

Feasibility Analysis of Improving the Accessibility and Security of Nano-Labs via Kinect

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Abstract. This paper aims to probe into the feasibility of using Kinect to improve the accessibility and security of Nano labs, and characteristic analysis of the integrated system, i.e. Kinect, laptop, and IP Power, has been therefore carried out to interpret the feasibility in question. The finding is that the integrated system can improve the interaction between participants and labs, and the aforementioned interaction includes accessibility and security of both teachers and learners while using Nano labs. It is expected that following its future development, the use of Kinect on automatic switches of electronic equipment and devices, and the condition for commercializing the use on security maintenance and safety warnings of labs will mature in the future.

Keywords: Nano Lab(s), Kinect, Security, Accessibility

1. Introduction

According to Hazas, Scott and Krumm [1], the frequently used context-aware techniques include ultrasonic, radio frequency identification (RFID), global positioning system (GPS), infrared-based active badge system, wireless LAN (WLAN), global system for mobile communication (GSM), and Bluetooth, etc., Kinect is one of the newly risen wireless-sensing techniques. Released in 2010 to the public, this wireless sensor known as Kinect has the advantage of device-free and direct wireless motion sensing. Kinect was originally a sensing device developed by Microsoft for Xbox 360. The techniques involved are developed by PrimeSense, who has released publicly in 2010 the source code drivers of Kinect for Windows and Linux. Through NITE, one of the middleware, Kinect's 3D sensors can capture human motions and transmit immediately the signal to Windows or Linux. All the open source codes can be downloaded from OpenNI.org, and they will benefit the R&D on Kinect's applicability in a variety of fields [2]. The Biorobotics Lab at the University of Washington, for instance, has integrated Kinect with PHANTOM, a touch product, to probe into the possibility of fine-tuning surgical robots in terms of their touches [3]. Kinect's advantage over intuitive awareness of human bodies increases its applicability upon the interaction between contexts within classrooms.

The integrated system of Kinect, laptop, and IP Power can be employed to improve the interaction between teachers, students, classroom managers, and classrooms. This paper uses Nano labs as an example to illustrate how this integrated system can create accessible as well as secured interaction between human beings and their labs.

2. Structure of Design: The Kinect-laptop-IP Power System

As soon as someone steps in the sensor area covered by the Kinect-laptop system, Kinect catches the signal and transmits it via USB to the laptop, which then converts it into a command to activate the notifying or warning video. The laptop used in this research is installed the open source codes, such as OpenNI 1.0.0 for windows, PrimeSense 5.0.0 for windows, and PrimeSense NITE 1.3.0 for windows, released by

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PrimeSense and downloaded from OpenNI.org. A program written for the research as a dialogue interface interacting with Kinect on Windows XP is also installed and used to adjust the length of the sensor area, set the power switch of instruments plugged to the IP Power outlet, and activate the videos for warning or notifying according to the manager's needs.

Since the AVIOSYS's IP Power 9258 contains 4 electric ports providing 4 equipment with power supplies respectively and independently [4], and can be controlled via the Internet over the power switch, Kinect can transmit the signal it catches to the laptop to be converted and sent out to switch on or off the air-conditioner, PC, lights, or experiment instruments in a lab as soon as someone enters the lab. The structure of design is illustrated by Fig.1 below. The system is equipped with the accessibility to the lab, and applicability of energy saving via human motion sensing.



Fig.1 Structure of design: Using Kinect-IP Power System for Lab accessibility and energy saving improvement

In addition to the aforementioned design, the integrated system of Kinect and laptop can also be used to ensure lab security. For instance, since the instruments at Nano labs are normally expensive and require professional guidance, approaching those instruments without awareness during experiments is not desired. In light of that, Kinect sensors can be installed in advance at each entrance so that both students and lab managers can be notified promptly through sounds or voices upon unaware entry. Services, such as short text messages and webcam-videotaping, provided by telecommunication companies can also be incorporated into such application for remote notifying or monitoring. The planning of using Kinect-laptop system to improve lab security and remote notification is illustrated by Figure.2 below. The idea can also be applied to preventing students from approaching areas containing dangerous experiment medicines, or areas on-campus denying the entry of students. This integrated system of Kinect and laptop is able to improve lab security and campus safety.

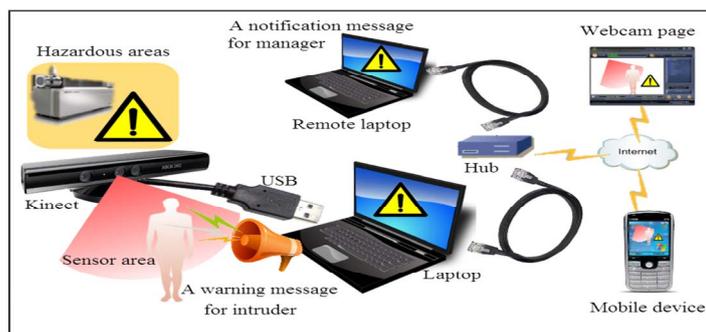


Fig.2 Structure of design: Using Kinect-Laptop System for Lab security and remote notification improvement

3. Characteristic Differences of Lab Application between Kinect and RFID

Radio-frequency identification (RFID) is a type of transmission technique using radio waves. An RFID e-Tag reader, for instance, can track and read RFID e-tags attached to something [5]. Although RFID technique has been used rather frequently in recent years on context-aware facilities, the wireless-sensing technique involved with is inferior to that of Kinect for one of Kinect's major advantages is free from hand-held devices, i.e. a truly hand-free lab interaction under real-world contexts. The characteristic comparison of lab application between RFID and Kinect is illustrated by Table.1 below.

Table.1 below shows that when conducting a context-aware activity with Kinect, there is no need to make and attach e-Tags, no hand-held devices required either for data saving since the data of interaction can be directly saved in the Kinect-integrated system. More importantly, Kinect is able to tell human beings from objects, which means it does not send out safety warning signals or activate power switches of electronic instruments on every object detected on-site by Kinect. Instead of wasting electricity like common security systems on detecting non-human motions and then activating security systems accordingly, the Kinect-based security system is able to avoid a good percentage of unnecessary auto-activation. Based on the research of Wen-Fu Pan, Hui-Fen Lin, and Mei-Yu Wu [6], there is applicability regarding the incorporation of Kinect into classrooms, for instance, sensor-activation on Nano lab facilities and warning of intruders on Nano lab security. As far as the future development is concerned, with miniaturization of its volume, and the improvement on its Cloud accessibility and recognition, Kinect can be used to send out safety warning when someone enters a lab or a dangerous location, it can even be used to record via videos procedures of individual experiments. The viewpoint of the aforementioned research proves the applicability of the system in this paper.

Tab.1 characteristic comparison of Lab application between RFID and Kinect

Entry	RFID	Kinect
1. e-Tag required?	Yes	No
2. Telling human beings from common objects?	No	Yes
3. How are data stored?	Hand-held devices required	On-site stored by Kinect; no need for hand-held devices

In short, as far as the integrated system of Kinect, laptop, and IP Power is concerned, there are at least three special features, i.e. (1) Popularization of Interactive Environments, (2) Customized Interaction, and (3) Easy Access to Data, can be employed regarding the accessibility and security of labs. (1) Popularization of Interactive Environments: Since hand-held devices are no longer required to interact at labs, RFID devices are no longer needed either for wireless sensing. (2) Customized Interaction: The content of safety warning or the facilities requiring auto-control over power switches are to be arranged by lab managers, which means lab managers can customize contexts of accessibility and security clearance to meet different experiment requirements. (3) Easy Access to Data: Since the signals from Kinect are to be sent out to Windows, the commonly used and familiar with by lab managers, the data saved can then be designed to used for remote notification or online monitoring, which means lab managers can update promptly the data required by labs for interaction.

4. Further Thoughts on Improving the Accessibility and Security of Labs via Kinect

The wireless-sensing technique of Kinect is a breakthrough since the development of RFID. No more e-tags or hand-held devices are required for those, who participate in contexts provided by the Kinect system. Furthermore, the use of the integrated system of Kinect, laptop, and IP Power with the open source code released by PrimeSense installed onto the laptop can increase the opportunity for system users to interact with the classroom they are in, and improve the accessibility and security of labs and electronic instruments regarding both teachers and learners. Firstly, as far as accessibility is concerned, right after the learner enters the labs, the integrated and pre-programmed Kinect-laptop-IP Power system will automatically activate the air conditioner(s), computer(s), lights, or Nano experiment instruments. When ongoing experiments come to the end, Kinect will automatically switch off facilities designated in advance as soon as it senses that there is no student left in the lab. In other words, managers of Nano labs no longer need to switch off one by one, and the accessibility of labs as well as the effects of energy saving can be improved. Secondly, under the circumstances of instruments being operated during ongoing experiments or dangerous medicines being stored in some specific areas, the integrated Kinect-laptop system can be employed as a security robot by Nano lab managers to prevent ongoing experiments from interferences or students from danger. In other words, once students approach designated areas, the system will automatically and promptly send out

warning signals, “Keep Away!” for instance, directly notify responsible managers, or inform staff far away from the site through Webcam or mobile phones, i.e. short text messages. The security of Nano labs can be greatly improved.

Departing from the abovementioned creative use of Kinect, this paper would like to make three announcements regarding the improvement of labs’ security and accessibility: (1) Incorporation of Kinect into constructing an auto-energy-saving learning environment is applicable, (2) Kinect can be used to improve the current RFID-based safety maintenance of learning contexts, and (3) Kinect can be used to construct an easy-to-use and barrier-free environment for learning and increase free participation and interaction between learners and classrooms. Since PrimeSense’s Kinect is going to ignite innovative applications in various fields, this paper chose to analyze the features of Kinect as well as its integration with laptop and IP Power, and use Nano labs as the example to illustrate the possibility of the integrated system being used to improve the security and accessibility of the labs. The finding suggests that the integrated system can improve interaction between participants and classrooms, also the accessibility and security of the labs regarding teachers and learners. Following the development of Kinect’s various functions, the author is on the opinion that the use of Kinect on automatic switches of instruments and facilities, and the condition for commercializing the use on safety warnings of different contexts will be much matured in the future.

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