



USER EXPERIENCE DESIGN AND ARCHITECTURE – AN APPLICATION WITH ARDUINO

Ece KARACA ^{1,*} , Özlem KANDEMİR ² 

¹ Architecture, Faculty of Engineering and Architecture, Istanbul Esenyurt University, Istanbul, Turkey

² Architecture, Faculty of Architecture and Design, Eskişehir Technical University, Eskişehir, Turkey

ABSTRACT

User experience design, which provides the emergence of user-oriented designs, while meeting the needs of users functionally, also deals with their emotions and perceptions. With this interactive design approach, personalized design alternatives can be offered in accordance with the expectations of the users. At the same time, the flexibility with changing conditions, demands and pleasures ensures that designs are sustainable. Architecture is one of the disciplines where user experience design can effectively use. The inability of changing of buildings in traditional architecture causes another inability that to respond user's current needs and demands. Thus, in modern architecture many researchers and designers investigate for a solution to create different spaces. Moving, flexible and interactive spaces, which are shaped with demands and needs of the users, give importance to the user experience. In this context, a tent was designed as a temporary shelter with caring the user experience and changes depending on the demands and needs of the user, by using the Arduino Uno microcontroller development board. The prototype experiments of the tent design, which was modeled with SketchUp and rendered with Lumion, were made with the Fritzing program. Arduino Uno, sensors, lamp, relay module and servo motors were used in the tent design and the space was enabled to interact with the user's different senses. Two different sensors, temperature-humidity and sound were used in the study. The temperature-humidity sensor interacts with both the user and the environment. Since precipitation occurs when the relative humidity in the air reaches 100%, the program is coded to turn off the panel on the top of the tent when the humidity in the air reaches 70%. With the help of the sound sensor, predetermined colors are lit on the front panel of the tent with the user's hand clap. In the study, it is aimed to create different experiences by providing the interaction between the body and the space.

Keywords: User experience design, Architecture, Arduino Uno, Temporary shelter

1. INTRODUCTION

User experience design, which emerged in the early 1990s, means encountering the system that has a beginning and an end [1]. Kuniavsky (2003) defined user experience as all the factors that affect the relationship between the user and the user in an organization. In the user experience, the whole relationship between the product and the user is taken into consideration to examine the user's experience [2]. UX (User Experience) can be summarized as the quality of the user's experience when interacting with a product [3]. User experience design consists of five levels: surface, skeleton, structure, scope and strategy [4]. The surface includes visual design elements. Skeleton is information design and orientation design. The structure constitutes the information architecture of the elements contained in the application. Scope is the stage of determining the features and qualities that the design will contain. The strategy, on the other hand, corresponds to the design determined according to the needs and claims of the users [4]. User experience design emerges as a result of the user's current situation (wants, mood, needs, etc.), the characteristics of the designed system (purpose, function, etc.) and the context in which the interaction takes place [5]. This situation allows untold designs and experiences to be experienced in products for which user experience design is important.

*Corresponding Author: ecekaraca@esenyurt.edu.tr

Received: 04.09.2022 Published: 23.12.2022

The concept of experience has an important place in the field of architecture, as in many disciplines. Especially with the new developments in information technologies, the concept of experience has gained importance, helping designers to make designs that diversify user perceptions and experiences. Experiencing the space is actualized by interacting with image, texture, smell, taste, and sound. Sensory stimuli, which affect the sensory mechanisms of the space user, are processed, and make the experience possible [6]. While experience is personal, designers can influence users' experiences, but not design. Because experiences vary depending on many parameters such as past experiences, cultural differences, and ages of the users of the space. In order for the design to yield successful results, it is expected to provide solutions that meet the needs of the users during the construction stages of the space. Design cycles are created by determining the needs, identifying the problems, making them aesthetically pleasing by using information technologies, and evaluating the interaction received from the user. This cycle is seen in many areas such as interfaces of applications, architectural and industrial design, and visual channels of communication design. The common purpose of these design approaches is user-oriented solutions that serve the user first and then the society [7]. With the use of user experience designs in the field of architecture, users can actively communicate with the space, making it easier for them to perceive the space mentally and physically. In order to increase the user experience, static spaces can be transformed into interactive, mobile and flexible spaces.

In this study, information technologies were used in order to increase the experience of the users and to enable them to interact with the space, and it was aimed to have a changing and transforming structure of the temporary accommodation area by using the Arduino Uno microcontroller development board. The tent design to be used as a temporary shelter interacts with the user through temperature-humidity and sound sensors and a light source (lamp). The lamp on the tent surface can be arranged in different colors depending on the user's request. In addition, the top cover of the tent is designed as a movable system and it is aimed to come to a closed position by interacting with environmental effects such as rain with the help of temperature-humidity sensor and servo motors.

2. MATERIAL AND METHOD

In this study, information technologies and Arduino Uno microcontroller development board used in order to provide user experience. The tent, which was designed as a temporary shelter, modeled with SketchUp and rendered with Lumion, can be seen in Figure 1.



Figure 1. Tent as a temporary shelter (prepared by the authors)

In this study, which is aimed the user experience, two different sensors planned to be used in temporary shelter design are discussed. The first sensor is the temperature-humidity sensor, and the second sensor is the sound sensor. With the help of the sensors, it is planned that the space will

interact with the user and the external stimulus. The temperature and humidity sensor, DHT11, consists of a 1 k Ω resistor. The temperature and humidity sensor uses a thermistor and a capacitive humidity sensor to obtain ambient information. This sensor contains a chip to convert the read analog values into digital signals. Temperature-humidity sensor operating voltage 3.3 V-5.5 V, humidity measuring range 20% to 90%, relative humidity measuring accuracy $\pm 5\%$ RH, humidity measuring resolution 1% RH, temperature measuring range 0 $^{\circ}$ C - 50 $^{\circ}$ C (32 $^{\circ}$ F – 122 $^{\circ}$ F), temperature measurement accuracy ± 2 $^{\circ}$ C, temperature measurement resolution 1 $^{\circ}$ C, and signal transmission interval of 20 seconds [8]. Another sensor used in the study is the sound sensor. The sound sensor can detect sound values in different decibels and can control any AC or DC device by using a relay in accordance with the determined value, and it can make them light in different combinations by using LEDs or lamps [9]. In the study, Arduino Uno microcontroller development board developed for Atmega328 microcontroller, which can be seen in Figure 2, was used. The reason for choosing this development board is that the software is open source, and the hardware is affordable. The development board has 14 digital inputs/outputs and 6 analog inputs [10].



Figure 2. Arduino Uno microcontroller development board [10]

In the study, motion sensor and temperature-humidity sensor were connected to the Arduino Uno set, as seen in Figure 3, in order to close the top cover in a rain. The system, which can be seen in Figure 3, was built with the Fritzing program, an open-source startup that enables circuit creation to develop CAD software or run a prototype experiment [11].

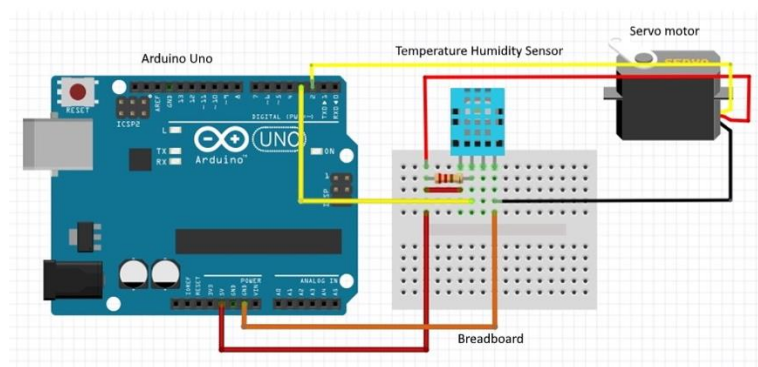


Figure 3. Connecting the circuits of temperature-heat sensor (prepared by the authors)

Thanks to the temperature-humidity sensor in the prototype tent design, the panel on the top of the tent can become closed under suitable conditions, as in Figure 4. Since the water vapor condenses and turns into precipitation as a result of the relative humidity in the air reaching 100%, the top panel has been designed to be closed when the humidity in the air reaches 70%.



Figure 4. Top panels open in sunny weather and closed in rainy weather (prepared by the authors)

Another sensor used to increase the user experience is the sound sensor. With the sound sensor, the user interacts with the tent with the help of a light source (lamp) located on the front of the tent. Depending on the user's request, the lamp on the front panel of the tent turns on when clapping hands or making a sound. Figure 5 shows how the sound sensor is located on the Arduino Uno development board.

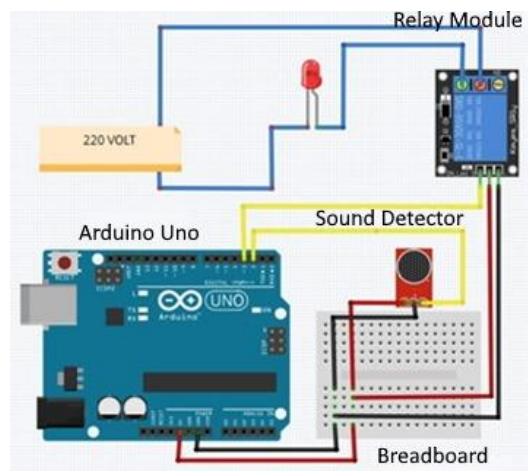


Figure 5. Connecting the circuits of sound sensor (prepared by the authors)

Figure 6 shows the color change on the front panel of the tent design when interacting with sound. Color selection can be changed depending on user request.



Figure 6. Panel color as a result of interaction with the sound (prepared by the author)

3. RESULTS

The mechanization and mass production that emerged after the industrial revolution led to the standardization of the products produced. These products, which are based on the repetition brought by mass production, cannot be continuous because they cannot meet the changing tastes and demands of the users, and this may cause various problems. On the contrary, experimental, creative, and innovative designs emerge with the interactive design [12]. The designs that interact with the user are experience-oriented. The smart phones, computers, tablets, watches, smart clothes, and other interactive products we use can be redesigned in line with the user's requests and tastes.

As a result of the literature review, it has been seen that the products designed by considering the user experience design principles take into account the following principles:

- They are designed to meet the needs of the user.
- They are easy to use.
- Design elements fully reflect the identity of the brand.
- The design appeals to all segments.
- Users feel safe and have no doubts while using the product.

As with the products we use, the user experience also plays an important role in the places we live in. In traditional architecture, the fact that the building does not show flexibility depending on the changing conditions after it is built and does not interact with the users who experience the space has put the designers in search of different spaces. These spaces, which can be mobile, flexible and interactive, can become a smart, sensitive product that can respond to users' requests and save energy.

The spaces using user experience design have the following features:

- They provide spatial diversity.
- They can change as a result of user requests and requirements.
- They diversify the perceptions and experiences of the users.
- They provide the emergence of flexible, interactive, and kinetic spaces.
- They have the ability to adapt to different seasonal conditions.

In the study, Arduino Uno development board was used to reveal the user experience. When the existing experimental sets are examined, it is seen that Arduino Uno is more affordable than other development boards. In addition, it has been observed that many applications can be made in a short time, as the application set does not require cable connections. In addition, the Arduino Uno application set can be easily transported and stored due to its portable nature.

Sound, temperature-humidity sensors, lamp, relay module and servo motors were used in the study. The user's hand clapping or any other sounds made depending on the user's request enable the lamp used on the surface of the temporary accommodation area to light up in different colors. This helps diversify the user's perception and experience. In addition, with the help of the temperature-humidity sensor and servo motor used in the top, the upper opening of the space can be closed automatically in case of precipitation. This ensures that the tent design shows the feature of a space that is mobile and at the same time gives importance to the user experience.

4. CONCLUSION

The changing social structures and perspectives with the industrial revolution have also caused the housing needs to change. With the developments in information technologies, it has been seen that new space designs that adapt to changing living conditions and transform in line with the demands and needs of the users have emerged. These changing and transforming new space designs can show smart, sensitive and interactive features. The concept of "user experience design", which emerged at the beginning of the 90s, has begun to be considered in the field of architecture as well as in different disciplines. The relationship between the experience concept and the body has influenced designers. Considering that the objects and spaces we use in our daily life are perceived and experienced only by our bodies, the importance of user experience design can be understood clearly. In this context, a tent is designed as a temporary shelter with interactive, kinetic and flexible features that change and transform with the movements of the user and the change of environmental factors. It is expected that this accommodation area will interact with different space and user perceptions with the help of Arduino Uno development board, sensors, lamp, relay module and servo motors. This helps the user to have a multi-sensory experience. It is important for designers to design by diversifying user experience and perceptions, as it is predicted that designs made with emphasis on user experience will take place more and more in our lives day by day.

CONFLICT OF INTEREST

The authors stated that there are no conflicts of interest regarding the publication of this article.

REFERENCES

- [1] Jokinen JPP. User psychology of emotional user experience. JYVÄSKYLÄ: The Faculty of Information Technology of the University of Jyväskylä, 2015.
- [2] Kuniavsky M. Observing the user experience: a practitioner's guide to User Research. USA: Morgan Kaufmann Publishers, 2003.
- [3] McNamara N, Kirakowski J. Functionality, usability, and user experience: three areas of concern. *Interactions*, 2006, 13(6), 26-28.
- [4] Garrett JJ. The elements of user Experience. United States of America: American Institute of Graphic Arts, 2004.

- [5] Hassenzahl M & Tractinsky N. User experience—A research agenda. *Behaviour and information technology*, 2006, 25(2), 91-97.
- [6] Aslan Ş. Temel tasarım eğitiminde duyum sürecine yönelik bir yaklaşım. Hacettepe Üniversitesi, Sosyal Bilimler Enstitüsü, İç Mimarlık ve Çevre Tasarımı Anasanat Dalı, 2012.
- [7] Erap BBN, Hilmioğlu S, Kariptaş FS. Kamusal mekânlarda deneyim ve kullanıcı merkezli tasarım. *Sanat ve Tasarım Dergisi*, 2021, (28), 335-347.
- [8] KY-015 Sıcaklık ve Nem Sensörü | Arduino Eğitimi, Projeler ve Dersler. (n.d.). Retrieved 2 September 2022, from <https://arduinoegitim.com/ky-015-sicaklik-ve-nem-sensoru>
- [9] Arduino İle Ses Sensör Modülü. (2015, November 5). *Maker | Türkiye | Robotistan.com*. <https://75.101.132.229/arduino-ile-ses-sensor-modulu/>
- [10] Arduino - Home. (n.d.). Retrieved 2 September 2022, from <https://www.arduino.cc/>
- [11] Learning, Tutorials.(n.d.). Retrieved 2 September 2022, from <https://fritzing.org/>
- [12] Karaca E, Kandemir Ö. Teknoloji ve hareketli mekân. *Yapı Dergisi*, 2021; (470),44-51