

Paperless Korean Language Learning Support System with a Tree-type Network of Android Devices

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Abstract: This paper describes a new paperless Korean learning support system for teachers and students who are preparing for Korean proficiency exams. The proposed system uses a Bluetooth network and learning applications based on the SQLite Database in Android devices. Experimental results show that the proposed system is useful for providing learning materials without network infrastructure.

Keywords: Korean learning system, tree-type network, Android, Bluetooth, SQLite

1. Introduction

To give Japanese students motivation for learning with the aim of passing Korean proficiency exams, we offer a Korean language class. In every class session, students take a paper-based mock examination (past and possible future exam questions) in a repeated manner as preparation for the Korean proficiency exams. After a mock examination is implemented, a teacher marks the exam papers and records the scores before the next session and gives feedback to students based on their results, thereby helping students to maintain their motivation for learning at a high level, not only during the class, but also up to the exam dates. However, such a learning style imposes a heavy burden of class preparation on teachers, and provides few benefits to students when managing and reviewing numerous printed materials.

To overcome those problems, Morita (2011) proposed an online automatic aggregation system on which aggregated students' answers can be marked on site using a classroom equipped with a Web server, mobile PCs, and a wireless LAN. Recently, many e-learning systems have been proposed for mobile devices, with materials based on PCs redesigned for mobile use. However, although numerous previous systems have used conventional e-learning environments such as learning management servers and wireless LAN or 3G telecommunication networks (Y. Suzuki, 2011, J. White and H. Turner, 2011, V. Nguyen and V. Pham, 2012, M. Wang and J. Ng, 2012, C. Chi, C. Kuo, and K. Lin, 2012, W. Ahmad, A. Shaarani, and S. Afrizal, 2012), it is difficult to make use of conventional learning systems when using lecture rooms or portable devices without access to communications.

As a solution to this problem, we propose a new paperless Korean language learning support system that uses Android devices. The proposed system requires no conventional e-learning environment, which constitutes a major difference from conventional systems. This feature leads us to infer that the proposed system can be used in a classroom without a learning management server and a network infrastructure. Therefore, using the proposed system enables a teacher to work toward maintaining students' motivation for learning and to reduce the burden of class preparation even in a regular classroom. It can also offer students a mobile learning environment that has fewer time and space constraints. The operation of the proposed system was verified by an evaluation experiment. Its availability as a new educational service is anticipated.

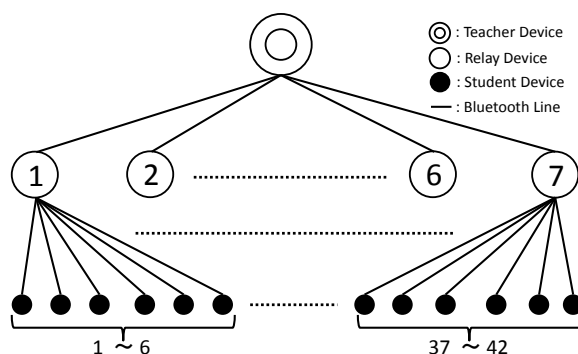


Figure 1. Tree-type network.

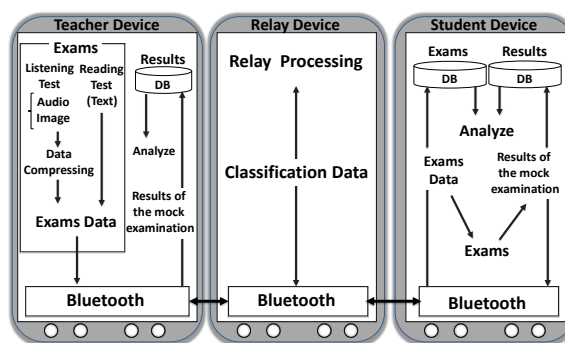


Figure 2. Outline of flowing data of each device.

2. The Proposed System

The proposed system consists of the three applications of the teacher's device, the relay's device, and the student's device. The applications in the teacher's device and student's device respectively include learning support and learning function based on the SQLite database. Functions of a connection and transmission and reception of data are implemented at each application. A Bluetooth network infrastructure can be built by using the functions in the proposed system. We developed these applications by using Android Developer Tools (ADT), and the compiling version was Android 2.3. These all details are described below.

2.1 Tree-type Network

We briefly describe the connection function of the proposed system. Establishment of a Bluetooth connection among Android devices (S stands for server device; C stands for client device) follows the following general procedure.

(Step 1) Enable Bluetooth on S and C. Then S and C can start enabling discoverability and discovering device states, respectively.

(Step 2) C requests a pairing setup with S. After the authentication passkey is confirmed, C can make a connection request to S.

(Step 3) S accepts the connection request from C. A mutual connection is established for S and C.

However, the general operation in steps 1 and 2 is troublesome. If a teacher conducts the connection procedures above for 30–40 students' devices at every class session, then the time to complete the connections to all devices and the possibility of connection troubles resulting from operational errors can be expected to be onerous. Therefore, the proposed system conducts a pairing setup after determining a connection destination for each device in advance. Although devices that have registered each other once the pairing setup can be connected using only step 3 while obviating steps 1 and 2, they have not yet produced a network with high fault tolerance.

To overcome this obstacle, we develop a tree-type network with high fault tolerance using a device to perform relay processing between a teacher's device and students' devices, as shown in Figure 1. In other words, all devices of students become end devices. Even if unspecified students' devices are missing, communications among other devices are unaffected. The proposed system conducts a pairing setup between a teacher's device and relay's devices, and between relay's devices and students' devices in advance. In doing so, from the next time and thereafter, it starts the connections automatically according to the pairing information that is registered once, simultaneously with the startup of each device. Therefore, a tree-type network can be built easily.

However, although the official Bluetooth specification allows connection of seven Bluetooth-enabled devices concurrently, the number to be connected depends on the manufacturer or the model in the case of Android devices. To our knowledge, the number of Android devices to be connected to Bluetooth varies among manufacturers and models, from a minimum of two to a maximum of seven. Because the proposed system uses Android devices connectable up to seven devices as a teacher's device and relay's devices, a teacher's device can concurrently connect to a maximum of seven relay's devices. A relay's device allows six concurrent connections to students' devices. Therefore, the proposed system is useful by a maximum of 42 students at a time. A Korean language class at our

university usually has limitations on the number of students who can take the class, not exceeding approx. 40. Consequently, the maximum number (42) of students who can use the proposed system is regarded as reasonable.

2.2 The Functions of the Each Developed Application

We briefly describe the functions in the developed applications of the teacher's device, the relay's device, and the student's devices of the proposed system, respectively, and present several illustrative figures. Figure 2 shows an outline of the transmission and reception of data among devices with the tree-type network.

Figure 3(a) shows the main screen of the developed application in the teacher's device. The application has three functions: question-checking (Fig. 3(b)), question transfer (Fig. 3(c)), and learning history (Figs. 3(d) and 3(e)) are described below. A teacher can check the contents of a mock examination by the number of exams using the question-checking function and can transfer the mock examination questions to students with the question-transfer function. The learning history function enables a teacher to review a detailed learning history of the answer data transferred from students, such as the number of examinees, the highest and the lowest scores, and the average scores by number of exams and by student. A mock examination saved in the teacher's device consists of two parts: a reading test (60 score) contains text files; a listening test (40 score) contains audio and image files. Mock examinations (10 times) are registered at the database in the teacher's device in advance. The size of one mock examination is approx. 2.7 MB. These operations of the developed functions are all based on the tree-type network constructed using the Android devices' Bluetooth and SQLite database. Therefore, using this application enables a teacher to work toward maintaining students' motivation for learning and to reduce the burden of class preparation even in a regular classroom.

The relay's device performs data transmission and reception between a teacher's device and students' device.

Figure 4(a) shows the main screen of the developed application in the students' device. The application has two functions: learning and a learning history are described below. Students can make an automatic connection to the relay's device with the learning function and can receive reading (Fig. 4(b)) and listening (Fig. 4(c)) of mock exam questions transferred from the teacher's device. After the mock exam

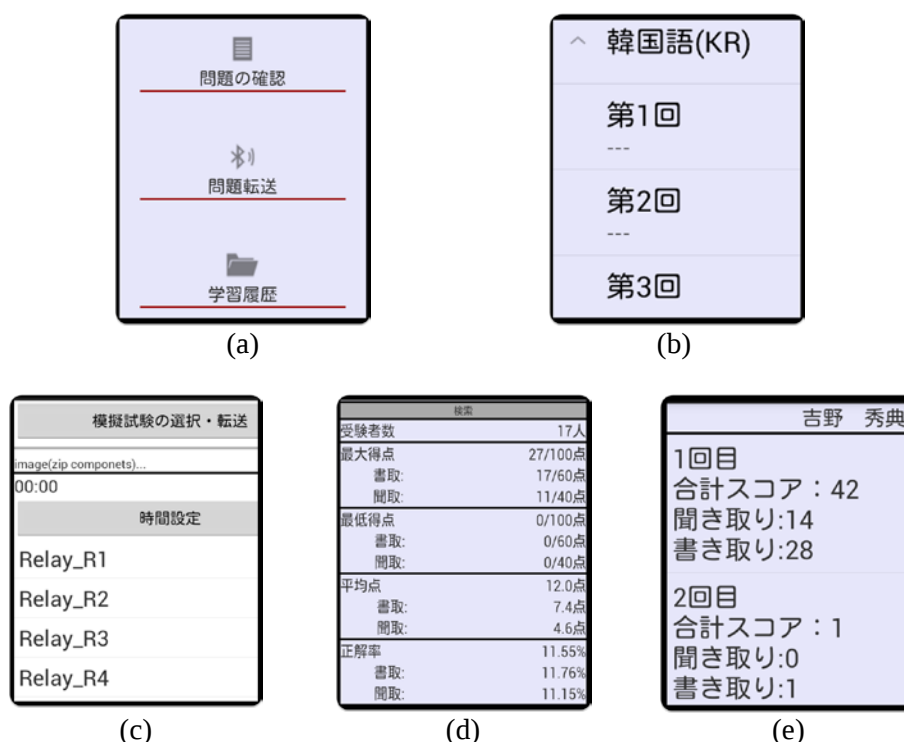


Figure 3. Examples of functions in the developed application of teacher's device.

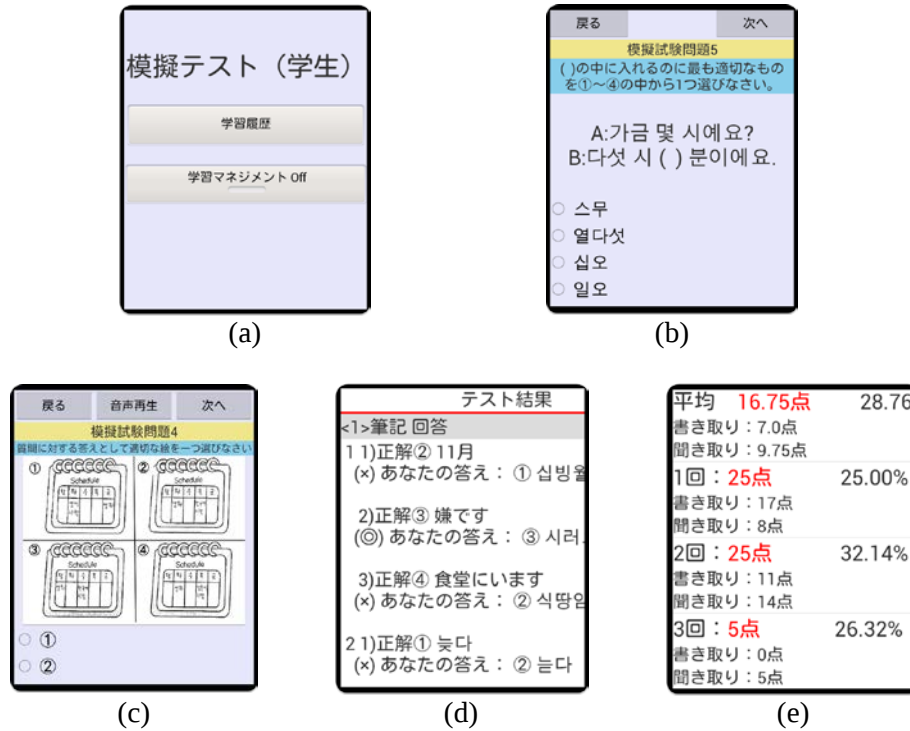


Figure 4. Examples of functions in the developed application of student's device.

is completed, students can check their results as soon as the data are transferred to the teacher's device. The learning history function enables students to confirm their mock exam results in detail by the exam number, as shown in Figures 4(d) and 4(e). Therefore, the application can offer students a mobile learning environment that has fewer time and space constraints.

3. Evaluation experiments

To verify the operations of the proposed system, we placed Android devices (T stands for teacher' device, R stands for relay' device, S stands for students' device) on the desk in a regular classroom without a network infrastructure as in the following conditions.

- Arrangement range: 4.4×5.4 m
- Arrangement interval: 55 cm
- Number of Android devices used: 50 devices (T, 1 device; R_{1-7} , 7 devices; S_{1-42} , 42 devices)
- The file size of a mock examination is 2.7 MB
- T and R_{1-7} are pairing each other in advance.
- $R_n (1 \leq n \leq 7)$ and $S_{\{(n-1) \times 6 + 1\}} - S_{(n \times 6)}$ are mutually paired in advance.

Figure 5(a) shows the outline of arrangement of Android devices. The real scenes are shown in Figures 5(b), 5(c) and 5(d). Android devices used in these experiments were various, including smartphones, tablets, and audio players. Table 1 presents detailed specifications of the Android devices used.

First, we performed building of the tree-type network with the Android devices eight times. The average connection times between T and R_{1-7} , and R_{1-7} and S_{1-42} were 5.1 and 4.9 s, respectively, as shown in Figures 6(a) and 6(b). The average connection times between T and each R were constant. However, the average connection times between each R and each S were not constant at Tablet devices (ICONIA A100: $S_{31-33, 36}$) and audio player devices (NW-Z1050: S_{13-18}), as shown in Figure 6(b). The reason Bluetooth specifications differ from those of other devices such as smartphones.

Second, we performed transfer of a mock examination file 8 times for S_{1-42} from T via R_{1-7} . Average transfer times between T and R_{1-7} , and R_{1-7} and S_{1-42} were 190 and 153 s, respectively as shown in Figure 6(c) and (d). All average connection times between T and each R were constant.

Finally, we confirmed that answer data from the students' devices were transferred with no problems until the teacher's device via the relay's device. All answer data were registered accurately in the database.

In this evaluation experiment, the proposed system was confirmed that building of a tree-type network in a short time, transfer (send and receive data), and database update were functioning normally.

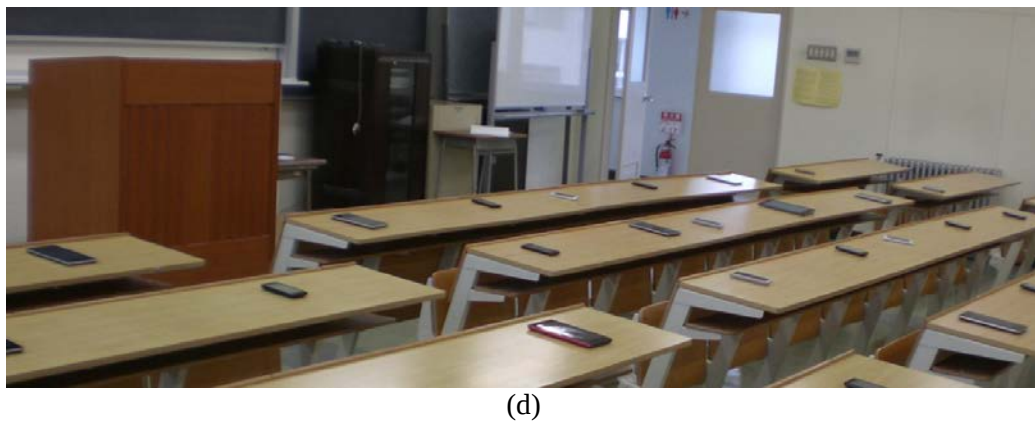
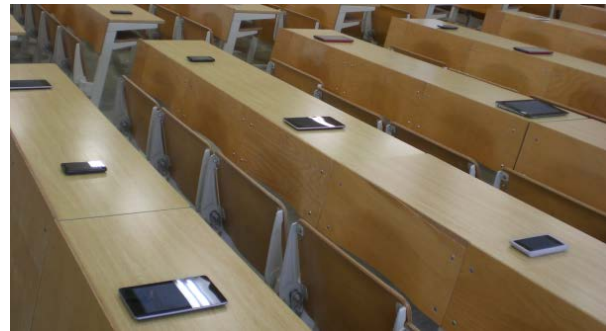
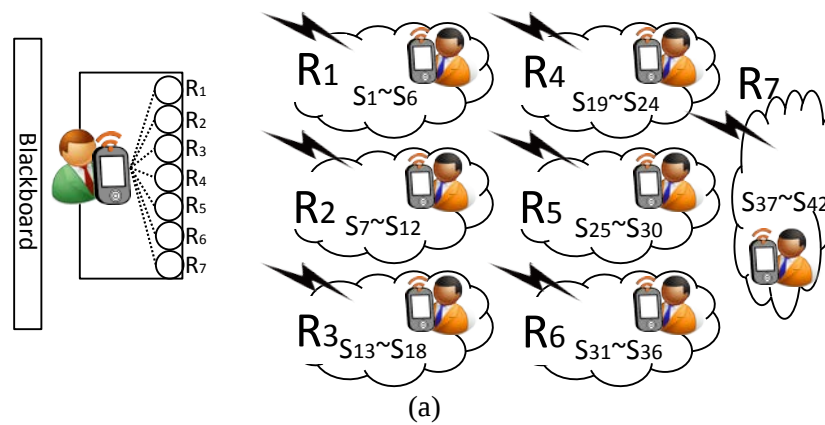
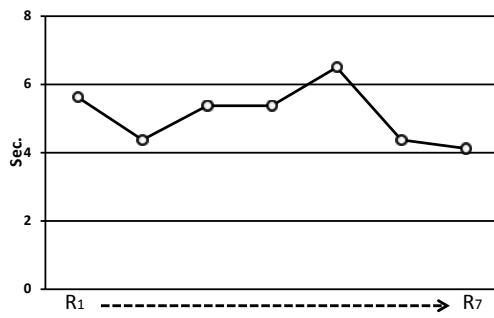


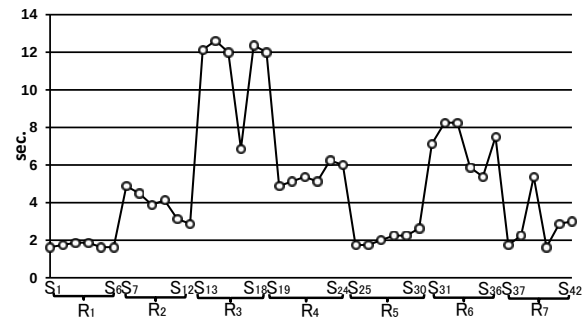
Figure 5. Performance among the devices implemented the each developed application.

Table 1. Android device specifications.

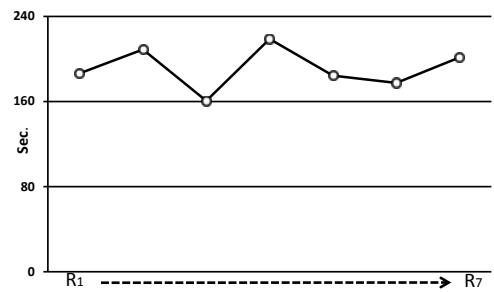
	Model	Bluetooth	CPU	Screen	OS	Manufacturer	Connectable
T, R ₁₋₇ , S ₁₋₆ , 37-39	ISW13HT	4.0	MSM8660A	4.7 inch	4.0.4	HTC	7
S ₇₋₁₂ , 40-42	Nexus 7	3.0 + EDR	Tegra 3	7 inch	4.2.1	Acer	4
S ₁₃₋₁₈	NW-Z1050	2.1 + EDR	Tegra 2	4.5 inch	2.3.4	Sony	2
S ₁₉₋₂₄ , 34-35	ISW11HT	2.1 + EDR	QSD8650	4.2 inch	2.3.4	HTC	2
S ₂₅₋₂₇	SO-04D	2.1 + EDR	MSM8960	4.7 inch	4.0.4	Sony	7
S ₂₈₋₃₀	SGPT111JP/S	2.1 + EDR	Tegra 2	9 inch	4.0.3	Sony	3
S _{31-33,36}	ICONIA A100	2.1 + EDR	Tegra 2	8 inch	3.2.1	Acer	3



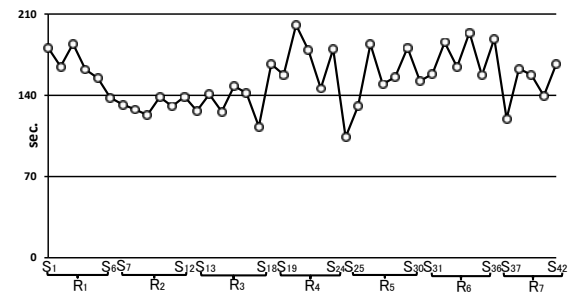
(a) Connection time from T to R.



(b) Connection time from R to S.



(c) Transfer time from T to R.



(d) Transfer time from R to S.

Figure 6. Results of connection and transfer time.

4. Conclusion

As described in this paper, we proposed a new paperless learning support system to improve the learning environment of the class to prepare for Korean proficiency exams. Because the proposed system builds a tree-type network using Android devices, it can provide learning management without a conventional e-learning environment such as a learning management server and a network infrastructure. Operation of the proposed system, as verified by evaluation experiments, shows great promise: the system can be available and useful in regular classrooms without a conventional e-learning environment. Future studies conducted with practical use of the proposed learning system in classrooms without a communication environment will clarify its educational importance.

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