

A Market Anywhere: Establishing an SMS-based Virtual Market in Developing Regions

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Abstract

We present a mobile phone based virtual market system to facilitate socioeconomic activities in developing regions. The system is built upon SMS (Short Message Service) platform. Our system, enhanced with novel integration of NLP (Natural Language Processing) technologies, provides an intuitive and reasonable means of exchanging market information across long distance and has a potential of benefiting over a billion mobile phone users across the globe, especially those in poor regions.

Keywords

Developing Regions, Mobile Technology.

ACM Classification Keywords

H.5.2 [Information Interfaces and Presentation]: User Interfaces -- Prototyping.

Introduction

In rural communities, lack of reasonable and reliable information infrastructure has been a serious cause of economic deterioration. For instance, farmers living in remote villages have little access to market information without making an energy extensive trip to a local market, and direct trade among people living in far apart villages is not realistic without costly intervention of middlemen [2, 3]. Consequently, many farmers fail to trade their products for fair prices in a timely manner.

In this paper, we propose the design of an SMS-based virtual market system that establishes a centralized network of market information by connecting buyers and sellers from different geographic locations. In developed countries, there are widely accepted virtual market systems such as eBay. However, most of these systems are web-based, making it difficult to access from rural areas due to a lack of reliable Internet infrastructure. Our SMS-based system has advantages in terms of ubiquity and cost; there will be no additional technological investment necessary on the user side since most people in developing countries already have access to SMS-enabled mobile phones [2]. The business investment on the operator side will also be minimal as the only equipment needed to begin with is a database server connected to the Internet. The concept we propose will exhibit an attractive business opportunity to local entrepreneurs, considering that there are many conceivable earnings models such as targeted advertisements and profit share contracts with mobile carriers. A novel contribution of our research is the integration of NLP technologies as a key component of our system. Such integration not only enhances the input flexibility but also overcomes several shortcomings of the SMS platform.

Related Work

Recently, several experimental projects have been deployed in developing regions to provide technological solutions to market-related issues, including Zaca [5], Xam Marsé [6], Farmprices [7], and TradeNet [8] to name a few. In this paper, we have given a particular attention to CellBazaar, one of the most successful SMS-based “e-marketplace” services matching buyers and sellers within Bangladesh, since CellBazaar uses a

menu-driven interface to access product information, which stands in a sharp contrast to our NLP-enabled system [1, 3]. It would be interesting to compare our system to other similar ones such as Nokia Life Tools [9] and Google SMS [10], but we had to omit it due to the space limitation. In short, we believe our system enabled with the natural language interface has more potential than other command-based or keyword-based systems in terms of flexibility and versatility.

System Overview

SMS Platform: The current trend of ICTD (Information and Communication Technologies and Development) research has shown that mobile phones, in particular using SMS as the platform, are the most ubiquitous information infrastructure available in developing regions [2]. However, SMS platform has some obvious limitations. First of all, simplicity of SMS user interface restricts the use of visual aids in the form of help-tips and input forms. CellBazaar successfully overcomes this constraint by introducing an interactive menu-driven SMS interface, composed of a series of multiple-choice questions. However, CellBazaar fails to address another constraint of SMS, namely the limited content length (e.g. 160 characters per text message). Due to the limitations of the menu-driven interface, CellBazaar requires the user to engage in a series (often at least five) of SMS transactions to complete even a simple query. This raises serious concern since each text message incurs additional cost, and accumulation of such cost could discourage users from using the system in a country like Bangladesh, where per capita income is as low as USD 470 [3]. We propose that integrating a natural language interface to the virtual market system overcomes the aforementioned constraints of SMS platform and addresses the drawback of CellBazaar.



Figure 1. Virtual market prototype in use: (left) a sell request of a fridge phrased in natural language; (right) an example response to a buy request.

Natural Language Interface: Our natural language interface allows almost any complex request to be organized into a sentence or two, which can be sent over a single text message (Figure 1). It also allows advanced users to phrase more complex and sophisticated requests as a single succinct sentence and obtain more accurate information easily. One of the most difficult challenges in deploying a technologically advanced system in developing countries is the issue of semi-literate users who are challenged by spelling. Our system currently addresses the issue partly by correcting misspelled words and supplementing missing words, but we will specifically investigate the issue more for an upcoming non-English implementation.

Component Overview: Figure 2 shows a brief structure of our system. Content analyzer/formatter, as a front end, processes an incoming message into a format that can be indexed and stored in the database. If the input is in natural language, it consults with the NLP engine to parse it into a machine-readable format. Ranking engine is used to sort query results in the order of relevance. We defined relevance as a function of parameters such as name similarity, price range match, and location proximity.

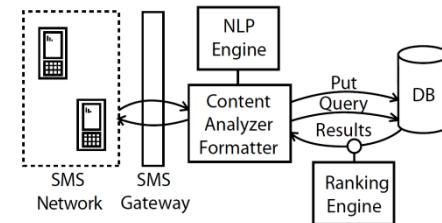


Figure 2. Components of virtual market prototype

NLP Engine Algorithm: Researchers have investigated NLP-related technologies in attempting to invent a human-friendly way to access a data-intensive database [4]. Within the scope of this paper, we have equipped our prototype system with a simplified implementation of NLP engine as a proof of concept, a decision list consisting of (pattern \rightarrow field_type) rules, where pattern is defined by a regular expression or a dictionary, and field_type is any of {action, product_name, price_range, location}. Given a natural language input, the NLP engine algorithm (Algorithm 1) extracts a set of fields that can be used to index the input in the database. Any phrase in the input that does not correspond to any of the predefined fields is stored in the database as a raw text so that when the NLP engine does not understand a query well, the system can still return a fairly reasonable response by using raw text match as a fallback action.

Algorithm 1. NLP Engine (*input*)

1. **while** *decision_list* is not empty
2. pop (*pattern* \rightarrow *field_type*) from *decision_list*
3. **if** any *phrase* in *input* matches *pattern*
4. *fields*[*field_type*] = normalized *phrase*
5. remove *phrase* from *input*
6. store *fields* and *input* in the database

Experimental Assessment

We have evaluated the efficacy of our system compared to that of CellBazaar as a baseline by simulating a real world situation where a series of buy and sell requests are submitted to the virtual market server. We have asked four fellow students, who are unfamiliar with our NLP engine, to generate a set of 100 queries in English. Some example queries are: "sell 20 tomatoes for \$15", "buy tomato 50 cent each at Jamalpur", etc. We have submitted those queries to the system and measured the accuracy of the responses in terms of field extraction success rate. Field extraction success rate is a reasonable measure of our NLP engine since once a set of fields is successfully extracted from an input query, the following path to response generation is identical to that of CellBazaar. The result showed a very high success rate for each field (over 90%), and all the fields were successfully extracted from 87% of the queries. In any of these successful queries, the user would be able to get enough information to initiate a trade in only two SMS transactions (one query for product search and another for contact information). In contrast, CellBazaar usually takes at least five SMS transactions to complete each of those queries [3]. There are currently over one million Cell Bazaar users in Bangladesh, a quarter of whom use the service on a regular basis, which let us estimate that the overall SMS expenditure in Bangladesh resulting from CellBazaar is roughly 5 million USD per year provided that SMS charge in Bangladesh is USD 0.014 [3]. Based on the estimation, our system could save roughly 3 million USD each year on users by reducing the number of SMS transactions per task from five to two on average.

Conclusion and Future Work

We have presented a solution to the problem of trading in rural regions caused by a lack of organized information infrastructure. Establishing an SMS-based virtual market system will provide people in developing regions with an easy access to market information and facilitate inter-village trades. We have shown that full utilization of the virtual market system can be achieved by overcoming the constraints of SMS platform with the integration of NLP technologies. As a part of the follow-up study, we are localizing the prototype to Thai language and planning to deploy the system in Thailand, for we have a fairly good access to the country. At that final stage, we will re-evaluate the system based on the overall user satisfaction and improve our system accordingly.

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