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Development of a Mobile Real-Time Feedback System for Engineering Education

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Abstract

In this paper, the development of a mobile real-time feedback system is reported, with discussions on its application to scenarios in education when some real-time feedback from students is necessary to better direct the delivery of specific teaching materials, lesson planning or the use of an appropriate teaching approach which are best suited to the current learning conditions. The requirements to be met by the scheme will be discussed, along with their implementation.

Keywords: Feedback; SMS; Mobile

1. Introduction

Student feedback is an important element of education. When it is implemented well, student feedback is able to provide the essential information for an educator to improve on his teaching materials, the approach to deliver them, as well as other finer details in education which would benefit even the most experienced educator [1]. However, the timeliness of feedback is a crucial factor governing the extent of its success. In many instances, feedback exercise is carried out on a cohort or students batch basis, at the end of the teaching semester. So, the feedback solicited will be used to direct efforts to improve materials or teaching approach for the next cohort of students. In a way, this is analogous to inferential control in a process control system design, where feedback occurs at time intervals which are long compared to the batch processing time, so that effectively, it is open-loop control in action between each batch update ([2] and [3]). It is common knowledge to a control engineer that such open-loop control based on last batch information is non-ideal, since disturbance factors can vary from one batch to another. Such consideration is even more important for monitoring and control of time-critical processes ([4] and [8]). Much work in the literature is devoted to real-time monitoring of processes and plants ([9] - [10]). In the same way, the nature, background, schedule, curriculum and learning environment can vary from one cohort of students to the next. However, this common phenomenon is understandable, considering the amount of workload to administer a complete student feedback and to analyze the feedback results. Till now, an efficient and systematic way of soliciting real-time field parameters from the class is mainly possible through smart classrooms with heavy infrastructure and equipment investment, and is limited to a small class. Otherwise, the "quick show of hands" has remained basically as the educator's only tool to seek the simplest "yes/no" immediate feedback from a class.

Tools developed from rapid advances in information technology (IT) could be harnessed for such purposes of feedback. There are many published works in the literature which utilize IT tools for education, commerce and manufacturing related purposes. It is the key objective of this paper to develop a mobile real-time feedback system which can be utilized by essentially the whole class of students without having to impose any noticeable costs on neither the students nor the school during the process of feedback, and without requiring expensive equipment to be installed in the classroom.

In the paper, the feedback mechanism most viable to meet the requirements will be first identified. The overall configuration of the proposed system and off-the-shelves component to realize it will be duly presented. Implementation details of the system will also be furnished.

2. Proposed Solution

In this section, the main components/processes necessary to fulfill the feedback system will be first highlighted. A system configuration to realize these processes will then be proposed, with details of its functionalities and system administration.

2.1 Constituent Processes in the Feedback System

There are generally four main processes to be present in the mobile messaging feedback system. The question(s) must first be conveyed to the targeted students. The feedback in the form of incoming messages must be consolidated for subsequent analysis. A categorization process will categorize the incoming messages corresponding to the survey/question(s) they are intended for. Finally, data processing will be necessary to yield the statistics which is needed by the initiator of the feedback session.

2.2 System Configuration

The proposed system should be able to support multiple users and multiple ongoing surveys. To facilitate operational independence, reconfigurability and future expansion, it is also desirable for the surveyors to have direct physical ownership over the mobile number in the form of the Subscriber Identity Module (SIM) Card. However, the current systems depicted in Figure 1 are not able to fulfill both attributes. A standalone application built into a GSM modem is potentially able to offer direct ownership, as well as support multiple users and multiple ongoing surveys.

A proposed architecture is given in Figure 1, and the physical configuration of this system is shown in the block diagram of Figure 2.

In this proposed configuration, a SMS feedback application is developed and stored into the internal Central Processing Unit (CPU) of a Telit GM862 GSM modem. The application is coded in Python since the CPU includes a Python Interpreter Engine that enables the modem to understand this high-level programming language. GSM communication is done through the GSM-GPRS Modem Engine. A power supply and SIM card from a local mobile service provider is all that is needed to set up this standalone system. Users are able to create, view and administer the SMS feedback using the SMS administration tools which will be described in the next subsection.

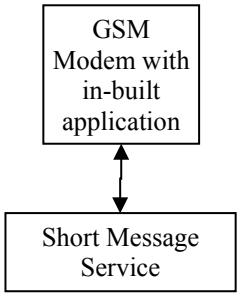

Fig. 1. Proposed in-built application using GSM modems

Fig. 2. Physical configuration of in-built application using GSM modems

2.3 System Administration

With administration of the feedback system through SMS, a surveyor is able to access the final processed data through his mobile phone. This greatly expands the application of the feedback system as it can be used even during outdoor field educational trips where there are no other devices available. Administrative functions, suitable for SMS administration, include the creating, retrieving, deleting and results-viewing of surveys. Surveyors only need to provide the correct password to access the system. This means that multiple administrators (surveyors) are allowed so that the system can be optimally utilized.

Each administrative action must be identified with a unique keyword. The main consideration is that the SMS text messages must be confined to supported character sets and message length. All English characters based SMS text messages must be confined to 160 characters while Unicode characters based SMS text messages must be confined to 70 characters.

This constraint can be overcome by concatenated or multiple SMS messages. In such cases, a mechanism should be designed to identify and arrange SMS messages that may arrive out of sequence. This mechanism will be similar to the commonly known methodology used in TCP/IP. However, unless the automation of the SMS indexing and rearrangement can be automated at the sender end, its usage can be complex and tedious.

With this system, any message received will first be checked for the keyword ‘PWD’ followed by the correct password. Once the password is verified, administrative action keywords (CREATE, DELETE, RESULTS, RETRIEVE, RETRIEVE_ALL and CHANGE_PWD) associated with the respective administration actions will be carried out as shown in Table 1.

Table 1. SMS-based feedback keywords for surveyors

Administrative Actions	**SMS Keywords (Example)**
Creating a survey	CREATE
Deleting Surveys	DELETE <SPACE> <IDENTIFIER>
Viewing survey results	RESULTS <SPACE> <IDENTIFIER>
Viewing survey questions	RETRIEVE <SPACE> <IDENTIFIER>
Viewing questions of all surveys	RETRIEVE_ALL
Changing password of system	CHANGE_PWD <SPACE> <NEW PASSWORD>

Respondents on the other hand, only need to provide a valid survey identifier to retrieve or answer the survey questions. If no password is detected from the received SMS, the system carries on checking if the first word corresponds to a survey identifier stored in the system. When verified, actions keywords such as 'RETRIEVE' and 'ANS' are detected and carried out as shown in Table 2. Only answers that fall within the range of 1 to 5 are accepted as this system is designed specifically for rating questions.

Table 2. SMS-based feedback keywords for respondents

Actions	**SMS Keywords (Example)**
Viewing survey questions	RETRIEVE <SPACE> <IDENTIFIER>
Answering questions	ANS <SPACE> <ANS1> <SPACE> <ANS2> etc.

To avoid problems on character case error, keywords identification will be case insensitive. Upon detection of the action keywords, the message contents will be extracted and stored into the system. If the command is correctly resolved, a confirmation SMS text message will be sent back to sender. If there are formatting or system errors, it will alert the sender with a SMS text message containing the error code and corrective action advices.

3. Implementation

The implementation of the mobile feedback system was done and some snapshots of thewill be furnished, together with illustrations, for better understanding of the usage of the system.

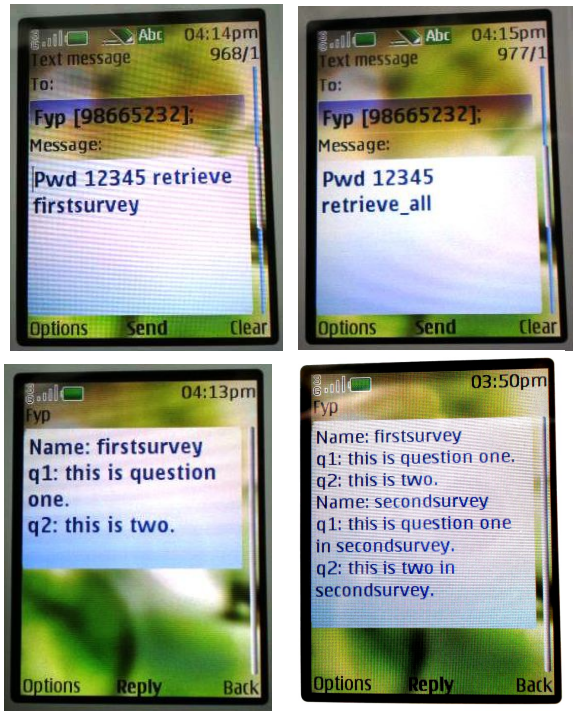

Fig. 3. Example of SMS for retrieving questions. Top pictures show SMS sent to system. Bottom pictures show SMS received from system.

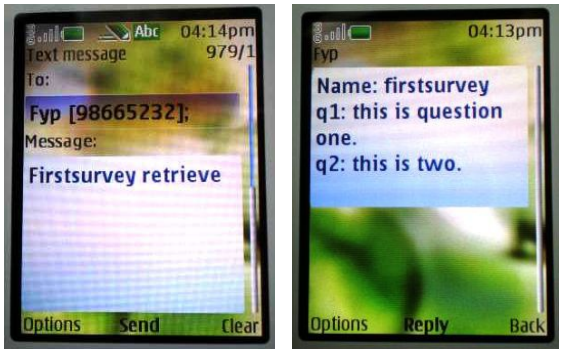

Fig. 4. Example of SMS for retrieving questions. Left picture shows SMS sent to system, right picture shows SMS received from system.

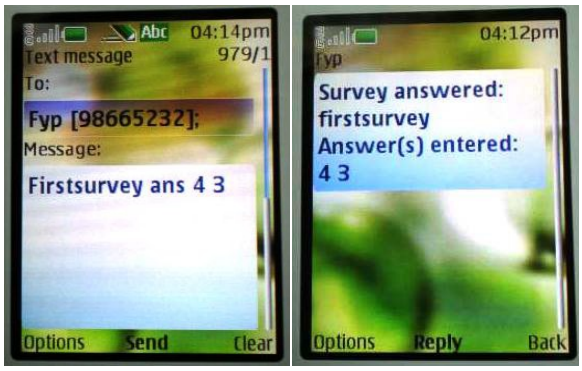

Fig. 5. Example of SMS for answering questions. Left picture shows SMS sent to system, right picture shows SMS received from system.

4. Conclusions

Mobile technologies have continued to enable new innovations and approaches in education. The development of a mobile real-time feedback system has been presented in this paper, with details on its requirements, configuration, functionalities and implementation.

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