Development of Smart Fashion System for Interaction between Humans and Dogs

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Abstract-The prevalence of companion dog ownership is rising, and the humanization of pets is becoming more popular Accordingly, dog-related businesses and wearable products for dogs are being actively developed. On the other side, social issues brought on by dog abandonment or loss are growing concurrently. This is believed to have occurred due to poor communication between humans and dogs. In this regard, wearable products that inform the emotions of dogs are being sold. However, because the dog's characteristics were not taken into account in the aim or design, there is limited opportunity for human-dog contact. Therefore, the purpose of this study is to develop a customizable couple look based on fabric electronics technology to establish a smart fashion system that helps interaction between humans and dogs. The research methods and contents are as follows. First, the characteristics of the product were examined by analyzing representative examples of smart fashion that help the interaction between humans and dogs. Second, the communication patterns between humans and dogs were identified by reviewing previous studies and the development direction of interaction design was established. Third, guidelines for interaction design in terms of both functional and aesthetically pleasing elements were defined based on an analysis of the visual characteristics of humans and dogs. Fourth, a prototype was developed by selecting techniques and materials for effective interaction. As a result, five functional characteristics clarity, information, simultaneity, convenience, and enjoyment and five aesthetic attributes symbolism, multipurpose, practicability, wearability, and diversity were derived. This study is significant because it develops a strategy for creating a smart fashion system that promotes interaction, suggests a customized pair appearance based on fabric electronics utilizing computer embroidery, and increases the value of both functional and aesthetic features.

Keywords: Interactive smart fashion, Computer embroidery machine, Fabric electronics, Customizing, Couple look

1. INTRODUCTION

The proportion of raising companion animals is on the rise due to the increase in single-person households, non-marriage, low birth rate, and population aging. According to Statistics Korea data (2020 Population and Housing Census), there are 3.12 million households raising companion animals. 15.0% of all households had this, with those with companion dogs having the greatest proportion (Jeong, 2021, p.6). The phenomenon of recognizing companion dogs as family members and treating them as emotional personalities is pet humanization, which has become a global trend and is spreading in Korea (Hwang & Son, 2021, p.16). As a result, interest in welfare to lead a happy life for dogs is increasing and related businesses are expanding. In addition, the field of companion animal-related wearable devices is actively growing, and technology-based services like healthcare, monitoring, play, and feeding are being provided thanks to the introduction of 4th Industrial Revolution-based technology and the development of ICT convergence technology (Lee et al., 2019, pp. 29-30). However, companion animal-related societal issues are also becoming more prevalent.+ As of the end of 2020, it was investigated that 130,401 lost or abandoned animals were rescued and protected, and 26.7 billion won was spent operating 280 animal protection centers nationwide (Choi & Jang, 2021, p. 2). The welfare of pets is under danger in addition to the significant social cost involved. As a result of a survey of people who have experienced considering giving up and abandoning their companion dogs, behavioral problems such as damaging objects and barking were the most common reasons (Kim & Jung, 2022, p. 2). It is believed that the cause of these

behavioral problems is a lack of understanding of the characteristics of the dog species, resulting in communication errors and poor emotional exchange. In response to this, smart fashion products are being sold that help to understand the emotions and moods of companion dogs and communicate with them. However, the majority of them come in the shape of hard objects that dogs cannot wear and are primarily intended for monitoring the living body, making them insufficient for human connection. Accordingly, there is a need to develop products that promote emotional exchange by helping interaction between humans and dogs based on technology that strengthens user-friendliness. Therefore, the purpose of this study is to build a smart fashion system for interaction between humans and dogs by proposing a customized couple look based on fabric electronics.

Research methods and contents are as follows. First, a representative case of smart fashion that helps the interaction between human and dog was investigated to extract the necessary elements of product development and devise measures to improve the insufficient elements. Second, through theoretical consideration of previous studies, the communication pattern between the human and the dog was identified, and the direction of interaction design development was set. Third, based on the understanding of the visual characteristics of human and dog, interaction design guidelines in terms of functional and aesthetic aspects were established. Fourth, based on the considered characteristics and guidelines, a fabric electronics-based material was selected to develop a prototype and present a customizable couple look that can effectively interact.

2. THEORETICAL CONSIDERATIONS

2.1. Cases Analysis and Characteristics of Dog Smart Fashion

Wearable devices refer to all devices that have the function of collecting and managing personal biometric information by being attached to or worn on the body (Park, 2020, p. 162). Dog smart fashion is a type of wearable device that adds functions to basic items such as collars and harnesses. In this study, cases of smart fashion for dogs that help interaction with people are classified into three applications: (1) photographing a dog's point of view, (2) monitoring a dog's emotions, (3) monitoring a dog's emotions and activities.

First, GoPro's product is a representative example of an application that helps identify the field of activity and view by shooting from the dog's point of view. Attach the camera to the chest or back of the harness as shown in Figure 1. It is a function that records and collects the dog's view, which is difficult for the human to grasp, through a camera device, and transmits it through Bluetooth to show it as an application. The product's design and color are integrated, and its shape and substance take detachability and waterproofness into account. It is also a Nikon product that works based on the dog's heart rate to help capture points of view and understand tastes and emotions. It is used by attaching it to the chest of the harness as shown in Figure 2. When the dog's heart rate rises above a specified threshold, the camera automatically snaps a photo. The heart rate sensor detects the dog's heart rate. The collected data is transmitted to the application via Bluetooth and displayed to the companion. The product has a single design and color, is constructed of elastic material for a snug fit, and was created with detachability in mind.

Second, Dogstar's product monitors emotions by analyzing a dog's tail movements. It is in the form of a strap and is worn on the tail as shown in Figure 3. It is a function that uses accelerometers and gyroscope sensors to identify emotions such as "happiness", "excitement", "anxiety", and "aggression" and sends them to the application through Bluetooth to deliver them to the companion. The strap has one design and comes in three colors: black, orange, and blue. It is made of a material that considers durability, water resistance, and anti-chewing functions. It is lightweight compared to other products and can be worn easily. In addition, NSID's product detects and analyzes a dog's brain waves to help identify emotions. As shown in Figure 4, it is a type of headset worn on the head. It is a function that analyzes the dog's brain waves using a brain wave sensor and converts them into human language such as 'tired', 'curious', and 'excited', and provides voice guidance through the speaker attached to the headset. The headset design and color are one, and the material is made of plastic.

Third, it is a Petpuls product that informs the dog's emotions and measures the amount of activity based on voice recognition. It is composed of a collar and device as shown in Figure 5. It conducts emotional evaluation through voice recognition of dogs and informs five emotions such as "stability", "anxiety", "anger", "sadness", and "happiness". In addition, GPS and acceleration sensors are used to measure the amount of activity of the dog, and the collected data is transmitted to the application through Bluetooth and provided to the companion. A device can be attached and detached to change the color of the pattern, which is made of five colors of the same form in a silicon material that is waterproof. In addition, Inupathy's products measure

emotions based on a dog's heart rate and intuitively inform it through color. It consists of a harness and a device as shown in Figure 6. Based on the heart rate sensor, it intuitively shows emotional states such as 'comfort', 'tension', 'interest', and 'stress' through the color of the LED. At the same time, the amount of activity is collected using an acceleration sensor and transmitted to the application through Bluetooth to provide it to the companion. There is one harness design and the colors are red, gray, and white. The device provides various LED colors and is manufactured in a form that can be detached and attached.

The characteristics of the three application cases of (1) dog point-of-view photography, (2) emotion monitoring, and (3) emotion and activity monitoring were examined by classifying them into functional and aesthetic aspects as shown in Table 1. The investigation shows that the product has limitations in terms of companion interaction because it is primarily focused on tracking emotions and biological data. In addition, the product design in terms of aesthetics is monotonous and lacks aesthetic sensibility due to the size of the device. Therefore, in this study, we went beyond monitoring emotions and moods to develop smart fashion products that effectively help interactions, and devised a method to improve the diversity of designs. In terms of functionality, intangible elements such as perspectives and emotions that are difficult to grasp are conveyed through sight and voice. It has the characteristics of intuition and clarity. In terms of aesthetics, it has waterproof or detachable properties in material and shape. Therefore, in this study, the necessary elements of the product were composed of intuition, clarity, and detachability and applied to the development of prototypes.

Table 1. Smart fashion for dogs for interaction

Application	Brand & Product Name	Composition		Characteristic
Photographing a dog's point of view		Functional	· Device: Camera · Communication: Bluetooth · Other: Applications	· Check activity range and field of view · Compatible with 10 camera models
	Figure 1. Gopro & Fetch	Aesthetic	· Items: harness, camera · Color: 1 · Material: Hydrophilic material (harness), waterproof lens (camera)	· Detachable/attachable camera · Excellent durability and waterproof
		Functional	· Device: Camera · Sensor: Heart rate sensor · Communication: Bluetooth · Other: Applications	· Check activity range and field of view · Identify tastes and emotions
	Figure 2. Nikon & Heartography	Aesthetic	· Items: harness, camera · Color: 1 · Material: elastic band (harness)	· Detachable/attachable camera · Comfortable fit
Monitoring a dog's emotions		Functional	· Sensors: accelerometer, gyroscope · Communication: Bluetooth · Other: Applications	· Understanding Dog's Emotions
	Figure 3. Dogstar & Tailtalk	Aesthetic	· Item: Strap · Colors: 3	· Lightweight · Easy to wear

		Functional	· Sensor: EEG (Electroencephalogram) · Other: Speakers	· Understanding Dog's Emotions
	Figure 4. NSID & No more woof	Aesthetic	· Item: Device · Color: 1 · Material: Plastic	· Durability
Monitoring a dog's emotions and activities.		Functional	· Sensors: Accelerometer, GPS · Device: Microphone · Communication: Bluetooth · Other: Applications	· Grasp emotions · Provide activity · Healthcare
	Figure 5. Petpuls & RPL-0011	Aesthetic	· Item: Color, Device · Color: 5 · Material: Silicone (collar)	· Detachable/detachable device · Waterproof · Customization (collar)
		Functional	· Sensor: heart rate sensor, accelerometer sensor · Communication: Bluetooth · Others: LED, Applications	· Grasp emotions · Communication help · Healthcare
	Figure 6. Inupathy & LI001, LI002	Aesthetic	· Item: Harness, Device · Color: 3 (Harness), Various LED Colors (Device) · Material: Not waterproof	· Detachable/detachable device · Provide aesthetic sensibility of LED

2.2. Interaction Design based on the Visual Characteristics of Humans and dogs

The term "interaction design" is a combination of the terms "inter" and "action," and it refers to how the products and services that people use are linked together and how they are connected to one another through them (Bill, n.d). In this study, interaction design was defined as a series of processes in which companions and dogs objectively convey information and respond to actions through smart fashion products. In order to establish the direction of interaction design development, the existing communication methods between Humans and dogs were primarily reviewed.

2.2.1 How to communicate between a human and a dog

The existing communication methods between humans and dogs were reviewed through three preceding studies. According to a preceding study by Yu-yeon Kim (2018), the communication methods between humans and dogs are divided into language-oriented communication and action-oriented communication. Humans communicate mainly using verbal elements, and dogs mainly use non-verbal elements such as tails, ears, facial expressions, and gestures (Kim, 2018, p. 11). In a recent study, Yong-jae Park, Dong-woo Kwak, Jin-ah Kim, Chang-beom Shin, and Ki-seok Jeon (2014) found that dogs utilize gestures to convey their feelings because they cannot speak and find it difficult to distinguish the width of changes in their eyes and ears (Park et al., 2014, p. 938). According to a previous study by Da-young Lim (2019), dogs' communication methods express emotions or feelings with their own actions, and behaviors using the same body part are also conveyed in a different meaning by a slight difference (Lim, 2019, pp. 19-20).

The results of examining the communication method between human and dog through previous studies are

as follows. First, dogs' express emotions based on their tails, gestures, and other behaviors. Second, it is difficult for humans to grasp the exact meaning of the content conveyed by the dog. Third, it is impossible to deliver objective information. In other words, efficient communication between the two subjects is not achieved with the existing communication method, and it is difficult to identify risk factors arising from the external environment. Therefore, as a means to improve the limitations of the existing communication method, a visual-based communication method that can deliver intuitive and clear information was devised and applied to smart fashion.

2.2.2 Visual characteristics of humans and dogs

In order to establish a visual-based communication method, the visual characteristics of humans and dogs that vary depending on the external environment were examined. During the day, human vision is comparatively better than that of dogs. Dogs have a short visual distance, so it is difficult to grasp distant objects and their ability to distinguish colors is poor (Ryu, 2020). In addition, the colors that dogs can see are black, white, gray, yellow, and blue, and the colors that can be clearly distinguished are yellow and blue (Jeong et al., 2021, p. 453). At night, dogs' vision is comparatively better than that of humans. Dogs have excellent ability to distinguish between light and dark and can detect moving objects well (Kim, 2018).

As such, the visual characteristics that differ according to the amount of light can act as an element that hinders communication. Therefore, in this study, an intuitive interaction design Development direction was established to prevent risk factors that may occur from the external environment and overcome the limitations of communication by considering visual characteristics that appear variably according to changing environmental factors.

The interaction design process is shown in Figure 7. In terms of functionality, it is designed to implement sensor- and board-based LED light to deliver objective information and perform immediate response actions. In terms of aesthetics, it was designed to reduce the risk of loss by forming a bond and increasing visibility using a couple look. As a result, it is possible to implement effective interaction that induces emotional exchange by protecting health and smooth communication.
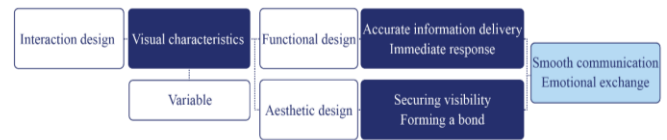

Figure 7. Interaction progress

2.3 Couple look for interaction design

In terms of aesthetics, a couple look was selected as a means to effectively design interactions between humans and dogs. Clothing reflects the wearer's psychology and can convey intentions in a visual form. The dictionary meaning of a couple look is to wear clothes of similar shape or color (Korea University Korean Dictionary, n.d.). By revealing to others that they are special to the reference group or individual to which they belong, they gain emotional stability and form an individual's identity (Han, 2005, pp. 756-762). In other words, simply wearing a pair appearance might physically communicate that your relationship is positive and amicable. Couple looks for humans and dogs on the market were investigated, and three design characteristics of fabric, color, and graphic were considered. As a result, the couple looks of Mardimercredi in Figure 8, Nerdy in Figure 9, YALE in Figure 10, and MLB in Figure 11 showed similar design characteristics. The same fabrics, colors, and graphics were used for the items of humans and dogs, and a sense of unity and visibility were secured. Therefore, in this study, the plan was conducted to effectively provide interaction by applying the same three design characteristics.

Figure 8. Mardimercredi

Figure 9. Nerdy

Figure 10. YALE

Figure 11. MLB

3. DEVELOPMENT OF INTERACTIVE SMART FASHION SYSTEM FOR HUMANS AND DOGS

3.1. Functional Plan

3.1.1 Research Methods and Materials

Fabric electronics, according to previous research by Lee Eun-kyu and Kim Yun-hee (2020), is a compound word of textile and electronic device, meaning electronic textile, and the manufacturing method is (1) fabric, knitting, and embroidery using conductive yarn and (2) printing type using conductive materials (Lee & Kim, 2020, pp 105-112). Among them, the embroidery technique utilizing conductive yarn is light and flexible because it is embroided on various knitted materials, and second, it is relatively straightforward and diverse to construct electrical circuits, allowing precision production. Third, it has the advantage that mass production is possible through process automation (Lee, 2020, pp 52-55). The manufacturing method of fabric electronics based on embroidery can improve the uncomfortable wearing sensation of existing wearable devices and enhance the aesthetic value of expanding the diversity of designs by enabling mass production. Therefore, in this study, a circuit diagram using fabric electronics-based computer embroidery was constructed and an interconnecting method was designed.

3.1.2 Building a system based on user scenarios

System construction was designed with hardware and software. The hardware system construction consisted of a wearable Arduino Lilypad 328 main board, battery holder, sensor, board, and LED. A circuit diagram was made by embroidering with conductive thread, each module was connected to realize the function of the sensor and board, and a system was built to deliver information to the user through LED.

The software system construction was programmed according to user scenarios based on outdoor activity situations that require the most interaction between companions and dogs, and these are summarized in Table 2.

First, the twinkle board was used considering the visual characteristics of humans who are less visible at night compared to dogs. The Twinkle Board draws attention and secures visibility through irregular LED lights during outdoor activities on a dark night. This increases safety by informing others and enhances fun by increasing immersion through LED lights.

Second, a UV sensor was used to inform the invisible risk factors in the external environment. The UV sensor detects the invisible amount of UV during outdoor activities on a sunny day and communicates the danger through LED lights. This supplement the limitations of visual ability with technology to prevent heatstroke in dogs and protect their health.

Third, an illuminance sensor was used considering the visual characteristics of humans who are less visible at night compared to dogs. The illuminance sensor responds to the amount of light in the surrounding environment and increases visibility through LED light when it gets dark due to sunset during outdoor activities. This makes it easy to locate the dog and secures its safety.

Table 2. Situation scenarios for sensors and board
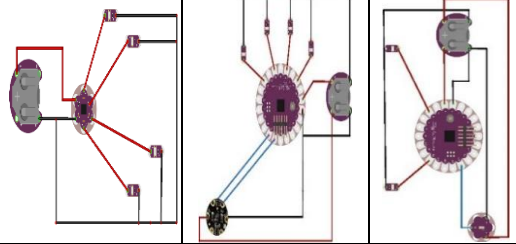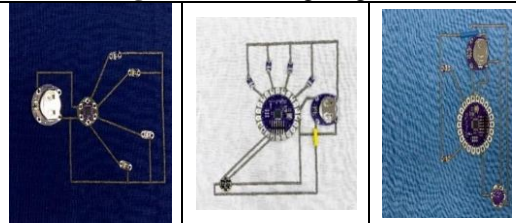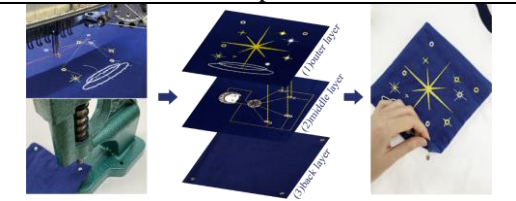
Sensor	Feature	Function	Situation Scenario	Effect
Twinkle board	Supplementing human vision that is difficult to see at night	Irregular LED light drive	Outdoor activities in the dark at night	Easy to locate Securing Safety providing fun
UV sensor	Recognize invisible risk factors	Notify the user with LED light depending on the amount of UV light	Outdoor activities during the daytime when the sun is strong	sunstroke prevention health protection
Illumination sensor	Supplementing human vision that is difficult to see at night	Notify the user with LED light depending on the amount of light	When it gets dark as the sun goes down during outdoor activities	Easy to locate Securing Safety

In this study, a module patch with three functions of twinkle board, UV sensor, and illuminance sensor was developed. In addition, it is designed to be detachable and attached according to the situation or preference. The manufacturing method of the module patch is summarized in Table 3 and is as follows. STEP. 1 designed a circuit diagram suitable for each function using the Fritzing program as shown in Figure 12. STEP. 2 A circuit diagram was created with a computer embroidery machine, connected to the wearable module, and the Arduino IDE program was uploaded as shown in Figure 13. Excluding the twinkle board programmed by itself, the UV sensor and illuminance sensor are designed to emit LED light by presetting the amount of UV and illuminance to react to a certain external environment. STEP. 3 puts graphics on the outer surface with a computer embroidery machine and attaches snap buttons to the back. Then, (1) the outer layer with graphic embroidery, (2) the middle layer with circuit diagrams and modules, and (3) the back layer with snaps were combined into one layer as shown in Figure 14. When connected, the LED light is visible through the circle-shaped eyelet embroidery on the outer surface, and it is designed to be detachable and attached to the item with the snap button on the back.

Table 3. Module patch making process

Module	Twinkle board	UV sensor	Illumination sensor
Function	Irregular LED light drive	Notification of Excessive UV Amount	Notification of changes in illuminance
STEP. 1			

Figure 12. Fritzing diagram

STEP. 2			

Figure 13. Computer embroidery machine output

STEP. 3			

Figure 14. Combine layers

3.2 Design Plan

For the item design, the couple look was selected as a way to effectively interact with the aesthetic aspect, and it was composed of items that combine activity and practicality in consideration of the outdoor activity situation. The items were classified into clothing and accessories, and each two designs were developed: dog's clothing and harness, and human clothing and bag.

The effect of the couple look was secured by producing the same three elements of fabric, color, and graphic. For the colors, white, blue, and yellow were used in consideration of the visual characteristics of dogs that see limited colors. As for the design of the module patch, the twinkle board is a light, the UV sensor is the sun and clouds, and the illuminance sensor is the moon, and

graphics are inserted to intuitively represent each function.

3.3 Customization of function and design

In this study, a customizing design strategy was used to provide users with a choice of design and function by providing 3 types of module patches. Customization refers to a customized service in which a seller makes a product in response to a customer's request (Daily Economic Terminology Dictionary, n.d.). As shown in Figure 15, functions can be selected according to the situation or preference, module patches can be detached and attached through the snap button, and people and dogs can be applied to the four items presented above without distinction. It is a strategy that can realize detachable, which is an essential element of smart fashion products for dogs, and maximize the diversity of design. Thus, this is a design that considers practicality and cost-effectiveness

Figure 15. Customized couple look

3.4 Design Concepts and Interactive Design Characteristics

A total of four prototypes proposed in this study are shown in Table 4. How to wear STEP.1 Select an item, STEP. 2 Choose a module patch. STEP.3 Combine with a snap button and item. STEP.4 Put it on. It can be easily customized like this.
As shown in Figure 16, prototype A has a twinkle board module patch attached to the dog's clothing. When worn, irregular LED lights operate to secure safety and provide fun. As shown in Figure 17, Prototype B attached the UV sensor module patch to the dog's harness. When worn, LED light operates according to the amount of UV to prevent sunstroke and protect health. As shown in Figure 18, Prototype C attached the light sensor module patch to

human clothing. When worn, the LED light is driven according to the amount of light, providing the function of notifying the location and securing safety. As shown in Figure 19, Prototype D attached module patches of UV sensor and illuminance sensor to the human bag. It provides the functions of sunstroke prevention, location notification, and health protection at the same time.

The characteristics of the interactive design derived from the development of a detachable and attachable customized couple look using a computer embroidery machine are as follows.

Functional aspects include: First, the clarity of providing content in a concise visual language of LED light. Second, information that informs objective contents through LED light by driving based on sensor and board. Third, simultaneity in which content delivery and coping behavior occur immediately. Fourth, convenience that can be easily operated without other electronic devices. Fifth, enjoyment that provides fun by increasing immersion with LED light.
Aesthetic aspects include: First, the symbolism of showing a positive and mutual relationship by wearing a couple look. Second, the multi-purpose use of module patching according to the desired function. Third, the practicality of applying module patches to all items. Fourth, the wearability provided by the light and flexible characteristics of embroidery-based fabric electronics. Fifth, it was considered as a variety that provides various designs customized by users.

Table 4. How to wear prototypes and properties

Type	User	STEP. 1 Select item	STEP. 2 Select module patch	STEP. 3 Attach	STEP 4 Wear	Effect
Figure 16. Prototype A	Dog					· Securing Safety · Provide fun
Figure 17. Prototype B						· Sunstroke prevention · Health protection
Figure 18. Prototype C	Human					· Location notifications · Securing Safety
Figure 19. Prototype D						· Health protection · Location notifications · Sunstroke prevention

4. CONCLUSION

As the rate of raising companion animals increases and the pet humanization trend spreads, interest in welfare is increasing and related industries are expanding. In addition, wearable products based on ICT convergence technology that can understand the emotions and moods of companion animals are being developed. However, because this is a design that does not address the dog's comfort and is primarily used for monitoring the dog's body, it is insufficient to enable contact between humans and dogs. Therefore, this study proposed a customizable couple look based on fabric electronics technology to develop a smart fashion system that helps interaction between companions and dogs.

The contents of the study are: First, by evaluating sample cases of smart fashion goods that aid human-dog interaction, the three required characteristics for product creation were recognized as clarity, intuitiveness, and detachability, as well as the limitations of use and design. Second, through the theoretical consideration of previous studies, the communication aspects of humans and dogs were identified, and based on this, the development direction of visual-based interaction was established. Third, interaction design guidelines in functional and aesthetic aspects were established based on the understanding of the visual characteristics of humans and dogs, which vary depending on external environmental factors.

In terms of functionality, a fabric electronics embroidery-based circuit diagram was built to provide (1) irregular LED light driving of the Twinkle Board, (2) notification of excessive UV amount of the UV sensor, and (3) notification of changes in light from the

illuminance sensor. Through this, information delivery and coping behavior were achieved. In terms of aesthetics, the effect of the couple look was secured by using the same fabric, color, and graphic. In addition, a detachable module patch was proposed to make it possible to customize the function and design. This yielded five functional characteristics of clarity, informativity, simultaneity, convenience, and enjoyment, as well as five aesthetic characteristics of symbolism, multi-purpose, practicability, wearability, and diversity.

The conclusions of this study are as follows. First, based on an overall understanding of the visual characteristics of humans and dogs, risks were prevented and smooth communication was promoted. Second, the function of the product has been expanded by providing interaction with humans beyond the monitoring function provided by existing smart fashion products. Third, the design was diversified by proposing a customizable couple look of fabric electronics based on computer embroidery. This study proposed a customizable couple look using a fabric electronics-based computerized embroidery machine, and established a strategy for developing a smart fashion system that helps interaction and the basis for mass production. This study is meaningful in that it has improved the value in terms of functionality and aesthetics. In future research, we intend to present the possibility of commercialization and popularization as a product through user testing and application development using the developed prototype.

5. ACKNOWLEDGEMENTS

REFERENCES

[1] Bill, M. (n.d.). Humanitas Technology. Naver Knowledge Encyclopedia. from: https://terms. naver.com/ entry.naver?docId=1691526&cid=42171&categoryId=42190, Oct 10

[2] Choi, B. S., & Jang, S. E. (2021). 2020 Results of Survey on the Protection and Welfare of Pets. (n.d.). Ministry of Agriculture Food and Rural Affairs. from: www.mafra.go.kr/ bbs/mafra/ 68/ 327122/ artclView.do

[3] Daily Economic Terminology Dictionary. (n.d.). Naver. Sep, 28, 2022. from: https:// terms. naver.com/entry.naver?docId=20936&cid=43659&categoryId=43659

[4] Han, M. S. (2005). A Study on the Linguistic Manifestation of "Couple Look". The Research Journal of the Costume Culture, 13(5), 756-762.

[5] Hwang, W. K., & Son, K. P. (2021). 2021 Korean Pet Report. (n.d.). KB Financial Group Management Research Institute. from: https://www.kbfg.com/ kbresearch/report/ report View.do?reportId=2000160

[6] Jeong, N. S., & Park, S. N. (2021). Results of the 2020 Population and Housing Census (n.d.). Statistics Korea. from: https://www.kostat.go.kr

[7] Jeong, T. Y., Jeong, Y. A., & Park, K. J. (2021). Suggestions for communication with dogs and converged product design based on visual differences between humans and dogs. The Korean Society of Science & Art, 39(3), 453. doi: http://doi.org/10.17548/ksaf.2021.06.30.449

[8] Patel, S., Patel, P., Joshi, D. and Yadav, R., 2020. Performance Comparison of Flexible Alternating Current Transmission System (FACTS) Devices with Distributed Generation System. International Journal of Applied Science and Engineering Research, 3(1), pp.21-27.

[9] Nayak, S., Pradhan, S. and Mishra, S., 2023. Mathematical Modelling to extract feature for Cholera. Applied Mathematics & Computing, 1(1).

[10] Kim, J. H., & Jung, H. S. (2022). Announcement of the results of the 2021 National Consciousness Survey on Animal Protection. (n.d.). Ministry of Agriculture Food and Rural Affairs. from: https://www. mafra. go.kr/bbs/mafra/68/329297/artclView.do

[11] Kim, M. K. (2018,7). The Story of the Dog's Sensory Organ. Ggilbo. from: http://www.g gilbo.com/ news/ articleView.html?idxno=529221

[12] Kim, Y. Y. (2018). A Design of User Interfaces for Communication between Dogs and Humans (Master Thesis). Konkuk University, Seoul, Korea. uci: I804:11004-200000001640

[13] Korea University Korean Dictionary. (n.d.). Naver dictionary. Nov, 4, 2022. from: https:// ko.dict. naver. com/#/entry/koko/379bb152b424487a89ab3e3911dc147c

[14] Lee, E. G. (2020) Development of Mass Customization Tech-pocket Smart Fashion Using Computer Embroidery Machine Focused on web site development reflecting the characteristics of MZ generation (Master Thesis). Kookmin University, Seoul, Korea. uci: I804:11014-200000366952

[15] Lee, E. G., & Kim, Y.H. (2020). A Study on the Development of Fabric Electronics' Customized Smart Bag Using Computer Embroidery. Journal of the Korea Convergence Society, 11(7), 105-112. doi: https://doi.org/10.15207/JKCS.2020.11.7.105

[16] Lee, S. M., Hong, S. G., Jeong, D. Y., Park, H., & Kim, S. H., (2019). ICT R&D Trend. (03). IITP. from: https://www.iitp.kr/main.it

[17] Lim, D. Y. (2019). A study on the expression of ceramics based on the signature of dogs (Master Thesis). Seoul Womens University, Seoul, Korea. UCI: I804:11036-200000223961

[18] Park, B. I. (2020). A Study on the Latest Trends and Development Prospects of Wearable Healthcare Industry: Focusing on Healthcare Products and Latest Research of a Renowned International Journal. The Journal of Next-generation Convergence Technology Association, 4(2), 162. Doi: https:// doi.org/ 10. 33097/JNCTA.2020.04.02.161

[19] Park, Y. J., Kwak, D.W., Kim, J. A., Shin, C. B., & Jeon, K.S. (2014). The Integration Communication Appcessory Used by the Tail of a Companion Dog. HCI Society of Korea Conference, (n.d.), 938.

[20] Ryu, J. H. (2020,11). Understanding your dog's vision. Naver blog. https://blog.naver.com/tak-dog/ 222 153078637