Analyzing Spectrum Management Policy for Utilizing TV White Space

Eunsuk Jun, Keon Chul Park, and Bong Gyou Lee

Abstract—With the digital TV transition, TV white space issue stands out. While economic value of TV white space is estimated to be about 200–320 million pounds, there are several problems such as spectrum interference, publicity and business model issues. To analyze current spectrum management policy in utilizing TV white space in Korea, this research conducted FGI based on PEST frameworks. As a result, for successfully utilizing TV white space, Korea spectrum management policy should be evolved to maximize social welfare by considering adopting spectrum sharing and incentive system. This research has its limitation that FGI was conducted to a small group of people since TV white space is a touchy issue in Korea. Nevertheless, this study is expected to suggest political implications not only to Korea but also to other countries which is about to utilize TV white space in the future.

Keywords—Spectrum Management, TV White Space (TVWS), Spectrum Policy Framework, White Space Management, Digital TV Transition

I. INTRODUCTION

With the digitalization of analogue TV around the world, national interests on TV white space have been increasing. In case of Korea, the Korea Communication Commissions announced a national plan that described specific strategies for utilizing TV white space in Korea starting from 2013. Some insists that spectrum shortage driven by mobile traffic explosion can be solved by utilizing TV white space [1]. As a low frequency spectrum, TV white space has advantages of having large area of coverage and high penetration ratio [2]. Also, TV white space can be used in various ways in a variety area such as super Wi-Fi service, local information service, green information service and public safety service. Ofcom from UK estimated the economic value of TV white space as about 200–320 million pounds [3]. However, broadcasters are against to use TV white space saying there are spectrum interference and publicity of spectrum resources matter. Therefore, to successfully utilize TV white space, government’s support for technology developments and discovering business model to improve social welfare is essential. Thus, based on PEST framework, this research tries to analyze current spectrum management policy by conduction FGI to utilize TV white space in Korea. In addition, this study suggests the political implications for better spectrum management policy at the end.

II. PARADIGM SHIFTS OF SPECTRUM MANAGEMENT POLICY

Spectrums are public goods that have limited resources available. In this sense, governments have been managing them. At first, governments’ policy aims were to improve their efficiency and secure their public nature. However, as spectrums are being utilized for multiple purposes, the policy aims changed to overcome scarcity and to meet market demands. Now its ultimate aims are to secure social welfare and to maximize spectrum use’s social and economic utilities.

In the early stages, the spectrum management policy was on the basis of the Command-and-control Model because there were few demands in the market [4]. In this model, a government determined spectrum distribution and the purpose of use were based on a specific service or type of technology. Also, the government determined the range of spectrum use as well as spectrum allocation. As social environments have changed to being communication intensive and as spectrum technology is continuing to be developed, the spectrum management policy principle was changed to being an Exclusive Use Model [4]. In this model, a market determines spectrum distribution without there being any restrictions of specific services or technology. Also, the government determined the range of spectrum use as well as spectrum allocation. As social environments have changed to being communication intensive and as spectrum technology is continuing to be developed, the spectrum management policy principle was changed to being an Exclusive Use Model [4]. In this model, a market determines spectrum distribution without there being any restrictions of specific services or technology. Also, when licensing service providers, a market mechanism was applied and this is why the auction system was first adopted. In addition, trading and use rights are freed in the second spectrum market.

Fig. 1 Paradigm Shift of the Spectrum Management Policy [4]
The next evolutionary model is the Commons or Open Access Model, in which many unlicensed service providers use the spectrum and there’s not a second spectrum market [4]. That is to say, the spectrum management policy’s paradigm has shifted to pursue free access and free use in order to maximize users’ rights as the development of telecommunication technology changes the market environment.

III. ISSUE ON TV WHITE SPACE

Apart from advantages that TV white space has as a low frequency spectrum, there’re many issues that hamper its utilization around the world. The major issue is a conflict between broadcasting industry and telecommunication industry. By taking a look at some global issues, this section is to stress the fact that there are various environmental obstacles in utilizing TV white space.

A. Spectrum Interference/Coexistence Issue

There are two means to utilize TV white space. First is DB method which is to build DB about available channels in advance so that existing services can be protected [5]. Second is Sensing method which TV white space devices sense surrounding spectrum environment and secure available channels [6]. Relating to Sensing method, there’s big interference issue. TV broadcasters insist that using unlicensed devices in TV white space can cause serious interference problem. Also, there’s an actual case that testing equipments from Google and MS caused spectrum coexistence [7]. However, this can be solved by technological innovation. In addition, major countries such as USA, UK and Japan are considering to adopt DB method at the same time.

B. Publicity vs. Economic Value Issue

In terms of TV white space, there’s also publicity and economic value issue. Some within broadcasting industry insists that spectrum should not be used for commercial purposes because it’s public goods with limited amount of resources. However, others on the other side argue that utilizing TV white space for telecommunication purpose can improve social welfare as mobile data traffic has been dramatically exploding recently. Annual average added values of TV white space per 1MHz are estimated 5.1 billion for broadcasting and 73.8 billion for telecommunications [8]. If this calculation is expanded to 108MHz which is total TV white space bandwidths, it turns out that economic values are 554.8 billion for broadcasting and 7 trillion and 974.3 billion for telecommunications [8]. Currently, only 210MHz is allocated for telecommunication in Korea, for technological innovation beyond 4G, securing spectrum is pressing.

C. Service/Business Model Issue

For successfully utilizing TV white space, various business models are necessary. KCC is considering 4 options [9]. First is super Wi-Fi to improve network connectivity in rural area where wireless network is weak and urban area where there’s interference because of high spectrum density. Second is for local information focusing on local communities such as event hall, tourist spots, and auditorium. Third is utilizing TV white space for green growth such as water quality monitoring system, smart grid and sensor network. Fourth is for public safety such as fire monitoring, traffic safety and school safety. The types of services provided are especially important when they can’t meet the market demands. In 2010, there was a case in Japan that mobile multimedia broadcasting business using TV white space was in danger because no contents providers who thought it would not beneficial participated. Therefore, the Ministry of Internal Affairs and Communications of Japan tried to collect the business ideas from citizens in public [10].

IV. RESEARCH METHODOLOGY

To analyze environmental inhibitors of Korea spectrum market in utilizing TV white space, this research used two methodologies which are PEST analysis and FGI.

A. PEST Analysis

PEST analysis is a scan of the external macro-environment in which an organization exists and it’s useful for understanding the political, economic, socio-cultural and technological environment. It can be used for evaluating market growth or decline, and as such the position, potential and direction for a business [11]. In this research, PEST analysis was used to deduct key factors in analyzing Korean spectrum market regarding utilization of TV white space.

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<th>Category</th>
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B. Focus Group Interview(FGI)

As a qualitative research technique, Focus Group Interview (FGI) includes 8-10 persons brought together to respond to questions on a topic of particular interest, which is TV white space in this case [12]. In this research, therefore, experts on spectrum management policy were gathered and asked about considering factors and inhibitors when utilizing TV white space in Korea. This study conducted FGI based on PEST framework and respondents were asked to evaluate the domestic spectrum market level from 0 to 7. They were also asked to answer to the questions about major domestic issues and considering factors/inhibitors in utilizing TV white space.
V. Research Analysis

A. Political Environment

As a result of FGI, Korea political environment of spectrum market is appreciated to be quite stable for utilizing TV white space but not matured enough to suggest political issues. Since Korea spectrum management policy is shifting to pursue free access and free use successful utilization of TV white space can be expected when Commons or Open Access Model is adopted. However, simply sharing spectrum also can cause inefficient usage of resources such as over-utilization or under-utilization, which eventually leads to Tragedy of Sharing. To overcome these side effects, incentive system in using spectrum resources should be considered.

"Service providers should be given rights to use TV white space based on incentive system. This can motivate them to pursue profits so that technological innovations and efficiency can be achieved eventually"

B. Economic Environment

As a result of FGI, the level of Korea economic environment of spectrum market is appreciated to be high for utilizing TV white space. Especially, in Korea where mobile data traffic has been dramatically exploded for the last few years, applications like super Wi-Fi are expected to have high economic values. Also, utilizing TV white space as offloading of mobile telecommunication services should be taken into consideration.

"In Korea, wire line and wireless network that covers beyond rural area is already well-built so governmental support to develop service and business models is needed"

C. Social Environment

As a result of FGI, the social environment of Korea spectrum market is appreciated to be maturated enough to utilize TV white space. Although there is a conflict between broadcasting industry and telecommunication industry, they are approaching to agreements. Not to cause interference problem to broadcasters, Korea is considering adopting DB method which is to build a database map about available channels by region and time.

"As broadcasters insist the publicity of spectrum the fact that utilizing TV white space doesn’t do any harm on broadcasting’s social function should be stressed"

D. Technological Environment

As a result of FGI, Korea technological environment level of spectrum market is not enough to utilize TV white space. To successfully utilize TV white space, all devices in the market should be equipped with functions to detect the available spectrum nearby. However technological innovation in Korea is premature yet so governmental support is fundamental. Furthermore, political support to promote technological innovation will protect the domestic market and encourage international trade.

"For various application of TV white space network investment is essential but overlapping investment with existing services should be avoided and possibilities of technological support should be considered"

VI. Implications and Discussions

Korean spectrum market is currently facing a new condition relating to utilizing TV white space. The introduction of new services using TV white space should be accompanied with several policy measures that are designed to enable market functioning in an efficient manner. However there’re some issues and challenges so this study analyzes them through FGI based on PEST framework. In general, Korea spectrum market is evaluated not matured enough by experts. Therefore, Korea spectrum market environment including economic environment needs to be supported by reforming the spectrum management policy.

The policy directives driven from this research results are summarized following. First, spectrum management policies should be shifted to encourage spectrum sharing. With the explosion of mobile data traffic, Korea is suffering from spectrum shortage. Since TV white space is considered to be one means to solve this problem, new spectrum management policy for spectrum sharing is inevitable. Like USA, Korea also should allow service providers to use TV white space by registering not licensing. Along with this, there should be an institutional strategy such as incentive system to encourage service providers and prevent Tragedy of Sharing. Second, the principle of spectrum management policy should be shifted to
maximizing economic values and improving social welfare. Unlike policies in past which purpose was publicity, new policy should take economic efficiency and social welfare into account. For this purpose, Korea government should develop various service/business models to meet customers’ demands. Third, new spectrum management policy should consider various market players. They’re broadcasters and telecommunication companies in case of TV white space. Fourth, new spectrum management policy should be shifted to promote technological innovation and encourage international trades. In long-term, this will improve technological competitive edge by developing state-of-art technologies relating to TV white space.

This study has its limitations in that FGI is conducted to small group of people because currently TV white space is a touchy issue in Korea. Also questions are limited to domestic market environment. In the future study, spectrum market environment of leading countries can be compared with domestic market. By analyzing current spectrum management policy of Korea this study has implications in the political, economic, social, and technical arenas to other countries which is about to utilize TV white space in the future as well as Korea.

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REFERENCES

Abstract—Personalized cervix scanning is important when it comes to autonomous diagnosis aiming at best possible image results. In order to provide a method for the positioning of a automatically manipulated ultrasound transducer probe, a setup was developed including the AX-18A Smart Robotic Arm, CM-510 controller connected to RoboPlus software and equations meeting different female body structures based on height, weight and waist circumference. Data was taken according to the developed formula and processed with image enhancing and analyzing methods. Results show that the proposed setup follows in image data wherein the human cervix could successfully been recognized. Furthermore, it is shown that the data quality refers more to waist circumference than to the BMI. The presented setup is a desired component used for operator independent screening, autonomous real time monitoring or 3D reconstruction.

Keywords— bodystructure, cervix, robot, ultrasound

I. INTRODUCTION

MECHATRONIC systems like robots can help diagnosing the cervix but are more foreseeable to repeat programmed steps in the same way than to react differently towards individuals. Individual scanning of human is necessary since the body structure can vary significantly among humans. Here, we provide a method based on individual parameters enabling personalized ultrasound scanning of the human cervix. The cervix plays a major role when it comes to medical examination [15], [17]. As a link between vagina and uterus, the cervix can lead to several difficulties. Due to life threatening diseases it is necessary to examine this female organ. Referring to the most recent cancer statistics of the GLOBOCAN database (for 2008) of the international Agency of Research on Cancer (IARC), cervical cancer belongs to the second most common cancer in women worldwide. Late detection of this cancer at advanced stages can lead to death. Moreover, other cervical diseases like shortened cervix have a great risk of preterm birth during pregnancy [9]-[11]. Here, we suggest a screening method, which can be easily used to detect those abnormalities autonomously. Furthermore, the data obtained in a 2D mode can be used to reconstruct a 3D model for surgical monitoring. Thus, the surgeon can use this real-time individual conform screening method to detect his surgical instruments in three dimensions inside the surgical field. This work is based on the AX-18A Smart Robotic arm in order to autonomously manipulate a transabdominal ultrasound probe connected to the TOSHIBA APLIO-MX ultrasound system and the ROBOPLUS software in combination with the ROBOTIS microprocessor CM-510. The movements of this probe follow an individual path calculated in respect to the individual body structure. The innovative equations are based on height, weight waist circumference and further heuristic parameters improving autonomous scans. The obtained images were enhanced and analyzed using the squared error of the histograms. The obtained data was gathered from three probands and encloses 50 image data.

II. CURRENT APPLICATIONS IN ROBOT ASSISTED ULTRASOUND APPLICATIONS

Robot-assisted interventions like prostatectomy (RAP) are an accepted approach. Real-time robotic transrectal ultrasonography (TRUS) guidance during RAP is already feasible and safe [1], [2]. Robotic TRUS provides valuable anatomic information. Applicable approaches on this topic started in the nineties of the last century [5]. Nowadays, robots are able to process complete 3D image volumes without human intervention [6]. Real-time, three-dimensional (RT3D) ultrasound is used for laparoscopic procedures as an additional intraoperative guidance tool [7]. Autonomous multiple-core biopsy systems guided by real-time 3D ultrasound show relevance in clinical procedures when it comes to computer aided diagnosis [16], [18]-[20]. Thus, robotic systems represent a promising approach in medical ultrasound imaging fields since they simultaneously control and collect image data for long-time scanning procedures and complex geometries [8], [13]. Currently, there are no autonomous systems developed for cervical ultrasound diagnostics like the proposed system. Here, we present the first approach in autonomous cervix scanning using a robotic arm based on a circumference based scanning equations.

III. METHODS

A. Precautions

The cervix of three different sized women was scanned. Here, the work refers to the belly circumference (C), height