

KNOWLEDGE SERVICE-ORIENTED BUSINESS MODELS BY CONVERGENT INTEGRATION OF AUTONOMOUS AND PERVASIVE COMPUTING TECHNOLOGIES

Keedong Yoo

Dept. of Management, Dankook University

Abstract

A knowledge service-oriented business has not been highly progressed because most of potential users do not expect much on it by chronic feeling of disappointment about conventional strategy of knowledge management. Since the approaches to manage and utilize knowledge within an organization were identically split into one of knowledge acquisition and distribution, few practical ways providing knowledge simultaneously with acquiring have been proposed. To enhance maximum utilization of knowledge in our ordinary life with guaranteeing its quality and reliability, a business based on the knowledge service must be underpinned by the rationality in knowledge acquisition regardless to types of knowledge, but also the autonomy in knowledge processing preserving accuracy and convenience in use. This paper aims to introduce several types of business models caused by the knowledge service. Also specific component technologies enabling the knowledge service revealed in each business model are illustrated so that practitioners or entrepreneurs who intend to prepare a new business can consult.

Keywords: Knowledge service, Autonomous computing, Automatic knowledge acquisition and distribution, Business models, Context-awareness

Introduction

As the level of education and life is improved ever before, the user's willingness and desire to solve his/her problem increase more and more. In the same vein, a business to fulfill the needs for assistance in resolving ordinary problems also gains much interest ever before. However, a knowledge service-oriented business has not been proliferated because of various reasons: One very critical and fatal cause can be found in the disappointment on the strategy of knowledge management boomed around late 90's. The main concern of knowledge management focused on identifying and managing implicit knowledge resides in human brain, and therefore to some degree, its contribution can be discovered in changing companies' viewpoint into their employees as the sources of companies' intellectual assets (Nunes et al., 2009; Zhou et al., 2011). However, to acquire knowledge, most of companies were simply dependent upon employees' voluntary articulation of knowledge. Neither the quantity of knowledge nor the quality of its contents could be satisfactory, because employees' burden to manually register their knowledge onto a KMS (knowledge management system) was serious. They also pointed out a kind of ambiguity in articulating knowledge because no standard guidance or templates to describe knowledge were provided. Although some pieces of knowledge had been registered on the KMS, each piece could not help being separately formatted. Worse than these, conventional approaches of knowledge management are split up into two categories: either the acquisition of knowledge or the dissemination of knowledge. The trials for knowledge acquisition did not consider the procedure for knowledge distribution, and vice versa. Especially conventional researches related with the distribution of knowledge have simply focused on how a system correctly or timely provides knowledge to users without considering how the knowledge must be formatted during acquisition. They simply assumed that the format of acquired knowledge had been defined in a tale with the format of distributed knowledge. Whatever the format a piece of knowledge may have, the format of acquired knowledge must be a reference model for a proposed method of knowledge distribution to have the practical value (Kwan and Balasubramanian, 2003; Yang and Huh, 2008; Yoo, 2013b). For these reasons, the KMS, the artefact through not a little endeavor in time and money, could not be practically utilized to perform daily business activities, and therefore most of users became disappointed at the validity of knowledge management: eventually few businesses related with the knowledge and its service are exhibited.

The knowledge service is the information technology-based fully automated service of knowledge acquisition and distribution at anytime and anywhere (Yoo, 2013a). Using the knowledge service, users can accumulate and extract knowledge properly applicable to their possible problems if they are located within the area of date communication

network. Hand-held devices, such as smartphones and smartpads, enable users to experience the service by delivering adequate knowledge according to their direct requests or to their automatically inferred situations in a real time basis. The service of 'Siri' operated under the iOS environment is a well-known example processing text-based knowledge using the voice recognition technology and speech-based user interfaces. A business underpinned by the capabilities of the knowledge service is indispensably required to fulfill the needs of current users.

This paper aims to address not only the business models derived by the knowledge service, but also specific enabling technologies constituting each model. Also, to demonstrate the validity of proposed business models, an example prototype which acquires and distributes knowledge related with ordinary dialogue is introduced.

Candidate business models through knowledge service

In this paper, four types of knowledge service-oriented business models are introduced as examples, which emphasizes not only acquiring knowledge from knowledge possessors automatically but also archiving and distributing knowledge in a fully automated manner. Usually knowledge can be discovered in dialogues, meetings, conferences, and any kinds of similar events gathering people, therefore their knowledge-capturing activities such as recording, dictating, and photographing are the very references to initiate automatic acquisition of knowledge. Once knowledge has been captured in any format (*.wav, *.txt, *.jpg), its topic (or keyword) must be automatically identified so that the captured knowledge can be also automatically filed in a knowledge server under the extracted topic-based title. According to the types of knowledge, in other words whether the knowledge is voice-based or image-based, three types of business models can be derived; according to how knowledge can be delivered to users, one business model is exemplified.



Fig. 1 BM#1. STT-based automatic meeting minutes

BM#1. STT-based automatic meeting minutes

Lots of knowledge are usually discussed during meetings or conferences, and therefore documenting what participants discuss especially focused on critical information or knowledge is very important. Since most of participants attend a meeting with holding various types of mobile devices, such as smartphones and smartpads nowadays, they do not have to directly write down meeting minutes if any kind of mobile devices can process recording and dictating what they discuss. Once the recording and dictating is completed, the resultant file must be classified and archived into pre-defined categories. To be done so, the topic or keyword of the given dialogue must be automatically identified in advance using automatic document summarization technology. <Fig.1> shows how the STT (Speech-to-text)-based automatic meeting minutes can be formulated.

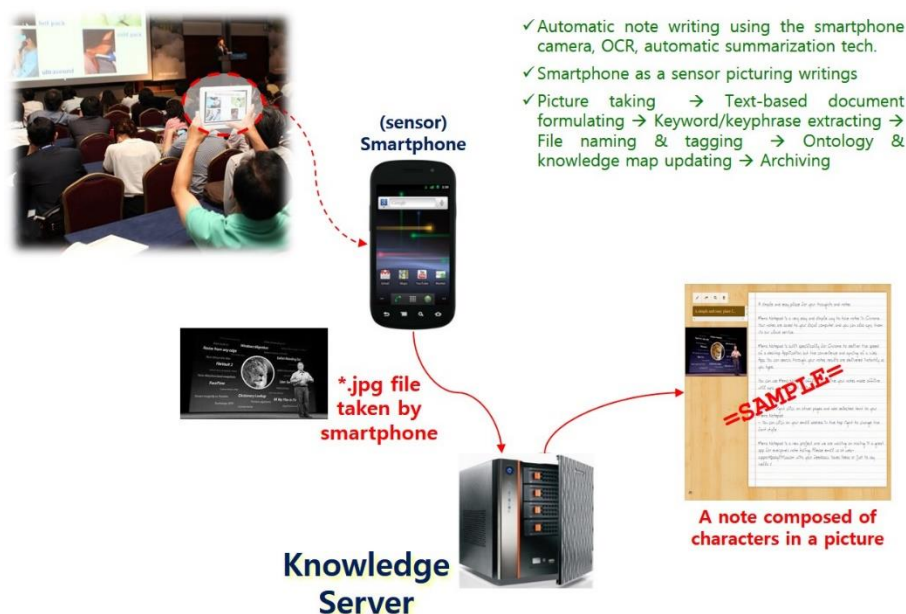


Fig. 2 BM#2. OCR-based automatic note writing

BM#2. OCR-based automatic note writing

Lots of knowledge are announced during presentations or lectures, and therefore audiences usually take pictures of the displayed materials or slides not to miss contents in them. The contents, especially character-based contents can be automatically captured if the OCR (Optical Character Recognition) technology is applied, and a note containing the contents in the pictures can be automatically made. As the same way in STT-based automatic meeting minutes, the topic or keyword of the given picture can be automatically identified using automatic document summarization technology. <Fig.2> shows how the OCR-based automatic note writing can be processed.



Fig. 3 BM#3. Automatic content summarizer

BM#3. Automatic content summarizer

As understood in the BM#1 and BM#2, to automatically figure out what subjects are dealt in any types of media file, the technology of automatic document summarization plays the most important role. Automatic document

summarization is the process of reducing a text-based document to extract a summary that retains the key points of the given document. The notion of ‘too-long-don’t-read’ so called reveals the interests the automatic document summarization technology is needed nowadays. Various types of the Web contents are typical examples the technology must be applied to, because recently those kinds of Web-based contents are dealt on small sized screen-based devices such as smartphones and smartpads more and more. <Fig.3> shows how the automatic content summarizer initiates its function and how results are outputted.



Fig. 4 BM#4. Context-based knowledge recommendation

BM#4. Context-based knowledge recommendation

Once automatic acquisition of knowledge has been completed, acquired knowledge must be also automatically delivered to users according to user's request or intention. In many cases, knowledge are usually extracted and distributed under user's direct requests, however it must be also autonomously done according to inferred user's situation. The context data, such as time, location, schedule, identity, and preference, etc. play the role to infer user's specific need or intent, and one or more than one of inference algorithms must be applied. The resultant knowledge or information determined to be proper to user's problem situation can be transmitted onto user's devices as a kind of recommendation. Whether the recommended knowledge would be used or not is solely dependent upon user's decision. <Fig.4> shows which types of context data can be gathered to conclude user's situation and how the resultant knowledge can be serviced.

Enabling technologies

To generate the services illustrated in the previous business models, various interdisciplinary technologies especially focused on identifying the topic or subject of captured voice and image data need to be converged. One common workflow exhibited in previous business models is to automatically entitle the captured voice-based or image-based knowledge using automatically extracted topic or keyword of the given text-based file which has been converted from the captured original data file. The part of commonness means the most important functions are involved: therefore the automatic document summarization extracting topics or keywords of the given text-based file, the smartphone microphone-based STT dictating recorded dialogues, and the smartphone camera-based OCR wording characters in images are key technologies enabling proposed knowledge services. Also, several peripheral technologies completing one set of the knowledge service are ontology-based knowledge map, cloud storage-based automatic archiving, and autonomous knowledge recommendation based on context reasoning, etc. In this paper, instead of explaining each technology in detail, how these technologies are logically connected and integrated and how each technology constitutes to provide the resultant knowledge service are illustrated, as follows. <Fig.5> is a framework showing how related technologies are sequentially connected.

STT module

- Recording & dictating dialogues
- Converting dictated data file into text-based format (*.txt)

- Storing text data in the user device (temporarily)
- Transmitting stored data to the cloud server for further analysis

OCR module

- Extracting texts from image (picture)-based documents
- Converting texts into text-based format (*.txt)
- Storing text data in the user device (temporarily)
- Transmitting stored data to the cloud server for further analysis

Automatic document summarization module

- Extracting keyword/keyphrase of text-based documents stored in the cloud server
- Confirming the validity of extracted keyword/keyphrase by users
- (if valid) Generating a file name by combining extracted keyword (topic) and the date corresponding dialogue/image was captured
- (if invalid) Generating a file name by combining user-defined keyword (topic) and the date corresponding dialogue/image was captured

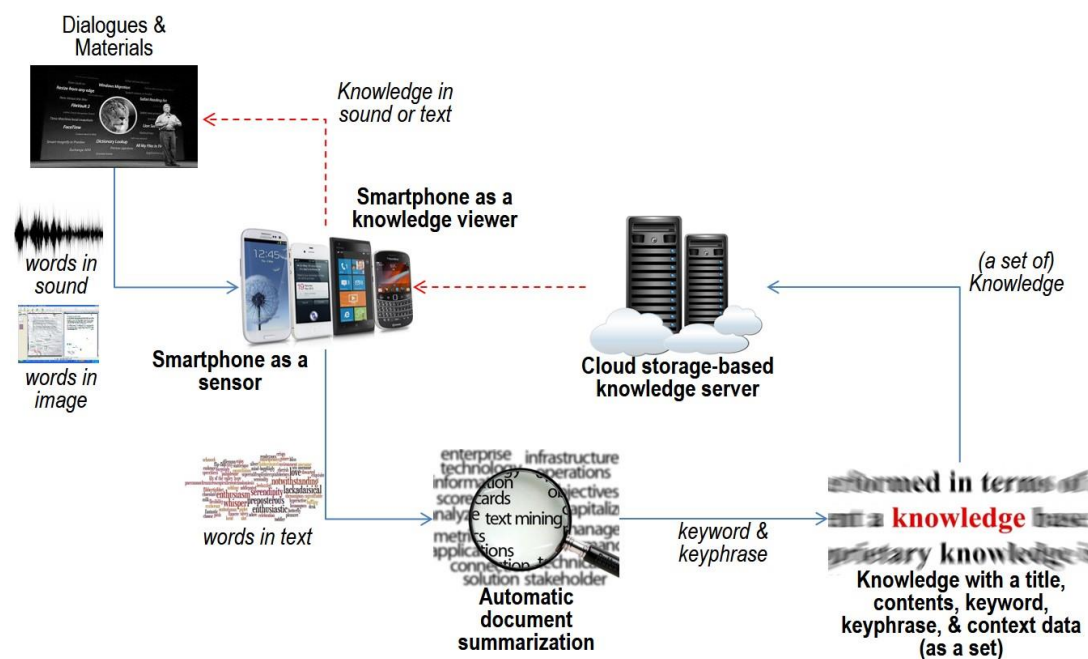


Fig. 5 Framework of Knowledge Service

Ontology-based knowledge map

- Determining topic (keyword)-based knowledge categories used in storing each piece of knowledge
- Defining hierarchy and relationships (properties) between categories
- Designing and implementing a knowledge ontology

-
-
-
-

Automated knowledge mapping module

- Profiling knowledge automatically w.r.t. title, data, text-based document (*.txt), raw data (*.wav/*.jpg), and ascending & descending knowledge, etc.

- Concluding ascending & descending orders between knowledge based on the knowledge network defined as an ontology
- Displaying global & local view of the knowledge map (Zoom-in/Zoom-out)

Cloud storage-based knowledge base

- Storing text-based document (*.txt) and raw data (*.wav/*.jpg) according to the identified topic (keyword) and date
- Maximizing convenience of registering and extracting knowledge using virtual desktop-based cloud storage
- Automatically archiving knowledge by comparing extracted/user-defined topic (keyword) with categories
- Informing the resultant directory to users when archiving completed

Context reasoning module

- Converting contents on working windows of user device into text-based document (*.txt)
- Extracting topic (keyword) of the text-based document using automatic document summarization module
- Reasoning corresponding users' job category by combining context data topic, schedule, identity, and location, etc.

Knowledge extracting and transmitting module

- Extracting knowledge corresponds to the concluded user's job category
- Alternately extracting knowledge from the Web if proper one is not found in the Knowledge Base
- Transmitting & displaying resultant knowledge onto user's device (or recommending knowledge with a format of the popup window)

Example prototype

To briefly show how the proposed concepts can be realized as a service, an example prototype system has been implemented and evaluated with respect to its functionality. The prototype system is designed to provide a knowledge service by automatically acquiring knowledge in dialogues and to archive it into a designated category on the cloud storage. Knowledge archived in the cloud storage-based knowledge base can be automatically extracted and transmitted to a user according to the user's situation inferred by the context reasoning module. <Fig.6> collects the screen shots to show prototype's functions from the acquisition by recording and dictating to the distribution using the popup window on user's smartphone.

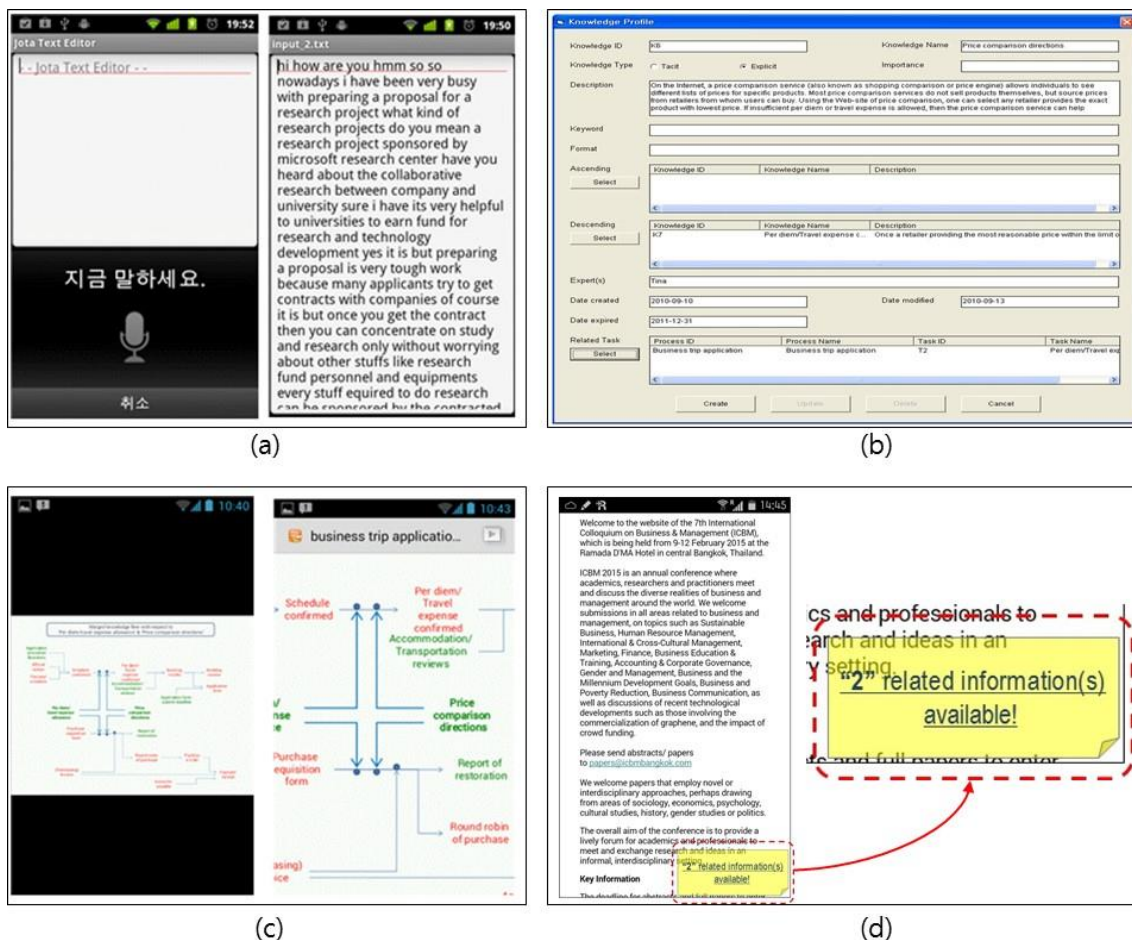


Fig. 6 Screen shots of prototype ((a) STT-based dictation, (b) Captured knowledge after profiling, (c) Knowledge networks in a Knowledge map, (d) Knowledge recommendation using fingernail-based popup window)

Concluding remarks

This paper’s main idea has been derived to provide an answer to the question ‘how human expertise can be fully preserved and freely disseminated in our ordinary life so that users can feel as if they are always being assisted by the real human experts?.’ To cope with such requests on the knowledge service, human’s patterns in dealing and using knowledge must be closely observed and analyzed in advance. No matter how recent edge technologies were deployed in a new service, since most of users feel a kind of burden to use if it is complicated or troublesome to use, the knowledge service must be provided as convenient as possible. In short, the requirements of user-friendliness and convenience in use can be guaranteed by an autonomous system which generates services with the functionalities of self-awareness, self-service generation, self-learning, and self-expansion (Yoo, 2013). The proposed business models of this paper consider fully-automated, namely autonomous functions in identifying, categorizing, storing, and distributing user-familiarized voice and image-based knowledge, and therefore can be practically consulted in preparing a business for the forthcoming new paradigm. Although some kinds of limitations in accuracy and reliability of the voice recognition and automatic document summarization technologies are still pointed out, sooner or later they will be negligibly resolved considering the progress pace of each technology. Main contribution of this paper lies in promoting the human life to be more creative and productive as well as reserving a new business paradigm with knowledge-centered.

Acknowledgement

This work was supported by the National Research Foundation of Korea Grant funded by the Korean Government (NRF-2013S1A5A2A01017530).

References

- Kwan, M.M. and Balasubramanian, P. (2003). KnowledgeScope: managing knowledge in context. *Decision Support Systems*, 35, 467-486.
- Nunes, V.T., Santoro, F.M., & Borges, M.R.S. (2009). A context-based model for Knowledge Management embodied in work processes. *Information Sciences*, 179, 2538-2554.
- Yang, K. & Huh, S. (2008). Automatic expert identification using a text categorization technique in knowledge management systems. *Expert Systems with Applications*, 34, 1445-1455.
- Yoo, K. (2013). Autonomous and pervasive computing-based knowledge service. *Lecture Notes in Electrical Engineering*, 156, 9-14.
- Yoo, K. (2013). Capture knowledge on the spot: toward the autonomous and pervasive service of context-rich knowledge. *Automatika*, 54(4), 401-414.
- Zhou, J., Gilman, E., Palola, J., Riekkki, J., Ylianttila, M., & Sun, J. (2011). Context-aware pervasive service composition and its implementation, *Personal and Ubiquitous Computing*, 15, 291-303.