Running head: SMS BASED QUERYING

An SMS Based Querying System for Mobile Learning

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Abstract

Mobile phone is the most widely used mobile device. Every mobile phone user can conveniently communicate with each other through SMS (Short Message Service) text messages at very low price. It is so commonly used that, in some countries like China, an SMS culture has emerged. Although there are some SMS based applications in m-Learning, most of them are only for administrative purposes, like delivering messages to students as reminders or alerts for some learning activities. In fact, text messages of SMS can effectively convey small pieces of materials related to learning processes, like course notes, items of glossary, small pieces of explanation and some links to detailed information etc. In this paper, we introduce a system for querying information and knowledge by the use of SMS in a mobile learning environment. The proposed system consists of a GSM Module (GSMM), a Dialogue Control Module (DCM), a Querying Processing Module (QPM) and a Knowledge Base (KB). GSMM includes a micro-controller and a GSM communication device with a SIM card in it. It processes the users' messages according to our defined protocol and acts as the interface between the mobile infrastructure and the rest of the system. DCM handles the content of the requesting messages and produces suitable querying tasks for QPM, which in turn searches and matches information from KB or Internet to produce suitable answering messages for the users according to their requesting messages. To help the system better understand the content of messages, natural language processing and theme recognition techniques are applied to message processing modules. Several scenarios about course notes and glossary querying are illustrated in this paper.
Keywords: short message service; GSM; knowledge querying; dialogue control; natural language processing.

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1. INTRODUCTION

Mobile phone market is growing very fast globally in recent years. According to the report of Pyramid Research, the mobile phone users will be 2.6 billion at the end of this year. More and more people are using mobile phones for business, education and personal activities in many countries, especially in developing countries. Among all the functions provided by mobile phone, Short Message Service (SMS) is regarded as the most money saving and convenient way of communication, and is still widely used for different purposes such as communication, entertainment, management and learning. For examples, in China, the world's largest and fastest growing mobile phone marketplace, SMS is the most popular and favorite mobile service. According to the monthly statistics of MII of China [MII, 2006], there are 443 million mobile phones by September 2006, and totally 310 billion messages delivered from January to September in 2006. In fact, as reported by XinhuaNet of China [Feng, 2006], the number of short messages has increased by 300 times in six years (from 1 billion messages in 2000 to 304 billion in 2005). Short Message Service has been employed by other service providers such as Internet service providers and media companies to deliver messages to their users or customers. Many people are willing to send greeting messages, poems or short stories by SMS, and a unique SMS culture, just like TV culture as we know, has emerged and been recognized in China.

Compared with other online functions such as tone service or Web browser of mobile phone, an SMS message can be delivered at any time you like, and automatically stored where it can be re-read, which proves particularly useful in the case of fairly detailed information that might otherwise be forgotten, such as test scores, booked class room numbers and short course

notes in education environment. For example, a teacher can deliver to students short questions or quizzes after class by using short message notifications.

There have been wide applications of SMS in E-Learning because of its advantages of convenience, popularity, low maintenance cost and so on. For example, SMS text messaging was used as an experimental method of providing a form of “mobile scaffolding” at a fundamental level to support those needs, and guide students towards independent self-management; i.e. creating a personal mobile support context for learning and doing [Stone, 2004]. Wang et al [Wang, 2003] employ mobile services including SMS to assist students with three kinds of information awareness (learning status awareness, schedule awareness, and mentor awareness) to promote learning performance of students. As mobile learning becomes more and more regarded as a future of learning [Ragus, 2006], several projects have been launched in Europe, Asia and Africa [Keegan, 2004], which demonstrates that SMS is one of the important ways to support managing, teaching and learning. For example, Cell phones prove to be a suitable way to leaning English on the air with the help of both SMS and MMS for delivering leaning content [Collins, 2005]. However, most of the current applications of SMS in e-learning or mobile learning are about delivering simple predefined messages for notifications or alerts to facilitate management or learning support. In this paper, we focus on the structure and functions of a system for querying information and knowledge by the use of SMS text messages, which can convey small pieces of materials related to learning processes, such as items of glossary, small pieces of short course summaries or examination preparation notes, student guidance, answers to exercises, second language learning tips etc. in a mobile learning environment.

The remainder of this paper is structured as follows. In the second section, we present the structure of the system and discuss each of the four modules of the system, while giving more

details on dialogue processing; in the third section, we introduce several simple scenarios to explain the functions of the system that is still under construction; we shall finish with some conclusions and further work.

2. SYSTEM OVERVIEW

In this section, we introduce the structure of our system which is to support students to query information and knowledge through SMS in a mobile learning environment. The system consists of a GSM Module (GSMM), a Dialogue Control Module (DCM), a Querying Processing Module (QPM) and a Knowledge Base (KB), as depicted in Fig. 1. By receiving from and sending to users messages through the GSM network, GSMM acts as the interface between the mobile infrastructure and the rest of the system. The processed requests are then transferred to DCM, which handles the content of the requesting messages and produces suitable querying tasks for QPM, which in turn searches and matches information from KB or Internet to produce suitable answering messages for the users according to their requesting messages.

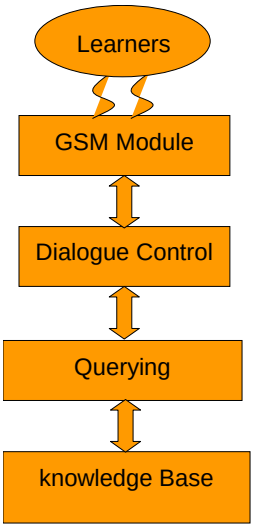

Figure 1. The system structure

2.1. GSM Module

GSM Module consists of a GSM communication device with SIM cards in it for connecting with GSM networks, and a micro-controller (MCU), which processes messages coming from the GSM communication device and communicates with upper computer hosting DCM and other modules. Its hardware structure is depicted in Fig. 2.

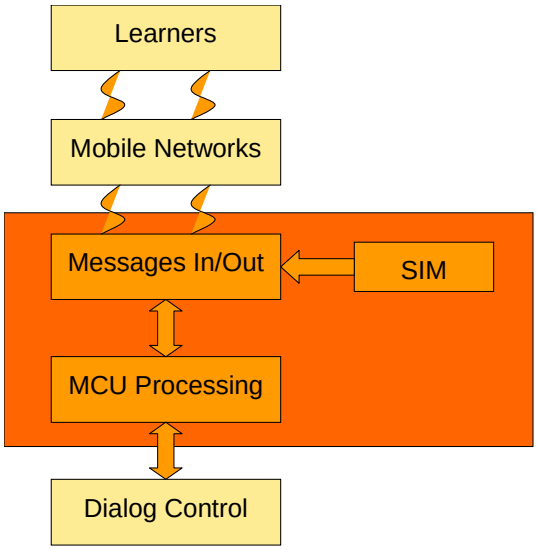

Figure 2. The hardware structure of GSM

The main function of the program running on the micro-controller is to handle the communication with both upper computer and GSM device, to process the user request messages according to certain pre-defined message protocol, and to transfer them to the dialogue module for further processing. We use Siemens TC35i hardware module as the GSM communication device [Siemens AG, 2003], and use Atmel AT89S52 micro-controller as MCU to control the TC35i module by sending AT commands [Siemens AG, 2003]. For instance, MCU uses command AT+CMGR to read the content of a short message that comes from a student through mobile networks. After MCU sends the AT command, GSM hardware module will reply messages to MCU. If it succeeds, MCU will receive data OK. If not, MCU gets data ERROR. Similarly, more communications and tasks can be done through other AT commands. Figure 3 shows the flow chart of the message receiving and sending involved in this module.

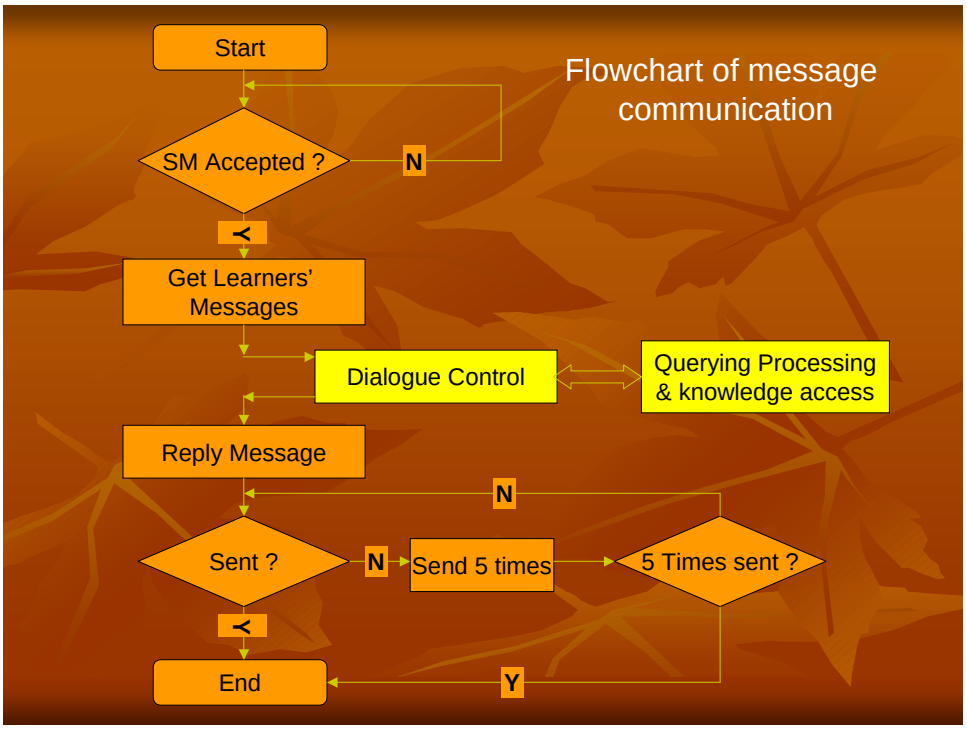

Figure 3. Receiving and sending message

The GSM module keeps awake to receive short messages from students, and transfer them to the dialogue control module, and deletes the successfully transferred short messages to save space. It is also responsible for sending answer messages from the dialogue module to the students in a robust way.

2.2. Dialogue Control Module

The main task of the Dialogue Control Module is to control the dialogue between the students and the system. Most of current systems involving SMS in education do not need this task, because they only need to SEND to students some information by short messages. As a querying system, dialogue control is inevitable here because the system needs to RECEIVE and RECOGNIZE the request messages from the students first and try to give the relevant answers to the students. If the information in a message for a querying is not complete, the system may need

to ask uses for confirmation and then give the right answers. Also, if it needs several steps to complete a certain querying process, i.e. several sending and receiving turns between the system and a student, the state of the dialogue need to be stored. So, recognition, confirmation and statefulness are critical to the dialogue control module in our querying system. The tasks of this module are as follows:

- Handling the content of the requesting messages
- Controlling the dialogue process
- Producing suitable querying tasks for QPM

Currently, there are several ways of modeling dialogue process, namely:

- Querying protocol based (Structured message) systems;
- Pattern matching based systems;
- Finite state based systems;
- Frame based systems; and
- Agent based systems.

Among these systems, agent based systems are designed to permit complex dialogues, while the protocol based systems can provide the minimum dialogue process. McTear [McTear, 2002] has presented a very good introduction to some of the systems. However, our system is not designed as a pure dialogue system. Instead of long dialogues, the purpose of our system is to provide information and knowledge querying with the help of relatively simple dialogue process with at most 2-3 turns. As a querying system, it functions between Question-Answering and the Spoken Dialogue Systems. With this understanding, we build the dialogue process module based on both querying protocol for structured request messages and frame approaches for multi-theme natural language text messages.

We will explain the protocol-based application in scenario 1 in section 3, while focusing on analyzing the unstructured text by frame based multi-theme dialogue control and Natural Language Processing (NLP) in this section.

To recognize the theme of a request message, a set of describing words is predefined for every registered querying theme of the system. For example, if a user's input includes key words such as TEST, PAST, SCORE, a course name like COMPxxx etc. then he may have the intention of querying the score of the course. For the cases that an input text message includes different key words from different themes, an algorithm from [Chen; Wen, 2005] will be launched to resolve the confliction by user confirmation:

1. $T_t = T_1$
2. while $t \le sizeof(registered \quad themes)$
3. {
4. for each describe word w of T_t
5. if w is substring of I
6. add T_t to $Theme$ and break
7. $t = t + 1$
8. }
9. if $sizeof(Theme) = 1$ return $Theme$
10. else return $Confirm(Theme)$

The algorithm starts from the first registered theme T_1, and then for each registered theme T_t, looks over its describing words dictionary. If any of the describing words w is the substring of the user's input message I, T_t will be added to the possible theme set Theme. After the loop, if the number of themes in Theme is only one, then the theme is the intention theme, or else a further confirmation will be taken to figure out the user's intention by calling a function Confirm(Theme).

If the incomplete information occurs when comparing the frame of a theme, the system should confirm the user's intention by asking the specific information lacking in the request message. And then the user will give a clearer answer.

The dialogue control is the core function of this module, which manages all the registered themes and controls dialogue flow. The control process can be summarized by the following frame-based dialogue control algorithm from our previous work [Chen; Wen, 2005]:

1. $S_i = ThemeRecognize(I)$
2. $S_t = S_{i1}$
3. while $S_t \neq S_F$
4. {
5. $A_t = NextAction(S_t)$
6. invoke A_t
7. O_t = environment response to A_t
8. $S_{t+1} = NextState(S_t, A_t, O_t)$
9. $t = t + 1$
10. $S_j = ThemeRecognize(I_t)$
11. if $S_i \neq S_j$ then $S_t = S_{j1}$
12. }

It is different and more advanced compared with traditional dialogue process algorithm [Levin, 1999]. At first, dialogue theme is recognized as S_i according to the user input I. Then it starts in the initial state S_{i1} of theme S_i. S_t denotes the system state at turn t. The function "NextAction" determines the next action A_t to be invoked, and the function "NextState" updates the state variables with the external observations. After that, a new user input I_t should be analyzed to recognize its intention S_j. If S_i is not the same as S_j, then system state should be updated to the initial state S_{j1} of theme S_i. The process repeats until a final state S_F is reached.

To facilitate understanding unstructured text of SMS message, we employ natural language processing to extract the appropriate key words and relevant values. A querying message in natural language provided by a user is first tagged by a Part-of-Speech tagger. In a sentence, the Part-of-Speech of a word correlates to its position in the sentence. For example, an adjective always appears before a noun. We can use Hidden Markov Model (HMM) to describe the Part-of-Speech possibilities, and WordNet [Fellbaum, 1998] is useful for this step, for it includes almost all of the possible Part-of-Speeches of the word. After a sentence has been tagged, the result will be processed by a syntax analysis module. Syntax analysis is defined to be the process to find the grammar tree for a tagged sentence, which is then combined with semantic analysis to support key words extraction and the theme recognition. More details about these topics can be found in our previous work in [Chen;Wen, 2005] and [Chen;Wen, 2006]. The flow chart is depicted in figure 4.

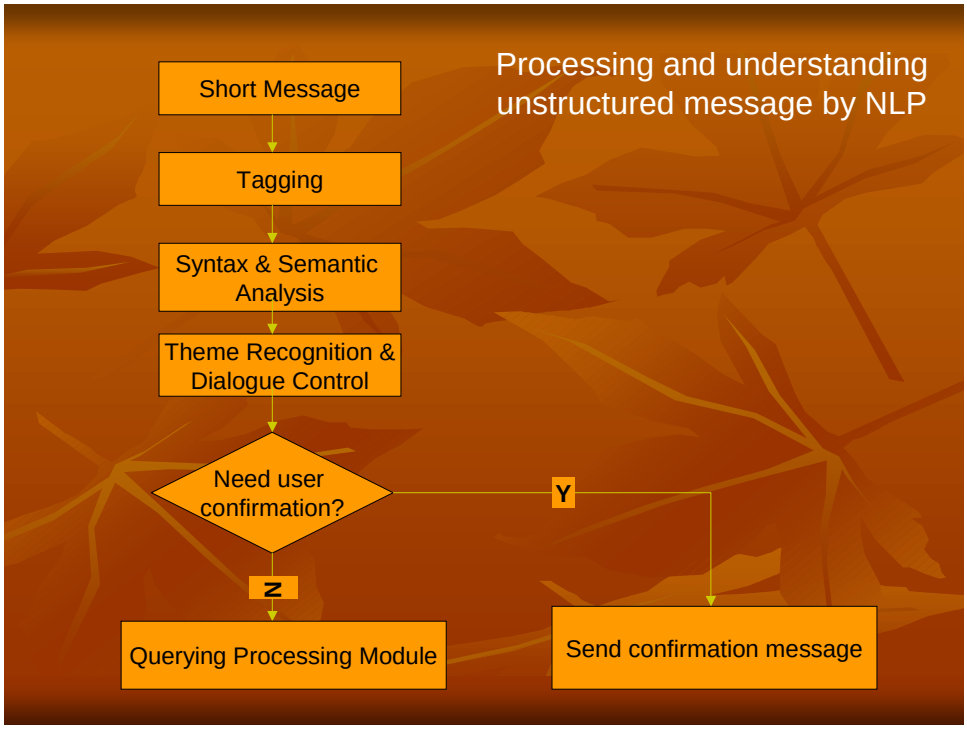

Figure 4.The flow chart of dialogue control and NLP

2.3、Querying Processing Module and Knowledge Base

The main tasks of the querying processing module are receiving the query requests from DCM, querying or searching information from database and/or knowledge base of the system, or from Internet, and then producing suitable answering messages according to their the requesting and sending them back to DCM. As you may have noticed, there are several different knowledge resources the system may access:

- Learning database, which includes predefined information of the mobile learning environment, depending on the categories and functions provided by the querying system.
- Cyc knowledge base [Siegel, 2004], a generic common sense knowledge base, also including specific information of some domains, which supports reasoning and complex knowledge querying, and provides CycL and Java API for applications based on it.
- Internet, querying the Internet on behalf of the students with the help of Google, Ask.com, or querying some knowledge intensive sites like Wikipedia.

We use different methods to query information according to different knowledge resources listed above. For example, we directly query information (by SQL) from the database according to the querying string conforming with the protocol, and the recognized theme and features, or query information with the help of Cyc knowledge base by CycL or Java API, or query knowledge from outside knowledge resources such as Wikipedia by Wikipedia API or Web pages on the Internet by Google Search API.

3. SCENARIOS

In this section, we present three brief scenarios to demonstrate the functions and applications of the system in different styles of messages and dialogue. The first scenario is to illustrate protocol based querying, while the second and the third are to illustrate the cases in which a user uses the natural language text messages for querying information or knowledge.

Scenario 1 – Protocol based querying

(1) A student sends “Get CN-3.3 COMP611 ”, where all the words are following the predefined protocol;

(2) The system parses the string according to the protocol;

(3) Queries the database;

(4) Sends the result to the student.

Scenario 2 – Text based querying

(1) A student inputs a message “Did I past the last test?”

(2) By NLP analysis, the system recognizes the keyword TEST and the meaning of PAST (asking for the SCORE), finding insufficient information of the course name (Do not understand “last” at this stage.) for the SCORE theme frame

(3) The system asks “which course are you asking for?” then student gives the further answer

(4) The system queries the database and replies the score to the student.

Scenario 3 - Text based querying with access to knowledge base

(1) A student inputs a message “what is catalyst for?”

(2) By NLP analysis, the system extracts the word CATALYST and finds that there is no information about it in the local learning database.

(3) The system tries to query Cyc knowledge base, which happens to have a good collection of knowledge of Chemistry, and finds the definition of CATALYST.

(4) The system replies to the student the information produced by Cyc's paraphrasing about Catalyst (combining with concepts such as ChemicalReaction etc.)

4. CONCLUSIONS AND FUTURE WORK

In this paper, we have introduced the structure and mechanisms of an SMS based querying system. The system currently employs GSM communications, dialogue control and NLP based message processing to provide the knowledge and information querying in mobile learning environment. Although the implementation of the whole system is not finished yet, the GSM module and dialogue module, including the multi-theme recognition based on NLP have been done. The future work will focus on the implementation of the querying processing module, and knowledge acquisitions from knowledge bases and the Internet by integrating several APIs such as Cyc API, Wikipedia API and Google Search API.

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Table 1

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Figure Captions

Figure 1. The system structure.

Figure 2. The hardware structure of GSM.

Figure 3. Receiving and sending message.

Figure 4. The flow chart of dialogue control and NLP.