1. ANDES 4.5m antenna

To manage the international distance education and research collaboration, Tokyo Tech Office (Thailand) was established in 2002 in the NSTDA building in the Thailand Science Park. In 2005 Tokyo Tech Office (Philippines) opened at De La Salle University, Manila, and Tokyo Tech Office (China) opened at Tsinghua University in Beijing in 2006. Those offices act as communication hubs for people in those areas. Through these offices remote students are taken care of. The Offices also handle research partnerships and information about studying at Tokyo Tech, and offer guidance for academic-industrial collaboration.

Figure 2. Lecturer in the Philippines

In addition to lecture delivery from Tokyo Tech, we also received lectures from abroad using Internet. "Technical Writing" course was transmitted from our Tokyo Tech Office (Philippines) and received in a classroom in Ookayama campus. The lecturer shown in Figure 2 was very encouraging and students enjoyed the course very much. The internet connection was not always good enough between Tokyo and Manila, but that made the students more careful to listen to the lecturer.

TAIST Tokyo Tech

In 2007, based on MOU with NSTDA and Thai universities, we established a new joint graduate program named Thailand Advanced Institute of Science and Technology (TAIST)-Tokyo Tech. TAIST is based on the idea of collaboration among Tokyo Tech, NSTDA and partner universities to develop human resources. TAIST serves as a virtual institution and focal point. NSTDA provides researchers to act as adjunct professors, research projects and scholarships for graduate students. Tokyo Tech provides world class background, expertise and experience, academic instruction and research advice. Thai universities provide academic framework, academic staff to oversee and guide students, and degrees for the successful candidates. The viability of the idea is nicely demonstrated by the creation of TAIST Tokyo Tech.

The main objective of TAIST-Tokyo Tech is to establish an institution for human resource development to foster and support world-class researchers and high-level engineers through a combination of advising from Tokyo Tech professors, excellent facilities and research staff in NSTDA, and established resources of Thai universities. The participating Thai universities are King Mongkut's Institute of Technology Ladkrabang (KMITL), Sirindhorn International Institute of Technology (SIIT), Kasetsart University (KU), and King Mongkut's University of Technology Thonburi (KMUTT).

Master's Degree Program in Automotive Engineering started in 2007, and then Master's Degree Program in Information and Communication Technology for Embedded Systems (ICTES) followed in 2008. Master's Degree Program in Environmental Engineering is expected to start in 2012. Each program accepts 30 students every year. In the first year students take many lecture courses mainly taught by Tokyo Tech faculty members and co-lectured by Thai university members. In the second year, research for master thesis is carried out mainly in NSTDA's various laboratories with NSTDA researchers acting as supervisors or co-supervisors. In addition to taking courses, all the students are required to do research and write their master theses. Each student is assigned to a laboratory in NASDA in the second semester. In the thesis project (2nd year) the students perform research under the supervision of Thai University staff (advisors), NSTDA staff (co- advisors) and Tokyo Tech staff (co-advisors). Advisors and co-advisors compose a thesis committee.

Figure 3. Distance education control room

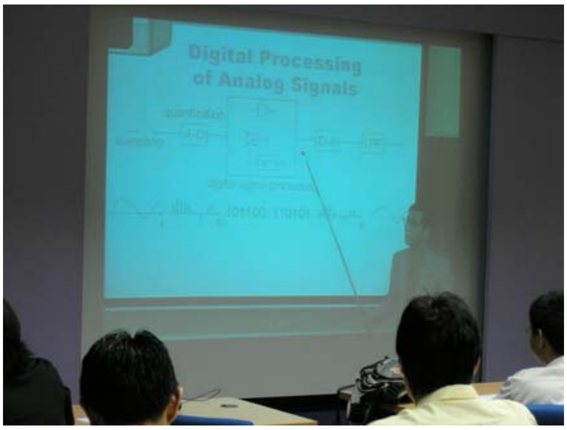

Figure 4. Lecture room in Thailand

Each TAIST ICTES lecture course is taught by a team of Tokyo Tech professor as a main lecturer and a Thai faculty member as a co-lecturer. Co-lecturers supplement the course taught by main lecturers and undertake exercises. In 2008 among 18 courses 7 were 1-week intensive face-to-face lectures given by Tokyo Tech professors who traveled to Bangkok, 7 courses were completely delivered from Ookayama campus in Tokyo or Suzukakedai campus in Yokohama of Tokyo Tech using Internet, and the rest were combination of face-to-face and distance education. In 2009 and 2010, the situations are almost the same, but in 2011 in order to save electricity consumption especially in summer, we encouraged Tokyo Tech faculty members to travel to Bangkok rather than giving lectures over internet. Distance lectures are given as shown in Figure 3, and it is transmitted to Bangkok by H.323 with about 500kbps bandwidth and shown to the students as in Figure 4. The connection is bidirectional, and the lecturer can also see and talk with the students. Lecture materials and other important information are put on a Learning Management System (LMS) named ELITE (E-Learning for IT Education) in advance. ELITE is operated using a hosting service of Tokyo Tech TSUBAME super computer For some courses, lectures are recorded and the videos are put on the ELITE site together with the lecture materials as shown in Figure 5, so that students can review the courses later.

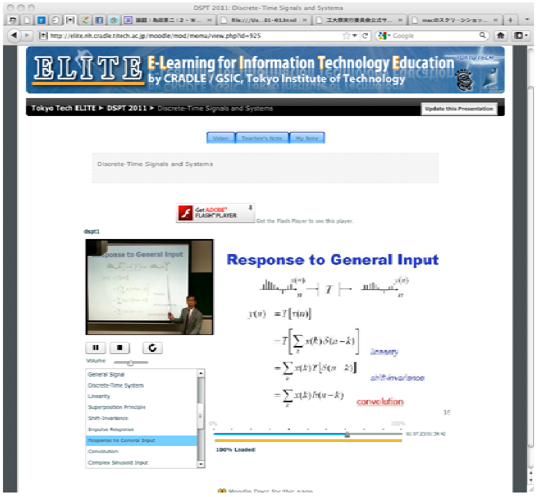

Figure 5. Learning management system

Comparison of Face-to-face and Distance Education

Every semester, we analyze students grades and questionnaire survey results. For 2008 and 2009 we did not find any big differences between face-to-face and distance courses [3]. Figure 6 shows the average grades of the courses taught in 2010, which does not show any significant difference between face-to-face and distance courses. Since average grades differ very much (maximum is 88.5 and minimum is 59.6) for the courses, we normalize the scores so that the mean is 50 and standard deviation is 10 in each course. The results for all 29 students are shown in Table 1, and Figure 7 shows their normalized average scores. Then students' average scores of face–to-face and distance education courses have correlation of 0.67 with enough significance ($p<0.01$). For each student the numbers of courses are not so many, but there are two students who have significantly higher scores for face-to-face courses, and two students who have significantly higher scores for distance education. There are three students who show marginal significance for high face-to-face scores, and one student who shows marginal significance for high distance education sores. For other 21 students we find no significant differences.

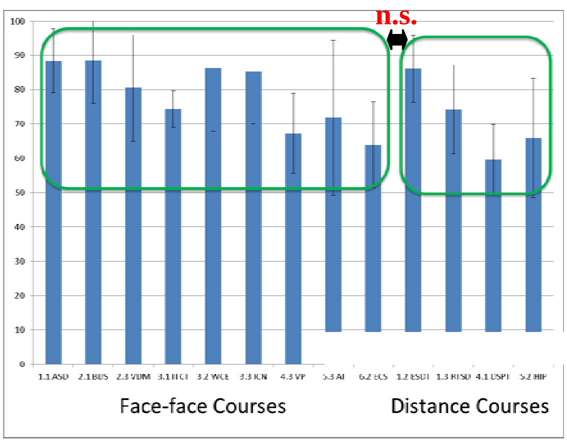

Figure 6. Comparison of average scores

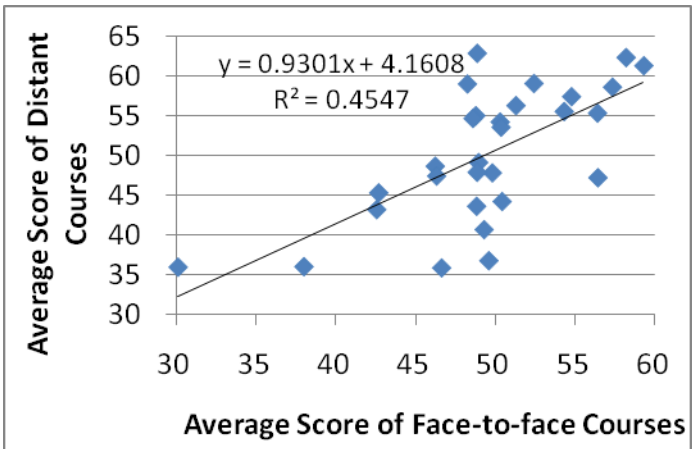

Figure 7. Normalized average scores for 29 students

Table 1 Comparison of Standardized Average Scores

student	Face-to-Face		difference	Distance Education	
	mean	s.d.		mean	s.d.
1	59.3	9.3	n.s.	61.3	2.2
2	58.2	14.0	< *	62.3	2.2
3	57.3	5.7	n.s.	58.6	6.4
4	56.4	12.6	> *	47.2	1.6
5	56.4	3.2	n.s.	55.3	1.7
6	54.8	9.0	n.s.	57.4	1.0
7	54.3	11.3	n.s.	55.5	3.1
8	52.4	9.3	< †	59.1	4.3
9	51.3	6.1	n.s.	56.3	6.1
10	50.4	11.6	> †	44.2	10.9
11	50.3	8.3	n.s.	53.5	9.3
12	50.3	10.0	n.s.	54.2	5.9
13	49.8	1.8	n.s.	47.8	6.5
14	49.6	3.1	> †	36.7	2.6
15	49.3	3.2	> †	40.6	9.2
16	48.9	8.3	n.s.	49.1	7.3
17	48.8	11.8	< *	62.9	6.8
18	48.8	6.4	n.s.	47.9	5.7
19	48.8	9.6	n.s.	43.5	6.3
20	48.8	9.4	n.s.	55.0	4.2
21	48.6	7.3	n.s.	54.6	10.5
22	48.2	6.6	n.s.	59.0	4.1
23	46.6	8.7	> *	35.8	7.8
24	46.3	14.0	n.s.	47.4	4.6
25	46.2	4.0	n.s.	48.6	8.2
26	42.7	2.2	n.s.	45.3	7.1
27	42.6	10.1	n.s.	43.1	8.5
28	38.0	10.8	n.s.	35.9	4.2
29	30.1	7.7	n.s.	35.9	5.8

† $p<0.1$, * $p<0.05$

ELITE system shown in Figure 5 is also used as a student evaluation system using 4 Lickert scale questionnaires. Some of the results are shown in Figure8. Averages for distance education are slightly lower, but no significant differences are found. With all things considered, we conclude that distance education has no significant difference with face-to-face courses. It is probably worth mentioning that those results cannot be obtained without close collaboration among participating members and institutions.

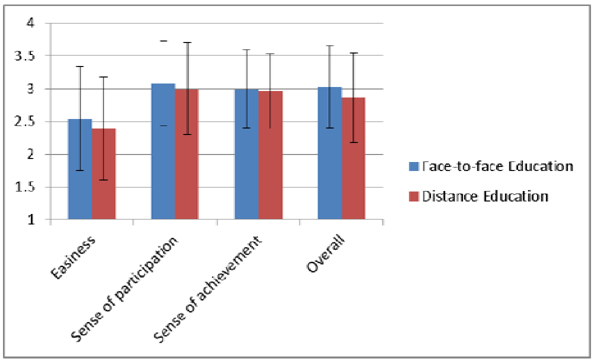

Figure 8. Student questionnaire survey results

JGN2, JGN2plus, and JGN-X

Since 2006 we used a Japan-Thailand link of Japan Gigabit Network 2 (JGN2, it is JGN2plus since 2008, and JGN-X since 2011), an open testbed network environment for research and development, which is operated by National Institute of Information and Communications Technology (NICT) [4]. JGN is an ultra-high-speed testbed networks for research and development collaboration among industry, academia, and the government with the aim of promoting a broad spectrum of research and development projects, ranging from fundamental core research and development to advanced experimental testing, in areas including the advancement of network-related technologies for the next generation and diverse range of network application technologies. When we use JGN, we reserve a certain bandwidth at JGN Center, so that we are sure that the bandwidth for high-definition video transmission is guaranteed. The problem is, however, the bandwidth in the domestic networks in Thailand, and it is not easy to steadily transmit high-definition video signals. We believe that high-definition video is more suitable for distance education [5], and will continue to explore new tools, new environment, and new technologies to have better distance education [6].

KIZUNA (WINDS)

A geostationary satellite KIZUNA (WINDS, Wideband InterNetworking engineering test and Demonstration Satellite) was launched by an H-IIA rocket on 23 February 2008 by JAXA (Japan Aerospace Exploration Agency) in cooperation with the NICT (National Institute of Information and Communications Technology) to establish the world's most advanced information and telecommunications network. KIZUNA satellite communication system allows a maximum speed of 1.2 Gbps communication. The project aims not only to establish Japanese domestic communication but also to construct ultra high-speed international Internet access, especially with Asian Pacific countries and regions that are more closely related to Japan.

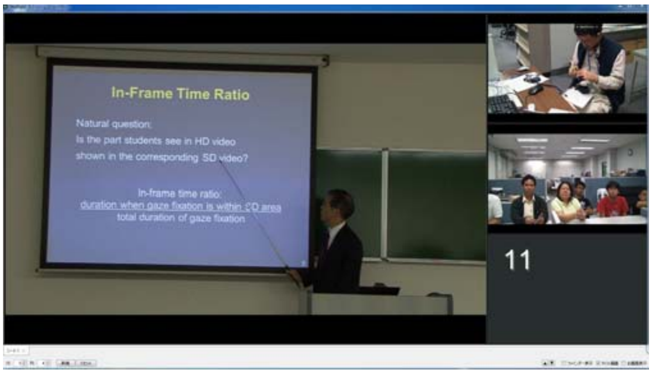

Figure 9. The author's lecture distributed by KIZUNA with high-definition video to HU and UP

KIZUNA (WINDS) has been used not only for basic experiments by JAXA and NICT but also 53 projects chosen by open applications. Those projects include distance education, remote medical care, disaster mitigation, etc. KIZUNA (WINDS) is expected to remove the digital divide by providing high-speed Internet service in areas where the terrestrial communication infrastructure is poor. Distance education and telemedicine are especially important from that point of view.

The author's group at Tokyo Tech has been cooperating with Chulalongkorn University, National Telecommunication Commission, the University of the Philippines, and Hokkaido University to utilize KIZUNA (WINDS) for distance education using high-definition video transmission. As shown in Figure 9, lectures can be transmitted using high-definition video. We also succeeded in seamlessly connecting satellite multicast and IP multicast in transmission of video streams, so that by sending one video stream several locations can receive the signal with minimum bandwidth usage as a whole.

Conclusions

Distance education activities conducted at Tokyo Tech is introduced with recent assessment data, which show no significant difference between face-to-face and distance education. Other than lecture delivery mode, however, there are many factors which affect the quality and effectiveness of education, such as course contents, course design, lecturer's skill, student attitudes, etc. So it is difficult to compare face-to-face and distance education in general [7], but we are at least satisfied so far with the results that our distance education can reach to our students in Thailand without any significant problems. Although the author believes face-to-face lectures are essential in education, information and communication technology can properly be used to overcome physical and mental distance between teachers and learners. We are also trying to develop useful tools to assist stakeholders to have even better educational environments.

Acknowledgements

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