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Collaborative learning support system in a classroom using ad hoc network of tablet devices

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***Abstract*—Having students ask and answer questions among themselves can help deepen their understanding of learning content. Tablet devices are advantageous for such application due to their portability and capability to support not only text but also images and sound. A few elementary schools in Japan have already started introducing tablet devices into the classroom. This requires making some changes to the environment, including providing an access point for the tablets to communicate with each other. To aid in the preparation for computer supported learning, we propose using an ad hoc network of tablet devices to deploy a delay tolerant network with the aim of achieving high message reachability over intermittent connections. The results of preliminary experiments show that our system can provide a high delivery rate, although its delivery speed is somewhat slow. We also created a practical application using the ad hoc network that students can use to exchange content.**

***Keywords*-ad hoc networks; computer aided instruction; tablet computers;**

I. Introduction

Tablet devices are currently garnering interest as instruments for computer supported collaborative learning (CSCL) due to their portability and ease of use for reading content and inputting responses.

Appropriate information and communication technology (ICT) is currently being prepared in Japan, and learning through the use of ICT has already started [1]. We believe learning using ICT will only increase in the future. Introducing tablet devices into the classroom requires making some changes to the environment. Using dozens of tablet devices requires sufficient space in the classroom to store them, careful power management, and an access point for the devices to communicate with each other. However, few schools in Japan currently have an access point in every classroom. Each access point needs to be carefully customized and have high performance so that it can deal with dozens of tablet devices and can ensure concurrent and frequent access. An unstable connection is unacceptable because it would interrupt the lesson.

To combat this, we propose using a delay tolerant network (DTN) [2] to provide sustainable message transmission over intermittent connections. It works as an overlay above the transport layers, it stores and forwards messages, and it provides a route to the destination. Examples of an intermittently connected network include sensor networks, ad hoc networks in disaster affected areas, and military ad hoc networks. An ad hoc network is a type of wireless network in which each node forwards data to other nodes directly without any infrastructure for wireless communication. Because almost all tablet devices come with an ad hoc mode already in their network settings, no additional access point is needed.

In this paper, we discuss tablet device networking in the classroom using a system that requires only the ordinary functions that most tablet devices already have. The results of experiments we performed to determine the performance of the DTN used in the system are herein presented.

II. Purpose of Our System

We consider using DTNs for ad hoc networks between tablet devices to be helpful in terms of introducing tablet devices into the classroom and in terms of conducting CSCL during lessons. Our system overcomes the aforementioned problems through its use of tablet devices for two reasons:

- It requires only tablet devices when in use.
- It transmits data stably.

III. System Overview

We implemented an application to examine how the communication between tablet devices is conducted and whether or not ad hoc networks help CSCL. Our system consists of a collaborative learning (CL) application with which students can exchange ideas and a DTN service for sending and receiving the data (Fig. 1). These two components run as different processes. The tablet devices communicate with each other over a DTN above an ad hoc network between tablet devices.

The application enables students to exchange content, either inside or outside the classroom, in the following ways:

- Students can input their ideas through handwriting or photos.
- Students can send content to each other and exchange feedback.

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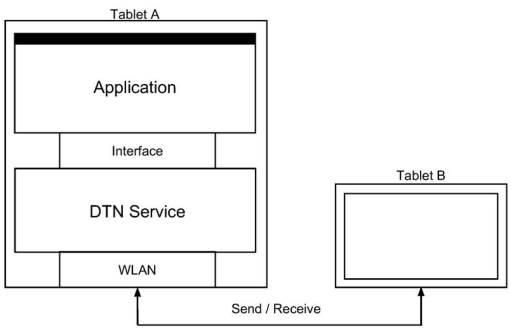

Figure 1. System architecture.

- Students can see content from others and change their own activity in response.

In this work, we focus primarily on the system being used in situations where students exchange their ideas in the classroom. However, the system can be used with additional settings, too:

- Students can exchange their own data in a laboratory.
- Students can exchange photographs in a zoo.

Each student can send images with the application to share information or to ask questions. At that time, the application forwards the data to the DTN service, and the DTN service then delivers it to another node. We chose potential-based entropy adaptive routing (PEAR) [3] as the routing algorithm in DTN. If the DTN service in the destination node receives data, it gives the data to the application working in the same node. If the communication between the devices results in failure, the DTN service stores the data and tries to replicate it in the same node again or in another node to create a detour.

IV. Communication Experiment

We conducted a preliminary experiment to investigate the characteristics of the DTN in both situations inside and outside the classroom. Our focus in this experiment was the time taken and delivery rate. The size of the tablet devices used was 10.1 by inches. They can communicate with each other 200 m away in a straight line with no obstacles via IEEE802.11a.

For situations inside the classroom, 14 tablet devices were deployed to create two columns and seven rows. A source node sent 100 messages to the destination every 10 seconds. The size of each message was fixed at 10 kBytes. On average, it took more than 20 seconds for the DTN to deliver the messages, and all messages were sent to the destination.

For situations outside the classroom, 3 tablet devices were carried by people moving randomly in each region(Fig. 2). Node #1 and #3 created a message to the node otherside every 10 seconds. All nodes tried to send their messages every 10 seconds. The size of each message was fixed at 727 kBytes, which was created by the CL application. On average, the delivery rate was 62%, and it took 611 seconds to deliver each message. Also, it took 353 seconds on average until the created message was first sent.

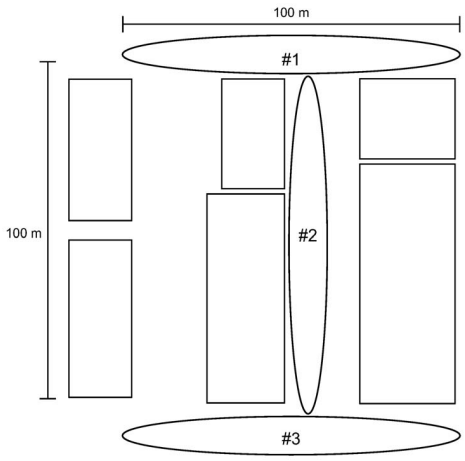

Figure 2. Node movement.

We considered the delivery rate would be enough to conduct observational learning outside while the delivery speed would be insufficient.

V. Conclusion

We reviewed both the benefits and problems associated with using CSCL with tablet devices and proposed using an ad hoc network and DTN to solve the problems stemming from wireless communication in the classroom.

We implemented a CSCL application on a DTN, where students could exchange their ideas to deepen their understanding of what they were learning. Using DTNs would provide high delivery rates in the classroom, but their delivery speed is not high. The delivery rate outside the classroom is not bad, but the delivery speed is not good enough. We plan to observe and measure the performance when the size of the data changes.

In the future, we will perform additional experiments to determine the effects of the application on students learning.

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