International Journal of Control and Automation
Vol. 10, No. 12 (2017), pp.189-198
http//dx.doi.org/10.14257/ijca.2017.10.12.17

Mobile IoT Interface using Emotion Information and Arduino on the Android Application

Young Jae Lee*

Dept. of Smartmedia, Jeonju University, Korea
**leeyj@jj.ac.kr*

Abstract

This paper proposes mobile IoT interface using data on users' emotional state and bluetooth of IoT. For the purpose, we develop an AR(augmented reality) game on Tablet PC. Joystick is used as the interface linking reality and AR in bluetooth of IoT environment. User uses joystick to freely move the virtual object in the AR game to interact with the opponent object. In particular, the camera on tablet PC is set at front mode to detect the face of the user. After that, face detection and landmark information are used to get information on user's happiness, which is then analyzed to generate data on emotional state. Here, the info on the emotional state is utilized to modify the difficulty levels of the game. The performance and effectiveness is verified through experiments. Through experiments with the designed game, we could compare happiness data with threshold. If the happiness data is larger or smaller than threshold, we changed factors which could affect interaction, to influence the user in a meaningful way. That is, in case when the happiness data was smaller than the threshold, we increased the movement information of the object in the AR, to make it move quicker so that it could defend against or even attack the foe object which was attacking the eye of the user. If the happiness data was bigger, we reduced the movement information to realize normal interaction with the enemy. The proposed method is not just limited to providing augmented information. It proposes the new interface using information on user's emotional state, and possibly increases fun and immersion for user experience. The proposed method might be used as various contents reference points for following researches in detecting emotional state of users.

Keywords*: Mobile, IoT, Interface, emotion information, contents*

1. Introduction

Revolutionary development of smart gadgets have allowed us to use various software and contents wherever and whenever we need them. Also, with advancement in IoT (Internet of things) technologies, people are getting more and more interested in service technologies which can provide convenient information when and where users need it [1]. Especially as AR and VR technologies appeared, there is growing number of providers of virtual contents and their consumers. Contents have been improving also in quality not just in quantity. So, the need is getting bigger and bigger for natural interaction between on/off-line contents in virtual space and users in the real world [2]. Augmented reality is a kind of mixed reality which is located in between the real and virtual worlds. It refers to 'augmenting' information on things or images by integrating virtual information into the real information. As it adds additional virtual information to information in reality, the term 'augmented reality' also refers to augmenting human sensing and recognizing objects. Recently as mobile gadgets with camera have been widely used, augmented reality has become applicable also to mobile devices. Real-time service has become

Received (October 26, 2017), Review Result (December 7, 2017), Accepted (December 11, 2017)

ISSN: 2005-4297 IJCA

possible with mobile gadgets since they are more free in service areas and applications than PCs. Also, we are seeing services with practical applications, such as location-finding with GPS. Especially, smart phones are being welcomed as the most appropriate media for AR: most of smart phones have camera functions which are central to realizing AR technologies, and they also have GPS. Furthermore, as smart phones are equipped with various sensors for detecting directions and slopes, they are well ready for getting added features for AR factors. People have been enjoying smart experiences with their mobile gadgets, thanks to their advanced user interfaces which include multi-touch input and app-based approach [3]. UI is the key area for considering applicability of devices as it supports interaction between humans and machine. The current changes are towards lessening dependence on keyboard or mouse. A lot of developers are focused on strengthening interaction with device in a more intuitive way through user interface. They are trying to deliver user's intentions more naturally and more effectively onto the gadgets. For that purpose, they are intent on user's emotion-based UI technologies using recognition of voice, motions, gestures, vital signals or facial expressions [4]. In addition, AR technology needs to be developed to supplement human abilities and to proactively provide customized services to meet user needs. For this purpose, we need to integrate human-centered UI/UX technologies to combine methods to apply user space and to consider human intentions. Simply supplying augmented information is not enough, but providing user experiences is required [1][5-6].

Therefore, this paper proposes emotional interface which links reality and augmented reality. For the research, AR game has been developed on Tablet PC. Joystick is the hardware for interaction with virtual object. And we adopted bluetooth method under IoT environment. Here, we use user face detection to get and analyze the information on user emotions. The emotional information is then used to control the difficulty level of the game. The applied method enables optimal service considering user emotions. This paper proposes the mobile IoT emotion-based interface, and its performance and validity are tested through experiments.

2. IoT (Internet of things)

Not to mention computers and data, the world is buzz with IoT(Internet of Things) technologies which connect things in the real world to the internet and gather situational information from things to control surrounding environment. In the future, we will get data, information and knowledge by linking up multiple computers on the internet. Futhermore, humans will be able to control environment by collecting information from things through IoT. To make this happen, IoT technology connects reality with virtual world through the internet. And it provides services to help recognize the real world situations through things and also to optimally control real environment and things depending on situations. Eventually, IoT will provide intelligent services which are convenient and secure. Figure 1 shows how IoT technologies connect the real world to the virtual world, how to generate virtual objects, and how to provide intelligent services through service objects [3].

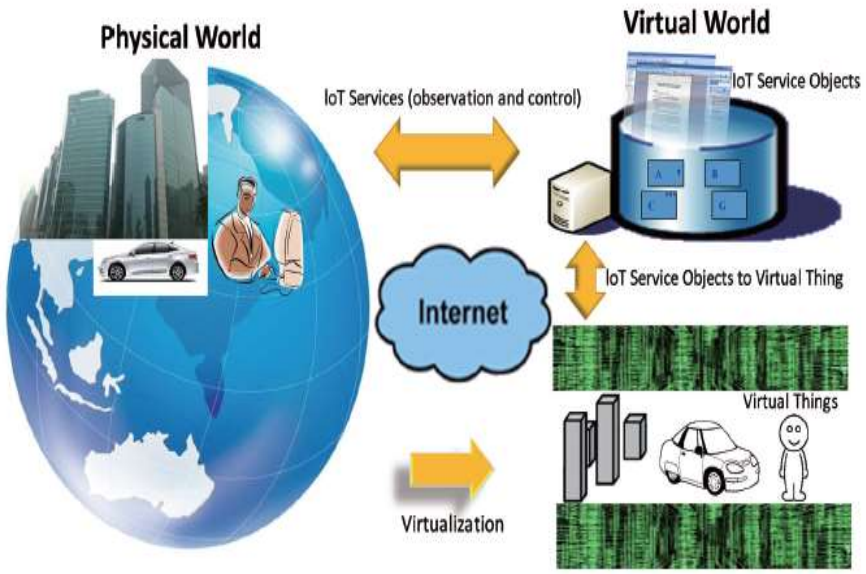


Figure 1. IoT-Based Connection between Real World and Virtual World

For rapid distribution of IoT technologies, they should be based on open standard architecture such as TCP/IP. Bluetooth wireless technology has dominant advantages in the area of low-power, short-distance wireless connection. Low-price small sensors generate many raw data which are gathered and processed through IoT. Power supply for these sensors should ideally come from the environment, or small batteries should sustain sensors for at least several years. Therefore, bluetooth technology is suitable for wireless sensors connected to IoT [7-8].

2.1. Bluetooth

Bluetooth uses 2.4GHz wireless link to exchange data. It enables wireless connection of gadgets in short distance, with low power and low price. Recently, many gadgets are connected wireless and most widely used in headsets, video game controllers, computer keyboards, and speakers. It is the best protocol especially for devices in short distance of less than 100 meters, and for exchanging small data. Also, bluetooth can replace wired serial communication interfaces with wireless. Bluetooth works in 2.4 GHz band. which is the RF band. ZigBee and WiFi also use this band which is designed to work separately from other protocols. All bluetooth devices have unique 48-bit(6 bytes) address called 'BD_ADDR', the value of which is always expressed in 12-digit hexadecimal. Upper half of the address(24 bits) is called 'organization unique identifier(OUI)' meaning the maker, and the lower half(24 bits) is the unique address for the particular device. And Bluetooth profile is the additional protocol to the basic standard, and it clearly defines the kind of data the device is sending. Bluetooth specifications define how bluetooth works and how the profile is used. Bluetooth profile determines how the device should act when connected. For example, hand-free headsets use headset profile(HSP), and Nintendo Wii Controller uses human interface device profile(HID). For the purpose of this research, we use SPP(Serial Port Profile) for bluetooth connection between Arduino and smart phone. You can use SPP when you want to replace serial communication interface(like RS-232 or a UART) with wireless through bluetooth. SPP is one of the basic profiles which is focused on exchanging volume data between two devices [7-8].

3. System Configuration

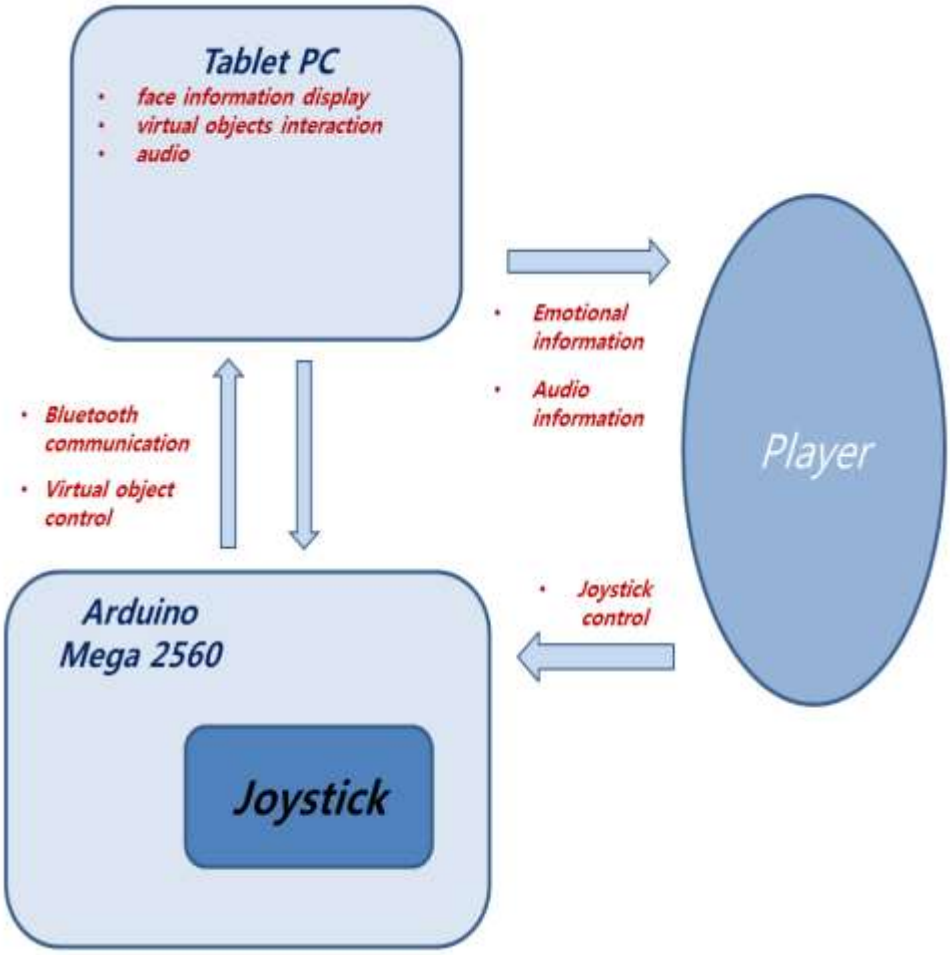


Figure 2. System Configuration

Tablet PC with AR environment is ready. In bluetooth communication IoT environment, user plays the AR game using joystick to move virtual objects. During the game, user's happiness information is extracted and analyzed which helps generate data on emotional state. With the emotion information, we can control the difficulty of the game and provide service considering user emotions.

On tablet PC, front camera detects user's face and shows landmarks for face configuration information. To realize interaction between user and virtual object, ally and foe objects are displayed. Background music is played and effect sound on collision is provided. For bluetooth communication in IoT environment, and for controlling movements of ally virtual objects, we use 'Arduino 2560 Mega', 'Dongle', and 'Joystick'. Detected face information is checked out on the camera, and the user controls the virtual ally object with joystick. To fight against the attack from virtual foe object, joystick is used in manipulating ally virtual object.

In the meantime, user's happiness data is extracted and used to modify the difficulty level the game. AR game on tablet PC detects user face and 8 landmark information in left eye, right eye, nose, left cheek, right cheek, left lip, right lip, and middle lip. This information has been realized through Google vision API [9-10].

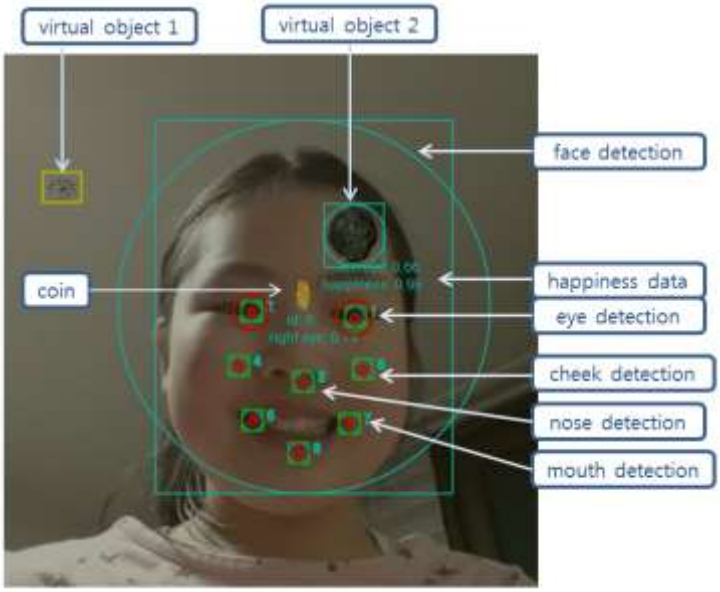


Figure 3. Construction of AR Environment on Tablet PC & Detection of Emotional State

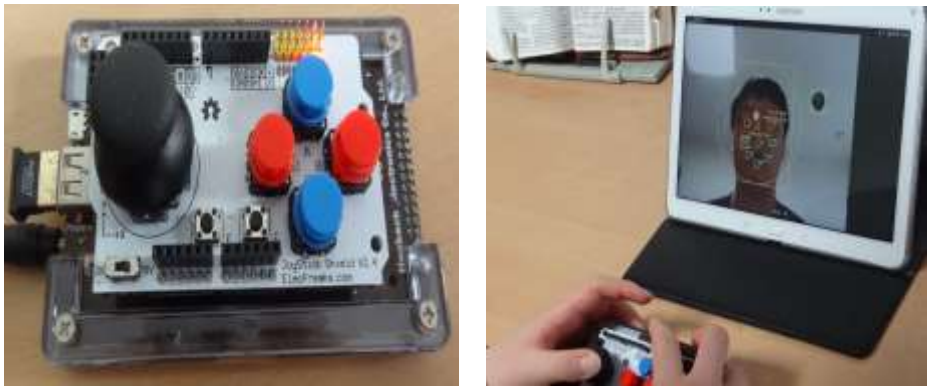
The rock, the enemy object, is randomly generated and moved(Figure 3. virtual object 2). This virtual object attacks and collides with the left/right eye of the user. The user responds by controlling the ally virtual object(Figure 3. virtual object 1) and counterattack the enemy to avoid collision. The enemy object is fast and big, but the ally object is small and slow. Therefore, to defend against the enemy attack, the ally should determine the optimal locational information and then move. If the ally succeeds in defense, ally and enemy collide and explode, leading to scoring. On the other hand, if the ally is attacked by the enemy, scores are reduced. If it grabs coins, additional scoring is given. Ally movements are controlled by joystick based on bluetooth method in IoT environment. And collision is identified through square collision method.

8-frame graphic image is used for better visual effects. Also, collision sound effect may help the user concentrate better on the game. In this kind of AR environment, when the user plays the game, his/her face is detected through camera, which, along with the landmark information, is used to analyze happiness data which is then used to infer the emotional state of the user. Based on the collected information, you can modify the difficulty level of the ally character by variating speed of movements.

4. Experiment

4.1. Experiment Environment

For this research, we used tablet PC camera(set at front mode) to develop AR and user-friendly environment. To control the movements of virtual object in AR environment, we chose bluetooth communication based on IoT. Arduino-based bluetooth communication connects the real world and the virtual world. Joystick moves the virtual object.



(a) (b)

Figure 4. Experimental Environment with Arduino and Tablet Pc

Figure(a) shows Arduino board and joystick used in the experiment. Mega 2560 Board(5V, 8bit, 16MHz) has been used and, for convenience, we fixed the joystick on top of the mega board. Also, USB bluetooth 'Dongle' was used as the communication module. Figure(b) shows the game designed to detect emotional state through bluetooh of IoT in AR environment. The user plays the game app and detects the face. Landmark information is output in the detected area. The enemy object randomly attacks the left/right eye of the user. To defend, the user can manipulate the joystick to move the ally object. For natural interaction between the reality and the virtual reality, the game realized object movement and collision. In addition, background music and sound effects increase concentration and fun of the game for the user. Futhermore, in the course of the game, we can collect the happiness data of the user and analyse the information to modify the difficulty of the game.

4.2. Experiment 1

Experiment 1 is about connection. You can name bluetooth devices to make it easier for the user to identify them. The names are shown, instead of unique addresses, to help the user distinguish among different devices. If you search bluetooth devices on our cell phone, you can see the names as follows.

(a) (b)

Figure 5. Experiment with Connecting Arduino and Tablet PC

Figure(a) shows BD_ADDR 00:15:83:EA:EB:BC of the bluetooth. The upper half '00:15:83(24 bits)' means the producer. The lower half '24 bits EA:EB:BC' shows the

unique address. And its name is Art_JS. Figure(b) shows the paging process for the connection of the tab and Arduino.

4.3. Experiment 2

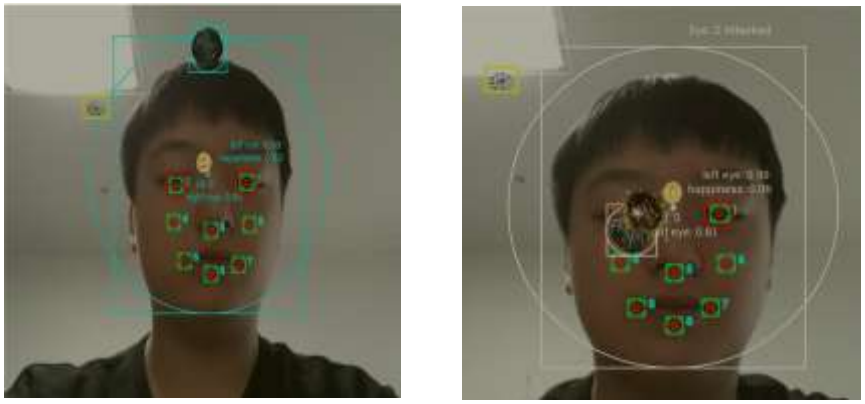


Figure 6. Sensing Information Detection and Interaction I in Mobile IoT Environment

In Figure(a), the game has started. Face has been detected and 8 landmarks are well output. The enemy object is showing active movements. In Figure(b), the ally and the foe objects are rather distanced. The user did not counterattack by moving the joystick, and the enemy object attacked the right eye, causing collision resulting in explosion. Table 1 shows the data of left eye, right eye, along with happiness data.

Table 1. Result of Experiment 1

	Left eye	Right eye	Happiness	Confer
Figure (a)	0/99	0.99	0.03	
Figure (b)	0.99	0.81	0.06	Right eye attack

4.4. Experiment 3

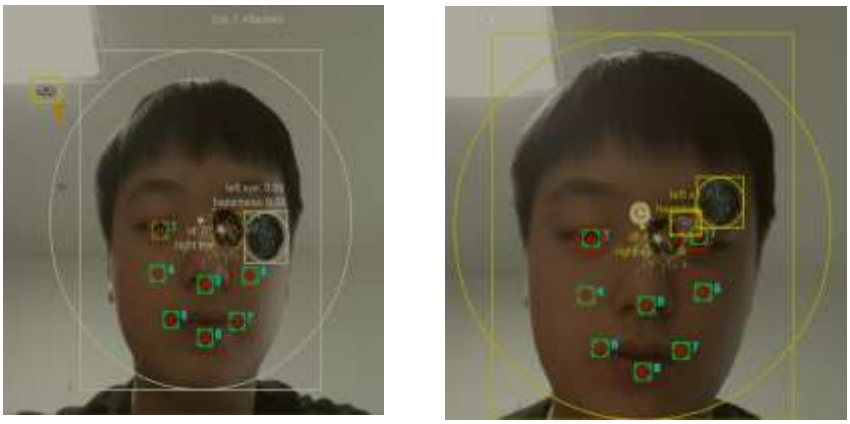


Figure 7. Sensing Information Detection and Interaction II in Mobile IoT Environment

In Figure (a), the user did not counterattack the enemy by using the joystick, and the

enemy object attacked the left eye of the user. Then, collision happened and explosion followed. In Figure (b), the user controlled the joystick to move the our flying object to the coordinate where the enemy is located. The user defended against the enemy attacking the left eye, and collided with the enemy. Explosion followed. In this case, considering that user's happiness data is low, we enlarged the movements of the ally character to make it move quickly to effectively defend against the enemy attack even from rather distanced position.

4.3. Experiment 4

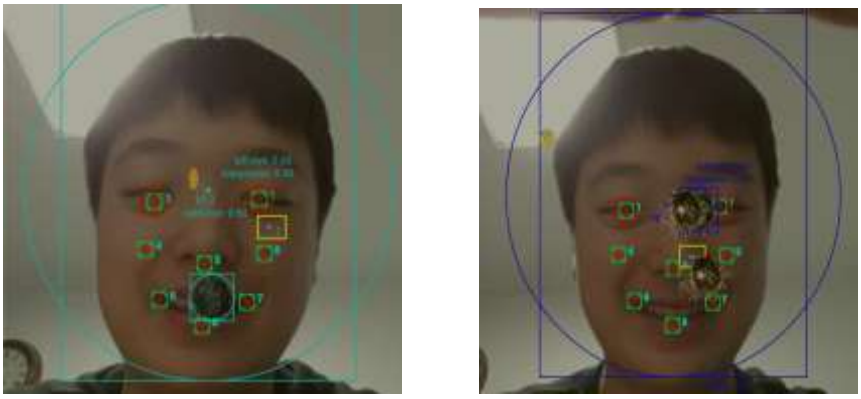


Figure 8. Sensing Information Detection and Interaction III in Mobile IoT Environment

Experiment 4 shows detection of face and 8 landmarks. In Figure(a), the user moves the joystick and places the ally object below his/her left eye to defend against the attack. Here, the left eye is slightly closed at 0.55, and the happiness data is rather high at 0.96. At this moment, the enemy attacks again, and the ally moves downward to make defense. They collide and explosion follows(explosion at bottom part of the figure). As happiness data is high, the enemy moves quickly, and the ally is slow. Then the enemy attacks the left eye of the user. They explode(the upper part of the figure). Experiment 3 and experiment 4 are experiments in which the degree of difficulty of the game is adjusted by adjusting the movement of virtual objects in consideration of the user's happiness data

5. Conclusion

The keyword in the smart era is 'communication between emotion and technology'. And the future information service is not just targeted at simply seeing and hearing [11-13]. Information service will be emotions-based, and its value will depend on communication with device by enabling the user to see, hear, touch, feel, and interact with the device. In the AR-based game service, user can intuitively enjoy games by interacting with augmented virtual contents in real space. In particular, vision-based augmented reality is an integral AR technology which can detect even emotional information of the user, using face detection and landmark info, not to mention its merits of convenience in use since it does not need additional sensors or markers [14-17]. Therefore, in this paper, under the Bluetooth of IoT environment with tablet PC with AR environment, user used joystick to freely move virtual objects in AR environment. Through the game, this paper proposed a method to create mobile emotional IoT interface. Camera on tablet PC detects the face of the user. Information on happiness emotion is extracted and analyzed to generate information on emotional state, which is then used to modify difficulty levels of the game, with a purpose to provide optimal service factoring in emotions of the user. For verification, we went through Experiment 3 and Experiment 4. In Experiment 3,

happiness data was lower than threshold, so we increased the movement information of the ally object to be bigger than the enemy's so that the ally could move faster. Faster object could defend against the enemy attacking the eye, and could even attack the enemy. In Experiment 4, happiness data was higher than threshold, and we reduced the movement information to make movements normal. In this case, we tried to induce explosion by counterattacking the enemy. However, the enemy moved and attacked the eye of the user, leading to two explosions. Through Experiment 3 and 4, we verified the possibility of the proposed method by collecting happiness data of the user, inferring emotional state of the user and applying the information on the enemy object in AR.

In the future, we need to construct objective database with user face detection info. Futhermore, we need further researches to more concretely display the emotional information of the user based on gestures, voice and other additional information.

References

[1] H.-S. Park, "Trend of AR technology development using human-centered UI/UX", Weekly technology trend, no.6, **(2016)**, pp. 2-14.
[2] H.-M. Lee, Y.-T. Woo, "Technology and prospects of user interface based on AR for organic interaction", Journal of information & science, no. 8, **(2011)**, pp15-19.
[3] "In-depth report on cultural technology", Mobile AR technology and industry trend, Korea creative content agency, vol. 4, **(2010)**.
[4] C.-M. Ahn, "Research of current trend for user interface & future development", Korea society of innovation, vol. 6, no. 2, **(2011)**, pp. 109-135.
[5] H.-B. Choi and M.-H. Kim, "Inside information: IT issue: IoT technology and service development in domestic and foreign markets", Regional information, issue 84, no.6, **(2014)**.
[6] D.-H. Kim, M.-K. Kim and Y.-K. Hong, "IoT-applied communication technologies - IoT communication technologies for smart world", Information and open lecture, vol. 32, issue 12, (special edition no.2), **(2015)**, pp. 3-11.
[7] S.-C. Choi, "IPv6 bluetooth smart technologies advancing the IoT era", Semiconductor network, no. 9, **(2015)**, pp. 95-99.
[8] www.hardcopyworld.com/.
[9] https://developers.google.com/vision/face-detection-concepts.
[10] Y. J. Lee, "Vision Based Natural Smart Phone Interface using Face Detection for Optimal UX", International Journal of Multimedia and Ubiquitous Engineering, vol. 11, no.7, **(2016)**, pp.321-330.
[11] H.-R. Lee, J.-S. Lee and J.-W. Lee, "Technology trend of emotion UX", Electronics and Telecommunications Trends, vol. 26, no. 5, **(2011)**, pp. 83-93.
[12] J. M. Harley, "Comparing virtual and location-based augmented reality mobile learning: emotions and learning outcomes", Educational Technology Research and Development, vol. 64, issue 3, **(2016)**, pp. 359–388
[13] J. Grubert, "Towards Pervasive Augmented Reality: Context-Awareness in Augmented Reality", IEEE Transactions on Visualization and Computer Graphics, vol. 23, issue 6, **(2017)**, pp. 1706-1724.
[14] L. Gruber, T. Langlotz, P. Sen, T. Hoelerer and D. Schmalstieg, "Efficient and robust radiance transfer for probeless photorealistic augmented reality", Proc. IEEE Virtual Reality, **(2014)**, pp. 15-20.
[15] J. Patoliya, "Arduino controlled war field spy robot using night vision wireless camera and Android application", 2015 5th Nirma University International Conference on Engineering (NUiCONE), **(2015)**, pp1-5
[16] T. M. Jenifer, "Mobile Robot Temperature Monitoring System Controlled by Android Application via Bluetooth", International Journal on Advanced Computer Theory and Engineering (IJACTE), vol. 2.3, **(2013)**.
[17] M. Selvam, "Smart phone based robotic control for surveillance applications", Dept. of ECE Karpagam University Coimbatore Tamil Nadu International Journal of Research in Engineering and Technology, **(2014)**.

Author

Young Jae Lee, he received a bachelor's degree in electronics from Chungnam National University in 1984, a master's degree in electronics from Yonsei University, and in 2000 acquired a doctorate in electronic engineering at Kyunghee University. He is currently full professor of the Department of Smartmedia at Jeonju University. His field of research includes smart media, IoT, computer vision, AR (Augmented reality), computer games.