Interactive WSN-Bar

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Abstract. Based on the concept of ambient intelligence, we utilized wireless sensor network (WSN) and vision-based tracking technologies to create an interactive WSN-Bar. WSN-Bar is an interactive and innovative creation which has two modules: Garden of Light and Vivacious Bushes. It refers the variety of natural environmental factors and focuses on the relationship between human and nature. WSN-Bar can also detect the changes of brightness, temperature, CO_2 density outdoors and the movement of people inside the building. Besides, WSN-Bar is an interactive installation art which creates the opportunity to reduce the estranged gape among the participants.

Keywords: Bar, wireless sensor network, ambient intelligence, interactive art, vision-based tracking technology.

1 Introduction

In recent years, the concept of Ambient Intelligence (AmI) has been gradually granted more attention in fields of information design and digital art design. AmI emphasizes ubiquitous computing, invisible technology, and natural interaction. Mark Weiser was the first person who mentioned the basic concept of AmI in 1991 [1]. The term of Ambient Intelligence was first proposed by Philips in 1998; then the meaning of this term was clearer explained by ISTAG (Information Society Technology Advisory Group) in 1999 [2, 3]. The concept is to blend computing devices into a daily living environment; therefore, it can detect human behaviors and body conditions, and then automatically provide users with the matching feedbacks. In 1999, MIT cooperated with Philips to create Oxygen project [4]. In the same year, AIR&D was established to integrate industrial resources for achieving AmI idea [5]. Artists also pay much attention to the concept of AmI. Marshall McLuhan, Guy Debord, and Jean Baudrillard successively queried the impact of media technology. These scholars claimed that the spirit of the Arts should not be puzzled by technology [6], which matches the main idea of AmI. Briefly speaking, the main concept of AmI is to make technology humble and invisible existence in our living space.

Based on the concept of AmI, we developed an interactive environment-sensing bar, "WSN-bar", which integrates wireless sensor network (WSN), environmental sensing, human locating, multi-touch, and vision-based tracking technologies. We collected the information from sensors and visualized them into art animation. Participants can enjoy

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WSN-Bar by art appreciation and be aware of the environmental variations through the animation in the bar.

Because of the maturity of WSN technology, WSN-Bar can be developed by applying smaller, smarter, and cheaper sensing and computing devices**.** It makes WSN-Bar easily to achieve the characteristics of AmI. We mainly used WSN wireless transmitting and locating system to achieve intelligence, ubiquity, and context awareness and we utilized the bar-like appearance and small WSN routers to attain invisibility; we applied the intuitional interaction system to implement natural interaction.

Moreover, we developed some vision-based tracking technology to make WSN-Bar with multi-touch interface. Previously iBar [7], MERL's DiamondTouch table [8], and Microsoft Surface [9] have developed multi-touch table. But our WSN-Bar is the first interactive bar applying WSN technology and can reflect the change of the environment and increase communications between human and natural environment.

WSN-Bar has two modules: "Garden of Light" and "Vivacious Bushes". In "Garden of Light" module: WSN-Bar can receive the environmental data from brightness, temperature, and CO_2 density sensors which were built outdoors by WSN short-distance wireless transmitting technology. Then WSN-Bar transfers the collected information into the interface of WSN-Bar to make interactive flower images on the bar. In "Vivacious Bushes" module: WSN-Bar can detect people's movement by WSN locating technology. It also symbolizes the information by bushes and butterflies. Butterflies' flying among different bushes signifies people's moving among different rooms in the building.

According to what has been mentioned upon, WSN-Bar is not only a practical, meaningful and innovative bar, but also an appreciative and interactive art work.

2 Concepts of Interactive WSN-Bar

In this section, we will describe the concepts of how we made these two modules, "Garden of Light" and "Vivacious Bushes". In WSN-Bar, participants can switch them using a cup as a marker and can communicate with natural environment easily by operating its multi-touch interface. We are glad that WSN-Bar also creates opportunities to reduce the estranged gap among the participants when people interact with it.

WSN-Bar video: http://techart.tnua.edu.tw/eTaiwan/contents/elife_wsn-bar.html

2.1 Module 1 – Garden of Light

The content of the multi-touch interface is an interactive garden. Flowers in the garden can move, grow, and change their colors to show the variations of outdoor brightness, temperature, and CO_2 density. Through WSN technology, the environmental sensors can detect and transmit the data from outdoors to the bar. By the artistic flowers, the participants can easily realize the real-time outdoor environment condition (Table 1, Fig. 2). The change of flowers' colors looks like using different colorful light to bright the garden, so this module is called "Garden of Light".

WSN-Bar contains vision-based tracking technology [10] that we have developed, so participants can interact with it by multi-touch interface. As soon as participants put their hands or objects on the top of WSN-bar, the flowers will track the objects

Fig. 1. The plastic design and two modules

and congregate slowly to their positions, which makes WSN-Bar interactive and entertaining.

Table 1. Relationships between environmental data and image content

	Temperature	brightness	CO_2 density
High	Flowers get warmer color	Flowers bloom	Plants become single color
Low	Flowers get colder color	Flowers wither	Plants become full color

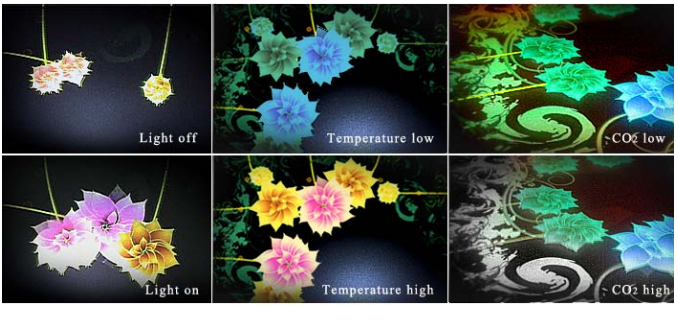

Fig. 2. Relationships between environmental data and image content

Fig. 3. The flowers congregate slowly to the position of participant's hand

2.2 Module 2 – Vivacious Bushes

ZigBee is the core WSN technology we used. WSN-Bar can detect the amount and positions of people automatically through ZigBee routers set in each room and ZigBee tags worn by each person.

The content of the multi-touch interface is bushes and butterflies. Bushes and butterflies symbolize the rooms and the people in the building. Each bush corresponds to each room; each butterfly corresponds to each person. When people move from one room to another, butterflies will fly from one bush to another correspondingly. In addition, people's identity numbers are shown in butterflies' flying paths at the same time (Fig. 4).

Just like the "Garden of Light" module, when participants put their hands or objects on the top of WSN-bar, bushes will trace the objects and congregate slowly to the object positions (Fig. 5). The bushes move according to user's behaviors, so we call this module "Vivacious Bushes".

Fig. 4. People's movements are according to butterflies' movements

Fig. 5. The bushes trace participants' hand positions

3 Interactive Technology

3.1 Vision-Based Tracking System

Vision-based tracking technology is the core of WSN-Bar's multi-touch system. There are infrared projectors and an infrared camera installed inside the bar (Fig. 6). WSN-Bar detects the positions of participant's hands and objects on it by receiving

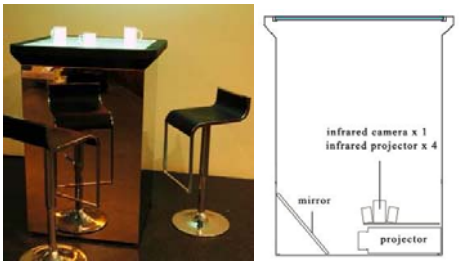

Fig. 6. The layout inside WSN-Bar

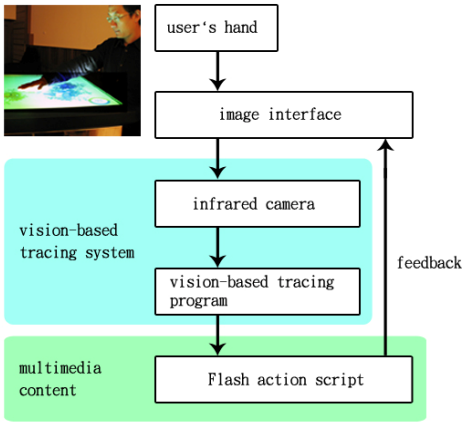

Fig. 7. The procedure of the vision-based tracing system

the reflection of the infrared. After receiving the position information, Flash program will change the media content according to the data. And then participants can see and appreciate the result of the interaction (Fig. 7).

3.2 Transmission and Positioning of WSN

ZigBee technology used in WSN-Bar was developed by Networks and Multimedia Institute of III (Institute for Information Industry) [11]. It follows the standards of the ZigBee Alliance and IEEE 802.15.4. It has the abilities of power saving, high stability and two-way transmission. It has been widely applied in health-care, access, and environmental sensing system. WSN-Bar primarily uses the environmental sensing, data transmitting, and locating functions of ZigBee technology.

The data from the brightness, temperature, CO_2 density sensors and ZigBee tags are sent to ZigBee routers, which transmit the data from one to another, and finally send the information to the ZigBee coordinator. After receiving the data from routers, the coordinator transmits these data to the ZigBee server. Finally, Flash program controls the changes of multi-touch interface according to the data passed by XML socket from ZigBee server (Fig. 8).

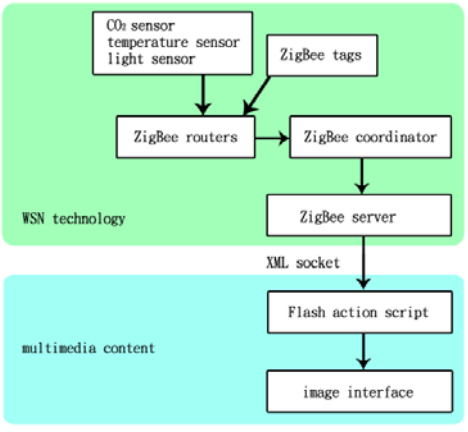

Fig. 8. The transmission procedure of WSN-Bar

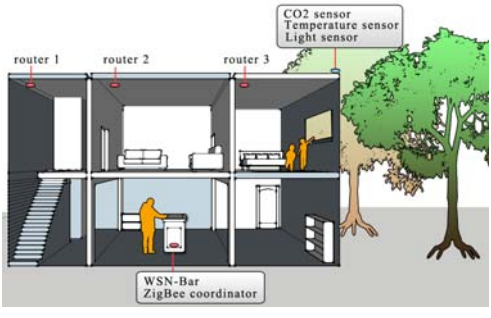

Fig. 9. The positions of WSN-Bar, WSN routers, and sensors

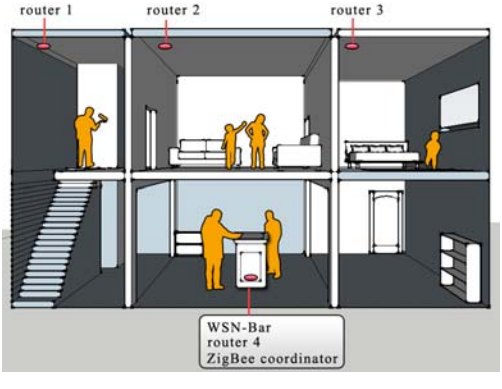

Fig. 10. The positions of WSN-Bar, WSN routers, and sensors

"Garden of Light" is primarily developed using the environment sensing technology and short-distance transmitting function of WSN technology. No matter where the bar is (Fig. 9), ZigBee routers can pass the information from outdoors to WSN-Bar. The application of WSN technology makes the concept of AmI easier to implement.

"Vivacious Bushes" can know people's positions by comparing different signal degrees from ZigBee tags. We installed ZigBee routers about every 5~7 meters (Fig. 10) to detect ZigBee tags' signals. Through comparing and calculating these signal degrees by RSSI-based and Area-based algorithm, WSN-Bar gets the positions of people. Therefore, participants can know other people's positions by tracing the butterflies' locations in WSN-Bar.

4 Conclusion

By integrating environmental sensing technology, multi-touch technology, and art design, WSN-Bar has finished up some goals: (1) Through ZigBee sensors, the bar can detect the brightness, temperature, and CO_2 density outdoors. (2) It can locate people's movement inside the building. (3) Participants can interact with the bar under entertainment atmosphere. (4) It is an art installation embedded with the environmental information visualization.

The emergence of AmI proves that people are full of dreams and exceptions for living in the future. Undoubtedly, our WSN-Bar achieves the idea which is to make our environment with ambient intelligence. As WSN technology can be blended into the home environment naturally, people can enjoy the convenience offered from the high-tech technology. In addition, our research and design is concerned that humans have become estranged to each other in digital age. WSN-Bar creates an opportunity to reduce the gaps among the participants.

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