SMART ALLEY: A Platform for Sharing Experience in a Community Space Augmented by Urban Media

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This research proposed an urban platform designed to facilitate the sharing of community experience in the spatial context of traditional 'alley'. 'Smart Alley' refers to a smart space in which various urban media, supported with IoT technologies, interplays so that the creation and consumption of media content leads to vivid social interactions in this specific urban space. The proposed urban platform is driven by the Content Management System (CMS). An urban ontology works as a logic model of the CMS. This paper focused on the conceptualization and design of both CMS and ontology modules within the smart alley framework. Outcomes from the 'Smart Alley Workshop' are presented, which was conducted to develop smart services to utilize the smart alley platform.

Keywords: *Smart City, Urban Media, Urban Ontology, Ubiquitous Computing*

BACKGROUND

Sharing has become a mainstream urban culture. Sharing services such as Couch surfing, Airbnb, and Car sharing turned out to be even profitable business models in addition that they proved the potential of cooperative consumption culture. In fact, a surprisingly wide range of tangible or intangible resources can be shared, including physical things, services, knowledge, even ordinary daily activities (dining, nurturing, and so on). Experience is something intangible, yet it has a significant value in shaping our life. Experience itself is a personal mental process, whereas it is also perceived as a significant social capital (Pine & Gilmore, 1999). In a sense, one of major functions of a city is to provide an environment to develop each individual and society by giving them the opportunity to learn lessons from shared experience (Landry, 2006). The society, in this way, becomes less vulnerable to recurring failure and problems, consol-idating sound social intelligence.

The booming-up of experience sharing culture may be attributed to the proliferation of Social Network Service (SNS). However, sharing experience has been around as an important function of urban space. Bulletin boards on the street or artefacts in museums and historical sites are typical cases. Compared with those, the experience sharing in smart city could be more systematic when augmented by smart devices, interactive urban media and platforms. This smart environment provides more real-time and information-rich experience sharing. D-Tower, for example, was a remarkable media installation representing collective emotions of citizens [1]. EcoMap was one of many similar endeavors of sharing environmental footprint to raise the awareness on sustainable lifestyles [2].

However, most precedents were too limited to induce significant social interaction or social engage-

ment beyond just sharing information. They have tried to facilitate the construction of ad hoc network for wide range of people. Moreover, creating communication of community through continuous feedback is still difficult, because they do not reflect local identity, problems, and issues. In order to address these problems, psychological factors rooted in local place should be considered.

Among various types of urban space, 'alley' possesses rich human contexts that cross over community experiences, cultural and historical stories. The function of alley has long been considered profound in the East Asia including Korea. As the alley is a place where various events of daily life occur in this culture, it is not possible to fully understand the regional substance until taking a closer look at the alley. Therefore, to utilize unique resources of the alley may create better social network, support activities of resident, and reflect features of the community. By resolving the lack of storytelling content in existing U-City smart service (Kim et al., 2007; Ringas and Christopoulou, 2013), this smart space framework focusing on the sharing experience may strengthen the business opportunity as well as cultural reinvention of the important urban element, alley, in Korea.

OBJECTIVES

The objective of this research is to design an urban platform that facilitates the sharing experiences of the community. The urban platform is especially customized to work with the space type, 'alley'. It will eventually communicate with various urban media and smart devices through the IoT technologies embedded in the smart alley. At the conceptual level, to facilitate sharing experience, the platform will collect experiential content from various people and resources, and then convey the content via urban media. Therefore, multilateral management of content (collection, processing, sharing, etc.) should be a main function, and Content Management System (CMS) be presented as a core element of the urban platform. This paper concentrates on the structure of CMS and its backend ontology. The urban ontology

plays an important role in reorganization and systematization of related information and content of Smart Alley. By analyzing previous research works, this paper outlines the urban ontology for Smart Alley.

The city government of Seoul announced to carry out 'Seoul IoT development project' by 2020. The aim of project is to foster digital city and solve the urban problems (safety, traffic, tourism, environment, etc.) by using IoT technology. A pilot project will be launched in the 'Bukchon' area as a start-up and the city will extend the project scope by stages. Accordingly, the Bukchon draws attention as a test bed for IoT technologies. This research suggests the Bukchon as a specific area to apply Smart Alley concept considering its social conditions. The Bukchon is a unique area where well-preserved cultural heritage coexists with daily life, while many problems occur among stakeholders. Consequently, the proposed urban platform should be designed to support activities of stakeholders by considering both problems and potentials of this area. This research proposes urban platform and promising services specialized to the context of Bukchon. The application was deduced by 'Smart Alley Workshop' that was conducted to cultivate creative ideas about smart urban services based on the understanding of ambient urban media. 21 postgraduate students participated in this workshop. And they explored the possibilities about how Smart Alley works effectively in urban context.

CONTENT MANAGEMENT SYSTEM (CMS) FOR SMART ALLEY

Based on the concept of 'alley as a platform', the Smart Alley proposes transforming an urban space, alley, into a smart space by coordinating IoT technologies. Thus, the alley becomes an augmented place facilitating the information sharing and interactions among people. The CMS (Content Management System) is at the core of the platform. The CMS is a system to provide a knowledge-base for producing, processing, management, and sharing of the content in this urban platform. The content covers

diverse topics including humanities, living & culture, and history of a place. The ultimate goal is to enable sharing experience by circulating value-added content between users. This chapter presents the CMS as an essential element to implement the Smart Alley through the Bukchon case, more specifically; 1) the structure and elements; 2) design and implementation of the CMS.

The Bukchon *Hanok* village located in Seoul has rich cultural and historical context sharing the rise and fall of Chosun dynasty for 600 years. Ever increasing tourists from all over the world visit this place nowadays to enjoy the unique sight of almost 900 traditional houses with actual residents, and closely experience traditional culture from the shops such as master craftsman workshop. This situation created a business-wise success as a result, giving birth to many commercial shops and restaurants within the vicinity. However, the Bukchon is a unique village still inhabited by real residents, different from other preserved districts of *Hanok*. The residents suffer from invasion of privacy, noise, and illegal trash disposal by indiscreet tourists. On the other hand, visitors complain the lack of tour content and amenities in this area. Local business owners concern the commercialization by franchise stores while the profit falls short of their expectation. While the Bukchon has cultural and historical potentials to attract tourists as a unique area, many problems as mentioned above exist among stakeholders. The city government of Seoul initiates a plan to introduce IoT technologies

in the Bukchon area as a part of the 'Seoul digital comprehensive plan 2020' The Bukchon, within this scheme, has a plan to carry out 'Bukchon walking navigation' as a part of a pilot project for the IoT application. 'Bukchon walking navigation' is a multilingual audio guidance system delivered through a smartphone app to help visitors experience street events and cultural facilities (ex. artisan workshop and traditional house). Furthermore, Seoul city has a plan to distribute this app to users which will interplay with the Beacons in the Bukchon are and the 'Smart Tour Guide' application. The 'Smart Tour Guide' has been already operated by Korea Tourism Organization (KTO). This integrated service can be especially useful for foreigners, but fails to address the problems and situations of the Bukchon enough, as discussed in Bukchon IoT expert forum [3]. Moreover, since the functions of the service are merely to provide location information by government agency unilaterally, the drawback is the lack of variety and sustainability of the content. For this reason, the sustainability of the service by the participation of the stakeholders gets priority when the urban platform is designed.

Seoul city plans to scale up the IoT application business to the whole city after conducting the pilot project in the Bukchon. However, experts point out that the plan should not be approached in the framework of test bed case, because the Bukchon is an actual residential area. The Bukchon needs to provided with proper technologies only after sufficiently un-

Figure 1
Jeon-ju storytelling map (made by Jeon-ju Korea Traditional Life Experience Park) (left), The interactions among stakeholders by Storytelling Map (right)

derstanding the demands of stakeholders; It should not be an integration of high cost services in a large urban space.

This proposal is to implement a CMS specialized to the context of Bukchon orchestrating relevant IoT technologies. The 'Storytelling Map' is a key application driven by the CMS. Figure 1 (left) is an example of the storytelling map. The map illustrates 'Jeon-ju *Hanok* village' that is a traditional house district similar to Bukchon. This map includes historical information regarding the village and its buildings. It also contains life stories about events of the elderly, the location and history of old restaurants, and popular dating courses from the old days. Updated every few years, this map helps visitors understand this area by providing the useful information to experience. Extending the concept of its predecessor, the Digital Storytelling Map works more than a typical electronic map. It enables people to communicate and share content by using urban media in real time. While the previous storytelling map is paper based one that requires reprinting for update, the 'Digital Storytelling Map' can provide more lively and various information in real time. The aim of this new map is to support community life more smart and convenient by sharing content easily about culture, history, and living of the village.

Figure 1 (right) presents positive effects caused by the 'Digital Storytelling Map' among the stakeholders. The 'Digital Storytelling Map' provides customized contextual information of a place based on the map. Mainly being populated with small-scale traditional houses, the alleys of Bukchon area have formed a labyrinthine pattern. It is also difficult to figure out specific landmarks as the heights of the buildings are more or less identical. The map has been a simple and effective tool to get information about the points of interests in a city. The storytelling map additionally provides more anthropogeographical information with the help of its user-created contents.

The Digital Storytelling Map is one of service applications that can be choreographed by the CMS.

The structure and components of CMS are illustrated in Figure 2. Urban platform consists of program modules including Data Classification Module, Ontology Model, and CMS. Ontology model plays an important part to provide logic model to process media content requested by user interactions. CMS creates media content by reconfiguring content source of Data Cloud and knowledge structure of Content Organization Ontology. The media content is converted to proper formats adaptive to specific media configurations by Media Stream Converter. The combination of media content presents to user at Storytelling Map by mapping onto geographic information via GIS Mapper.
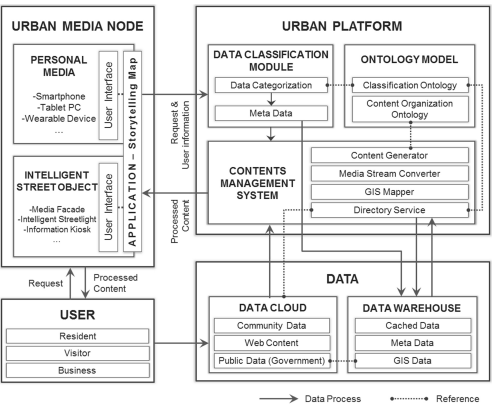

Figure 2
Content
Management
System (CMS)

Figure 3 is a diagram of data flow between each stakeholder and the system. With focusing on the Process of big circles, three types of Agents (Visitor, Resident, and Business) participate 'Content Collection' and receive proper rewards to each Agents. For example, by contributing user-created content, visitors can gain coupons or millage to purchase goods from local shops and acquire a priority to share the place offered by residents. Residents may take a free parking space by participating the open house campaign (ex, opening toilet, inner court, main floored room, etc. to visitors). Due to increasing visitors, even the residents of Bukchon suffer from the shortage of parking space. Moreover, due to its characteris-

Figure 3
Data Flow Diagram
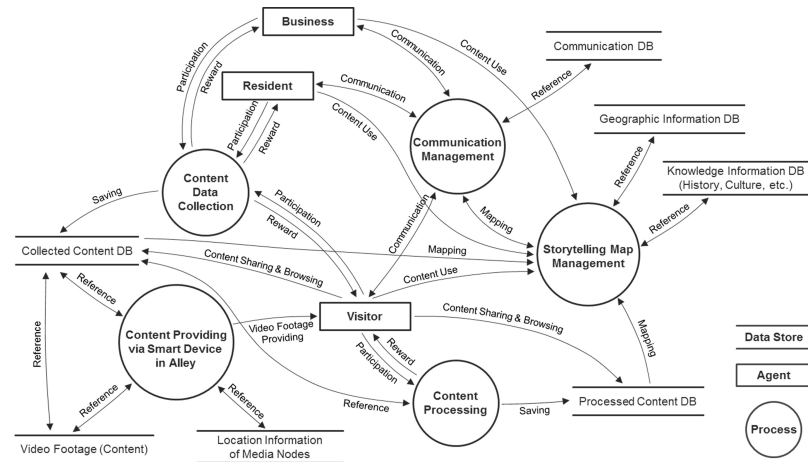
tic spatial structure of the traditional houses, enclosing walls often obstruct visitors who want to look at the unique and original design of inner space. Therefore, opening and sharing space by Resident can be a special experience to the visitor. Residents help local business owners by providing promotional information to visitor spontaneously, Business owners can return part of their profit for the maintenance of traditional houses and IoT facilities.

The content contributed by three agents is stored in the 'Collected Content DB' in the form of raw digital data such as text, image, and movie file. Every user has an access to this data though searching and browsing specific content by themes or keywords. As the event factor to enhance participation, the Beacon devices based on Bluetooth are installed in each point of Smart Alley. To facilitate the participation in the form of special event, passers-by may be provided with thematic movies on the contact with Bluetooth-based beacons on the street. The thematic movie is a short video of 3~5 seconds by sequences, and use data in 'Collected Content DB'. The visitor can collect and store several thematic movies about the Bukchon to his/her smart device from various spots of the alley during walking and sightseeing.

Visitors may open these short movies through mobile application of the Bukchon 'Digital Storytelling Map', and participate in 'Content Processing' on the spot. And they select and combine few short movies by intention, and generate a new content by their own. The generated content is mapped onto 'Digital Storytelling Map'. Anyone can give recommendation scores or opinions on this content within the 'Digital Storytelling Map', and share this content on other websites as in typical SNS apps.

The three Agents can share opinion and information via 'Communication Management' that is also mapped onto 'Digital Storytelling Map' in related location. 'Storytelling Map Management' renders general information of the place by referring to 'Knowledge Information DB' and 'Geographic Information DB', and also illustrates various information together of each place by mapping to 'Collected Content DB', 'Processed Content DB', and 'Communication DB'.

URBAN ONTOLOGY

The Urban ontology is constructed by analyzing environments, functions, and interactions of Smart Alley. As a main element of the proposed CMS, the urban ontology plays a critical role in reorganization and systematization of related information and content of Smart Alley. An ontology model should de-

fine a paradigm or a view of the world of the model, not merely the relations of objects. And through the consistent perspective, related objects are deducted, and connections of the objects are represented. Therefore, this chapter revisits the criteria, methods and reasons of the composition from previous research works. The urban ontology for Smart Alley will be constructed by combining and expanding related works.

The domains of urban area described as urban ontology cover a wide range in related research works. Following research works addressed the use of ontology for geographic information system, urban regeneration, urban design, road system, public panels, land use, travel, and etc.

Fonseca et al. (2002) proposed an ontology-driven geographic information system. This work did not provide urban ontology in full scale. However, the significance is in that this works provided a view of the world to redefine the real world as a computer model. To formulate the real world by ontology methodology requires a specific perspective to the world. The compositions of ontology can define newly or change their relations through this perspective. Fonseca et al. (2002) built the four-universes-paradigm for modeling a computer representation, focusing on computer graphics area - physical universe, mathematical or logical universe, representation universe, and implementation universe. In adding the cognitive universe, the human perspective was highlighted in the four-universes-model. The point of view of an individual or a group of individuals is perceived in the cognitive universe and modeled in the logical universe.

Caglioni and Rabino (2007) also proposed a specific view including human activities in their urban ontology. This ontology modeled the city as a system, modified by man, inside of which he lives, where for living they mean the performance of all those activities characteristic of human being. A city can be studied, according to this proposal, at three observation levels (physical, socio-economical, and mental level).

Soares and Fonseca (2011) proposed the use of a meta-model ontology based on scenarios for representing temporal relations and procedural knowledge of a domain. Scenarios have been used for identifying and capturing domain knowledge, but they are discarded once the ontology is completed. They argue that a domain ontology created with 'scenario-based approach' is enhanced by including knowledge about not only what the domain is but also how the domain works. This approach works well in particular when building an ontology for specific cultural area. It is because the characteristics of area are hard to explain relying on general urban ontology model. Therefore, the 'scenario-based approach' would be a way to make an adaptable ontology for the cases like Bukchon.

These research works presented methodologies to build urban ontology. They deduced components of urban ontology through a particular view and background theory for understanding the city. On the other hand, others proposed concrete ontology models that represent specific functions such as road system, mobility, water system, etc..

Berdier and Roussey (2007) implemented three types of experimental ontology models about road system, urban mobility, and urban renewal. This ontology model was developed to improve urban services such as road system management or public spaces management. Also, they described several difficulties found in developing ontologies for each domain. Road system ontology deals with a technical domain easily modelled. Urban mobility ontology, on the other hand, is difficult because the term interpretation was dependent of context. Urban renewal ontology, even though more important due to the appearance of social aspect, is difficult to model the social aspect per se. As shown in above cases, to express physical or fixed objects can be easy, but the contextual concept is complicated and hard to model.

Metral et al. (2009) presented the Ontology of Urban Planning Process (OUPP). It addressed the concept of 'soft mobility', as the ontology targeted the

region of Geneva, Switzerland. This case defined instances of Route and semantic annotation link between, on one hand data and documents of Geneva and, on the other hand, concepts and instances of OUPP. The specific instances including place names, geographic information, and images of Geneva were modeled and their relationships were defined in the framework of soft mobility model. This model was, however, developed from the perspective of planner. Furthermore, it does not fully reflect social aspects except for user types or speed of pedestrian.

To sum up, these related research works rendered detailed background and possibility to build urban ontology for Smart Alley by providing multilateral methods of observation, construct, and case applications. Nevertheless, some aspects of contemporary cities possesses considerable differences which were not covered in these works. Major differences include the use of Urban Media (Personal/Public Media) based on IoT technologies, massive data produced and shared by the urban media in real time, a large number of people to access these data and their increased or intensified interactions, and augmented space by invisible content. The elements make significant changes inevitable in terms of roles, functions, and the appearance of the street. Most of existing urban ontologies could not deal with such aspects either because the technology was not available or our daily life was not ready fully influenced by it. The application of smart media in space will be a major trend in future. Therefore these emerging elements of the city should be reflected in structure of urban ontology, and also the function of urban ontology needs to be redefined and extended.

Urban ontology, tailored to the Smart Alley case, can be organized into three layers (Figure 4). The first layer is a concept that extends hierarchies of previous urban ontology cases (ex. Building, road, geographic information, water system, etc.). This layer describes the physical world and classifies objects. The second layer represents invisible information created by urban media. People live in the physical world, but considerable parts of their daily lives are connected

in virtual world on the Web. The activities like content creation or sharing on the Web might be boiled down to just bits and bytes, but the impact is in many cases more substantial than what is gained in physical form. Especially, the augmented space by urban media such as Smart Alley is greatly influenced by virtual content and information. Sharing experience in Smart Alley also could be facilitated by the virtual content. Therefore, these elements are defined as an ontology layer.
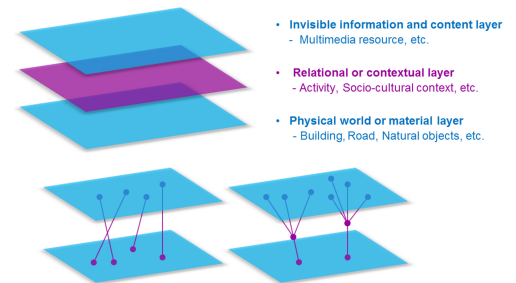
These three layers work as urban ontology for content management by cross reference.

The last layer is organized by referring previous research works. Fonseca et al. (2002) and Caglioni and Rabino (2007) emphasized human and activities when they proposed a perspective to build urban ontology. The reason is that other components are in fact highly affected by human activities and intentions. For example, activities like constructing a building or moving an object entail changes of context, and the changes influence other buildings and objects. According to this point of view, 'Relational or Contextual layer' is included. This layer in between two layers addresses socio-cultural context or relational feature about interactions and activities between human and objects. Since the relations are highlighted and multilayered between human and human or human and objects by smart media. The layer presents organization among physical world and invisible information as significant points of contact. These three layers work as urban ontology for content management by cross reference.

SMART ALLEY WORKSHOP

'Smart Alley Workshop' was conducted to cultivate creative ideas about smart urban services based on the understanding of ambient urban media. 21 postgraduate students from the Department of Architecture and Department of Convergence Engineering for Future City at SKKU participated in this workshop for 2 months. The 'Bukchon Hanok village', was assigned as the target area of the workshop, and the theme was 'Designing a Service for Smart Alley'. Introducing some selected services, this chapter discusses their potentials and implications.

The processes of the workshop are as follows: 1) understand core concepts of Smart Alley (Urban Platform, Street Computing, and Augmented Space) through case studies, 2) analyze existing cases, 3) derive required services through the analysis of problems of the area, and design scenarios, 4) specify the services by prototyping and technical implementation.

Smart Alley: Storytelling Map (student: Sun-Young Jang): Smart Alley: Digital Storytelling Map is a comprehensive result that is compiled problems of Bukchon, CMS, Data Flow, and application scenario from the previous chapters (Figure 5, left). The objective of this service is to provide a new communication channel by addressing these problems. 'Digital Storytelling Map' feeds information about living & culture, and history of a place in the form of map. This service is designed by considering sustainability through virtuous cycle that stimulates content contribution among stakeholders by participating and receiving proper rewards.
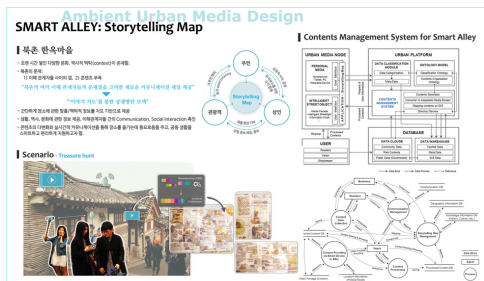
Foot Salon (students: Yong-Se Kim & Young-Min Kim): Foot Salon is a social sport system utilizing a mobile application (Figure 5, right). This service helps spontaneous participation of people who want to play street football by using abandoned spaces. The example is to install a temporary futsal court or Basketball court to use walls of Bukchon area by utilizing laser projection, web cam and low cost installation. Abandoned spaces can be a mediated space to create community. This team tried to minimize physical installations and manage most related information in mobile application (possible time to join, information of game and facility, personal profile and friends management, etc.). Also, they made an option for promotion campaign of sport business, so that the profits can be invested to maintain mobile software and physical facilities.

Jackpot & Saving Collection Box for Disposable Paper Cup (students: Han-Sol Shin, Won-Wook Choi): This service proposes a system to separate garbage to solve increasing disposable cups that harm the appearance of the Bukchon alley (Figure 6, left). This service is based on reward system in two ways. The first is 'Jackpot Collection Box' that counts the number of cups regardless of donor. When it reaches specific number, 'Jackpot Collection Box' prints voice message and QR code for reward. The second is 'Saving Collection Box' that connects smartphone via application. A donor gives a disposable cup to this collection box. And they receive the number of contribution in smartphone. When it amount specific number, they can receive reward. The reward of two ways is discount coupons of cul-
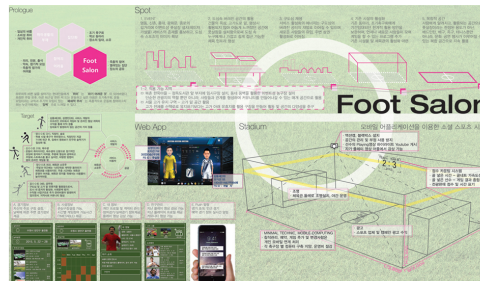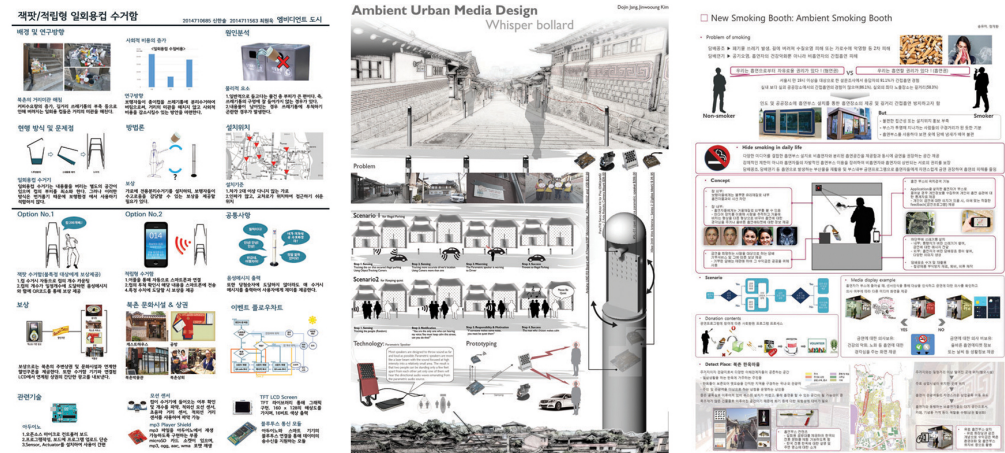

Figure 5
Smart Alley:
Storytelling Map
(left), Foot Salon
(right)

Figure 6
Jackpot & Saving Collection Box for Disposable Paper Cup (left), Whisper Bollard (middle), Ambient Smoking Booth (right)

tural facilities and shopping area in the Bukchon.

Whisper Bollard (students: Do-Jin Jang & Jin-Wooung Kim): Whisper bollard is a service to solve illegal parking that is caused by lack of parking place (Figure 6, middle). Illegal parking is occurred frequent in the Bukchon because of narrow street and high density of traditional house. This smart Whisper bollard is equipped with object detecting sensor and directional speaker. The tracking camera of Whisper bollard detects illegal parking car and sounds warning and guiding other parking place to the driver only. Because the Bukchon is a residential district and suffer from noise problem, this team uses the directional speaker to hear target person.

Ambient Smoking Booth (students: Yu-Mi Song & Jae-Hwan Jung): The Bukchon forbid smoking because of the fire risk of cultural assets. However, there are many still illegal smoking. Therefore, the Ambient Smoking Booth is proposed to reduce illegal smoking in the long them (Figure 6, right). This booth provides nonsmoking content or information of Bukchon through media display inside the booth. This booth is usually installed in commercial area, and induce user to commercial alley.

As a result, 10 service applications for Smart Alley are proposed. And useful 5 applications are ex-

plained among those works. The proposed services are designed by considering problems and features of the Bukchon. Also they provide the participation inducement, business model, and technological implementation concretely. Therefore, the workshop proves realistic possibilities for Smart Alley. Especially, many services consider citizen participation ways. This reflects the opinions to solve problems and weaknesses of current u-City service. The result suggests that future smart city service should be designed to create social interaction and engagement more than simply information providing.

CONCLUSION

This research proposed an urban platform designed to facilitate the sharing of community experience in the spatial context of traditional 'alley'. The term, 'Smart Alley', refers to a smart space in which various urban media, supported with IoT technologies, interplays so that the creation and consumption of media content leads to vivid social interactions in this specific urban space. The proposed urban platform is driven by the Content Management System (CMS). An urban ontology works as logic models of the CMS. In the process to specify components of space service enabled by smart media, the limitation of existing ur-

ban ontologies has been discovered. The technological environment has become significantly different from the time when previous urban ontology model were developed. Amount of data produced by the urban media has become massive, and human interactions and activities more complicated. The characteristics of space will be fundamentally changed and augmented by smart media, and this phenomenon will get accelerated in the future. Therefore, the urban ontology should be restructured. Accordingly, this research tried to reorganize the structure of spatial components, interaction, and data flow including smart media by extending existing urban ontologies.

The 'Bukchon' was chosen as a target site to apply Smart Alley concept, as this area has been currently going through the IoT application project of the City Government. While the Bukchon has cultural and historical potentials as a unique area, many problems exist among stakeholders. Therefore, this research proposed a service application by considering both problems and potentials of this area. The existing u-City smart service in Korea has applied high cost services on a large scale in a lack of understanding on the region or demands of user. As a result, while the citizen did not appreciate the service, the maintenance cost too much. Thereby the service fails to evolve from basic stage, and some even discontinue. Being aware of these issues, this research set up the 'Smart Alley Workshop' to develop smart service in the framework of Smart Alley. A group of postgraduate students participated in this workshop to propose interesting smart services. Main idea was to have a sustainable service model to ensure the profits of stakeholders and encourage the citizen participation to contribute the content. Some of the proposed smart services are planned to be deployed for test.

The Smart Alley has a limitation to be generalized for every smart space cases because the functions are designed to focus on the 'Bukchon' case. However, the ontology beneath the platform is still flexible to extend its applicability on the instance level. The platform will be able to host similar smart services and help build up the virtuous cycle of smart urban services.

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