Teaching Assistant Robot, ROBOSEM, in English Class and Practical Issues for its Diffusion

Seong Ju Park, Jeong Hye Han, Bok Hyun Kang, Kyung Chul Shin

***Abstract*—Various studies on robot assisted learning have proven them to be effective tools for language education because robots are remarkably successful in eliminating the affective filter. This study demonstrates ROBOSEM with class content for sustaining long-term interaction with students in English classes of elementary schools as a teaching assistant, not a teacher. We close with some practical considerations for the continuous process of improving technology and its diffusion throughout society, such as in elementary schools, through interviews with developers and observations from field trials.**

I. Introduction

There is a growing body of work investigating the impact of educational service robots on learning. Many studies confirm that the use of robots can positively contribute to improving learners' motivation for learning. Robots for English learning are especially highly regarded in robot-assisted learning (RAL) [1,2,3].

South Korean teachers teach English class with the assistance of native speakers. The government has been hiring these native English speakers to teach English in schools. In addition to learning English at school, parents are also sending their children to after-school programs [5,6].

Many studies confirm that the use of robots can positively contribute to improving learners' motivation for learning. Using robots developed for educational purposes has proven to be effective in enhancing English classes. Students of English classes using robots as teaching assistants have shown better learning achievements in speaking, as well as greater confidence and motivation [1,2,3,4]. The high demand and positive results on achievement have led to the commercialization of teaching assistant robots to replace native English teachers.

This study reviews some educational service robots for English learning and demonstrates ROBOSEM and its services as a teaching assistant for English class in elementary schools. Also, this study discusses the possibility of commercialization of this technology.

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II. Related Work

A. Educational Service Robot for English Learning

Robots can add more than what computers have offered to aid language learning because their anthropomorphic figures lower the affective filter and provide total physical response (TPR) in terms of actions, which may lead to form social interactions. They can also be an efficient tool to hone language skills for many people who feel nervous about conversing with flesh-and-blood native speakers [2].

The current Korean English education system employs over 30,000 teachers from native English speaking countries, such as the US, Canada, the UK, Australia and others. The problem according to the South Korean government is that it's too expensive to hire these teachers and it's often difficult to find teachers for rural areas [5,6].

The educational interaction offered by educational service robots can be referred to as RAL [2]. Han divided educational service robots as teaching and learning assistants into three categories: the tele-operated (or tele-conference, tele- presence) type, autonomous type, and transforming type, according to the location of the robot's intelligence [2].

Korean officials might consider using educational service robots full time if scientists upgrade them, making them easier to handle and more affordable[5,6].

B. RAL in r-Learning

RAL by educational service robots belongs to r-Learning (Robotic Learning). A literature review on RAL is categorized by the type of robot, the role of the robot, the target group, subjects taught, use of visual instruction material, such as computer-aided instruction (CAI) or web-based instruction, (WBI), the type of educational service provided, and the number and duration of each field experiment. RAL has seven features: the anthropomorphism of media for learning, provision of physical activities and nonverbal messages, reciprocal authority to start learning, responsiveness of teaching and learning activities, greater presenting of virtual as well as physical space, convenience of communication for teachers and parents, and provision of fantasy for immersion learning [2].

III. Development of Robosem

ROBOSEM utilizes external devices to play the visual materials, such as an electronic board, TV, projector, and so on, as shown in Figure 2. ROBOSEM converts between

tele-operation and autonomous control mode on command. It speaks in TTS in the autonomous mode, but in the voice of a remote instructor in the tele-operated mode. The conversion between voice machine and natural voices might confuse children about the robot's identity. Therefore, ROBOSEM transforms into the other mode by the children's voice command '*Abracadabra*'.

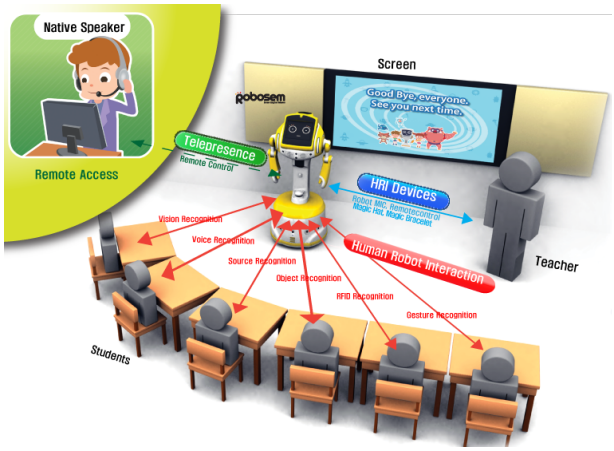

Fig. 1. The Service Framework of ROBOSEM in Classroom

A. Hardware Architecture

Figure 2 shows an overview of the hardware structure in ROBOSEM.

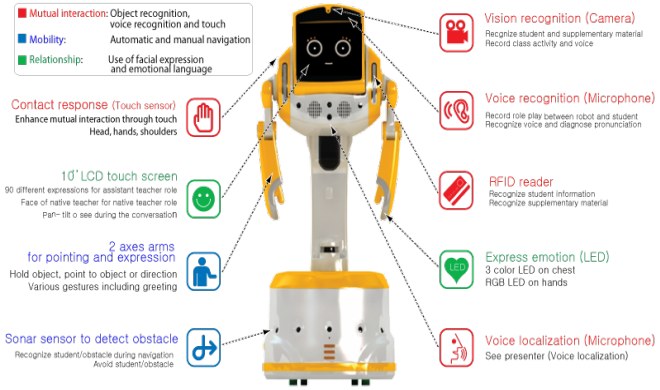

Fig. 2. Overview of Hardware Structure in ROBOSEM

Our design goal for ROBOSEM was to minimize the sales cost as well as to maximize the effects of HRI. The hardware specifications of ROBOSEM are shown in Table I. ROBOSEM can hang its head down to see material on the desk, however teachers have to bend its elbows when this is necessary since it has no actuators. There are 5 touch sensors in ROBOSEM.

TABLE I
HARDWARE SPECIFICATIONS OF ROBOSEM

ITEM	Specification
Size	1100(H)×450(D)×450(W)
SBC	IM-945GSE (Atom N270 1.6GHz)
Speed	1m/sec
Camera	2 MB Resolution
Microphone	1 for voice recognition 360° sound localization (3ea)
Touch Screen	10" (1024×768)
Head DOF	1 DOF, -10°~40°
Shoulder DOF	2 DOF, -40°~180°, -5° ~120°
Elbow DOF	1 DOF, No actuator
Waist Turret DOF	1 DOF, -180° ~ 180°
Touch Sensor	1 (head), 2 (hands, shoulders)
Sonar Sensor	Trans 3ea, Receiver 5ea
IR Receiver	Front, Rear IR Receiver
RFID Reader	13.56MHz, UART Interface
Bluetooth Receiver	V2.1 (Headset & Wimote)
USB to Serial Board	2ea
Magnet	Inside of Palms

B. Software Architecture

1) Autonomous ROBOSEM

The software architecture for ROBOSEM takes the form of a 3 tier system represented by the following figure. The black symbolic face of ROBOSEM and the visual materials on the TV or shared display are provided by the robot content player (RCP). The context-based actions of ROBOSEM are performed by the robot service executor (RSE). Users can easily develop the context-based actions and activities by providing visual and audience materials using the robot contents organizing software (ROCOS) released from Yujin Robotics, Inc.

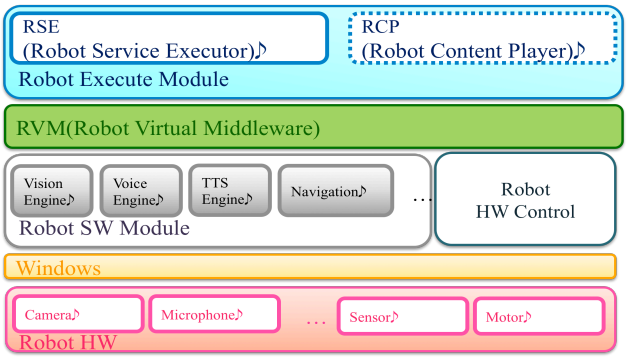

Fig. 3. Software Architecture of ROBOSEM

ROBOSEM can speak with English as well as Korean voice engines, because Korean TTS is useful for children in break time, but ROBOSEM can only recognize English.

2) Tele-operated ROBOSEM

We developed easily controllable software for tele-operators of ROBOSEM through ROCOS, and it is executed in RSE. As shown in Figure 5, this software provides a realistic presence through convenient operation by the native speaker which makes the robot like his/her own body for getting closer to certain students, facing students, looking down on the desk, pointing, and so on. The native speaker can see children and his own face as well as the visual materials to be provided by TV in the classroom and his own blackboard for handwriting.

Fig. 4. User Interface of SW and Tele-operated ROBOSEM

C. *Class Materials for Long-term Interaction*

To evoke children's imagination and to sustain children and ROBOSEM interaction, we designed the following class materials. They facilitate the learning of English, as well as giving the capability to record the learning activities, to improve ROBOSEM's vision, and so on.

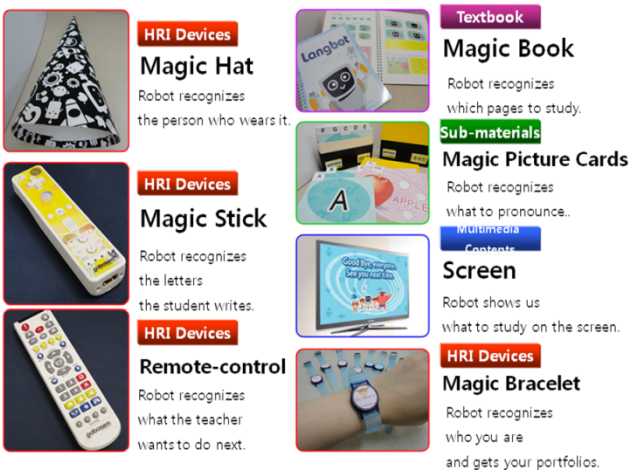

Fig. 5. Class Materials in ROBOSEM

IV. Services of ROBOSEM in English Class

ROBOSEM can react with about 60 context-specific scenarios. For example, when a child touches its LCD face the first time, ROBOSEM just steps back, but the second time this happens, ROBOSEM steps back with a wry face.

ROBOSEM serves rich optimized variety of educational contents: 3 levels (basic/intermediate/ advanced), 10 chapters for each level, 3 units by each chapter. The total 90 units are developed for after-school English program during 6 months, one semester in Korea. Every unit consists of *Guide and Diagnosis of English Pronunciation* (left at the top), *Guide and Diagnosis of Writing English with a magic stick* (right at top), *Recorder of Learning Activities with a magic watch embedded RFID tag*, and *Interacting with a magic card* as shown in Figure 6.

Fig. 6. Scenes of ROBOSEM in English Class

In class ROBOSEM faces toward the teacher when he/she is talking, turns toward sound, pronounces and diagnoses pronunciation, recognizes a child with a RFID tag or a marked hat and their voices with microphone, retrieves student portfolios, records children's credits, and so on.

The 34 students are between 10 and 13 years old of two elementary schools were selected for the field studies, which lasted for 4 weeks. ROBOSEM served each group 2 hours a week during one month through an after-school English program. Table II. shows the t-test result of the English achievement with ROBOSEM. Their after-achievements are very significantly different from the before-ones with $T=-3.588$ (p-value=0.0011) at $\alpha=0.01$.

V. Practical Issues

Through observing teachers, native speakers, and children, as well as interviewing the staff who developed ROBOSEM and its service, we noted some practical issues with RAL using ROBOSEM.

TABLE II
ACHIEVEMENT OF ENGLISH LEARNING WITH ROBOSEM

	Mean	T	P-value
Before	82.2	-3.588	0.0011
After	89.6		

A. *Issues in Class*

The children and teachers were satisfied with ROBOSEM as a teaching assistant throughout the month. The interaction remained high because teachers taught children with ROBOSEM. Teachers considered ROBOSEM as a teaching assistant, but native speakers felt ROBOSEM was their competitor, even though they enjoyed controlling it. The practical issues for applying ROBOSEM in class are as follows.

1) Children

- Awareness of the reason of symbiosis with robots (not for robots but for ourselves).
  - To enhance children's motivation & achievement
  - To increase the relationship and communication with friends, teachers, and their parents
- Etiquette of playing about with robots (robot ethics).

2) Teacher

- Awareness of the reason of symbiosis with assistive robots.
- Reminders to the children that the teacher is the master in classroom and the robot is just a teaching assistant.
- Positive attitudes to assistive robots.

- Use of robots for enhancing motivation and interaction of children as much as possible.

B. *Issues out of Class*

The transforming robots are suitable for elementary schools because of the quality of their networks. When the network was not stable or connected, the tele-operated robot could not assist the Korean teacher at all. That may be a fatal problem in classroom management. The out of class practical issues are the following.

1) Developers of Robot and its Services

- Improvement of artificial intelligence with robot visual and voice recognition using RFID, markers, Bluetooth microphones and so on.
- Increasing the productivity of authoring services for educational robots, such as for motion clips. Authoring robot services takes dozens of hours. Motion clips reduce the time needed to prepare for class.
- Improvement of robot communication so that they can interface with various devices, such as smart phones, electronic boards, beam projectors, etc.
- Provision of convenient tools and services for teachers, such as for controlling robots and revising the service

2) Researchers on RAL

- Development of design approaches and techniques that can sustain a long-term interaction beyond the novelty effect with limited artificial intelligence.
- Exploration of the various HRI issues on humans and society before full diffusion of educational service robots
- Study of the design principles and evaluation methodology for developing services for educational service robots
- Distribution of standardized software developer tools for educational robots by providing many trial applications.

VI. CONCLUSION

Many educational service robots for English learning have been developed based on the positive effects of RAL. Now RAL, through educational service robots in Korea, is facing its diffusion through the demand of parents and government.

This paper introduced ROBOSEM as an English teaching assistant and its service was developed with pilot studies. To avoid relying on the novelty effects of ROBOSEM and to retain children and ROBOSEM interaction continuously, the various supplementary materials used in class maximized the educational effect by enhancing interaction and recognition, such as magic hat or stick. The quantitative analyses were conducted to compare the English achievement of students' with ROBOSEM. It was found that ROBOSEM worked to increase their English achievement. Lastly, we propose some practical issues so that it becomes cheaper and can be diffused throughout society, such as in elementary schools.

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