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Envisioning Smart Hotels Through Spontaneous Device Integration

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ABSTRACT

There are a number of noteworthy advancements in the sensor technology domain. Sensors have become the eye and ear of new-generation IT. Sensor integration and fusion developments clearly portend a great future for sensor technologies in the realm of human society. Sensors are becoming smart and capable of communicating with one another wirelessly. Ad hoc networks of sensors are being readily formed and disbanded once the goal behind the network formation is over. Sensor-centric services are being highly popular and pioneering to sharply enhance personal as well as professional lives of humans. This research work deals with creating and maintaining a smart hotel. The existing hotel services and applications are remarkably increased with the synchronization of wireless sensors. The smart hotel is an environment that would make the entire stay a truly memorable and mesmerizing experience. The already available functionalities of a luxurious hotel are being significantly enhanced by the assimilation, adoption and adaption of various technologies such as ZigBee, Bluetooth, etc. Device profile for web services (DPWS) is the shrunken standard for creating best-of-breed middleware implementation that enables diverse and distributed devices to find, connect and collaborate.

Key words: Smart hotels, wireless sensor, Zigbee, Bluetooth, device profile for web services

INTRODUCTION

Technologies are capable of our lives more comfort and convenient. They are bound to bring more care and choice for people. Healthcare (Chen *et al.*, 2010, 2011; Chung 2012; Kwon *et al.*, 2012; Shin *et al.*, 2012) is one prominent domain wherein the leverage of robust and resilient technologies is on the climb. Smart technologies (Rashidi *et al.*, 2011; Augusto *et al.*, 2010; Gabbanini *et al.*, 2012) sharply enhance the quality of service (QoS) aspects such as productivity, security, simplicity, accessibility, affordability, amenability, affability etc. Technology penetration and popularity are on the rise consistently. All kinds of personal as well as professional domains are yearning for assimilating the technological improvisations.

Any hotel gets its name and reputation only based on the services that it can provide to its customers. In this very competitive world, it is the task of a hotel authority to ensure that the customers are satisfied to the maximum extent. This can only be achieved by providing a service that is unique and in some way, a step ahead of all others. One technique to create newer and better services is to employ the latest developments in technology in any feasible way so that they can serve humans better. New innovations are making a hotel room more comfortable and pleasurable. Not only must a hotel or resort be able to provide all the services of its adversary, but

also provide them at more competitive prices. To be able to do this, we must be able to connect all the already existing technology with all the enhancements that we wish to add. If we are to provide any more services using a newer technology, the biggest task would then be to integrate it with the already existing technology without affecting its performance in any way. This in itself becomes a daunting task. To solve this, we have used the principle of heterogeneity (Boukerche *et al.*, 2012; Nikolic *et al.*, 2011; Mao *et al.*, 2011; Kumar *et al.*, 2011). There are various marvels of the last few decades that surround us and those that make an impact by being efficient, convenient and affordable are the cellular phones and Bluetooth. Cellular phones are a part and parcel of the life of every common man today. On an average in a country like India there are over 300 million users of a cell phone. Cellular phones have been in use since quite some time. Bluetooth is used for transmission of data in ranges of up to 30 m. It has also been worked on for quite some time and its major advantage are its compactness and price. Hence, for the creation of a local wireless network within a room, it's efficient and a viable choice. There are many devices that are Bluetooth enabled and are able to connect with other devices. Hence we have taken these 2 already existing technologies which can be a part of a well-established hotel.

ZigBee (Fang *et al.*, 2012; Nadimi *et al.*, 2012; Shon *et al.*, 2011; Zhang *et al.*, 2012) is a relatively newer technology which aims at having a larger range of up to 300 meters and also consumes less power. IEEE 802.15.4 defines the physical and MAC layers and ZigBee defines the network and application layers. ZigBee is considered to be secure, reliable and self-healing, flexible and efficient and easily deployed. With all these added advantages and most importantly the cost factor, this study aimed to integrate the ZigBee network with the Bluetooth and cellular phone services.

DEVICE INTEGRATION TECHNOLOGIES AND PLATFORMS

DPWS (Device Profile for Web Services) (Sleman and Moeller, 2008; Huang *et al.*, 2011; Zeeb *et al.*, 2010) has been used as the standardized, open and industry-strength middleware. The middleware software consists of a set of services that allows multiple processes running on one or more machines to interact. This technology evolved to provide for interoperability in support of the move to coherent distributed architectures, which are most often used to support and simplify complex distributed applications. DPWS can work with devices that may not have large computation power, may be in a sleep state for a long time to save power and will work with various types of hardware.

Microsoft Visual Studio 2010 was used for the working on the programs for the middleware. The IDE has emulators that are able to simulate the working of a device with a few buttons for input and a screen that may be enabled with DPWS. Visual Studio was also used for the creation of the application that runs on the reception computer that receives the notification from the customers regarding their booking.

There would be a single ZigBee and Bluetooth enabled device installed in the room that communicates with all the devices present there such as the television and the room's Air conditioner. It also controls all the lights of the room. These are just a few of the basic services that have been shown. The ZigBee protocol is used to communicate with the room service and the reception as these services cannot be connected by the short range Bluetooth while the services in the room may already be connected by Bluetooth. Bluetooth, being secure and relatively cost effective is employed to communicate within the room, where we do not need long range communication standards such as ZigBee.

DESCRIBING A REAL-WORLD SCENARIO

Any person who is visiting a place for a short duration and needs a hotel to stay would surely book a room and if possible, pay in advance to confirm the booking also. Hence, we describe the actions that occur and those that would be automated after this system has been installed after this first step which is booking or confirmation of a room. The confirmation would require the person to send a message to the hotel. This was performed using a cellular phone. After a confirmation, the hotel knows about the approximate time when this customer would be coming. Based on that, all the services that are to be made available in the room are to be activated.

The interface installed in the room would receive message from the reception and this would activate this interface and also some of the services in the room. This entire process has been automated by employing a wireless network for the entire hotel. The next step is the activation of all the services in the room. This would be notified in the interface for any person who works for the hotel who may be checking the room for confirming that its ready and up to the expected standards. After the room is ready and has been occupied, the major role of the reception and the communication between the reception and the room is complete. Beyond this the customer would be communicating with the room service department or controlling the devices in his room.

The room has been shown with three basic services-the room AC, the Television and the lights. The entire system has been made scalable and hence more services (Baglietto *et al.*, 2011; Li *et al.*, 2011) can be added without any changes to the system. The final phase has been portrayed as a communication between the customer and the room service, where the person orders for a food item and the menu is displayed and the person can confirm his order without any person on the other side. These services which employ humans and use a phone device have been automated thus reducing the need of human labor to a great extent.

IMPLEMENTATION PROCEDURE

The implementation starts with the creation of a desktop application as the interface in the reception. It would be the place where the confirmation of the hotel room is received and the required actions henceforth taken. This application can get notifications and is also capable of transmitting messages to various nodes in the network. It acts like a master for the entire network as the initiation of this process begins from this application. The application would run on a computer situated on the reception and has been connected to a ZigBee node for communication. First, we receive a confirmation by a message sent from a phone in the reception. This would be display a message stating the room number for which the booking was done. The next step is probing for the room's interface. The protocol used here is TCP/IP over Bluetooth. A simple message received by the room interface would activate it. This device would then use WS-Discovery of DPWS to probe for the devices and activate them. All the services that receive this message would respond and also get activated. They would respond with a notification which would be displayed on the screen in the room interface. One by one, each device gets activated and the message received from them has been shown. After a certain period this interface would have received a confirmation message from all the available active services. This means that now the room is ready and all the services such as the TV, AC and lights can be used and controlled at will. All this occurs by the Bluetooth.

The next step is the room service. After the room has been occupied, we show a set of available options for the user. By the press of a one button he can contact the room service, by another, control the room's services while another can be used for communicating with the reception. A

typical interaction with the room service has been shown here. After the person presses the button for that, the interface would probe the interface present in the room service section. It would display the data present there in here and also over there. Thus a person who is present there to take an order can look that screen up and know of the customer's requests.

The person if he wishes to order anything to eat would contact the room service and look up the menu that is shown in his screen. Then by looking at the available items, he can place an order for them by pressing another button. The order is confirmed and the room screen reverts back to the initial state. The screen present in the room service section would display that an order was confirmed and that it must be fulfilled. An employee present there can take the order and get the food prepared and delivered to the room. This communication from the room to the service section would occur by ZigBee.

EXPERIMENTAL RESULTS

First, the computer that was installed for the reception received a message from a cellular phone. This message with the phone number was displayed in the application running in the same computer. This has been shown in the Fig. 1 and 2. The customer had booked the room number 108. A message to the device installed there was sent through the ZigBee protocol. The device installed in every room was named with the room number followed by the letters ZB, to indicate that this device is using the ZigBee network. In Fig. 2, the room number was sent a message to its device named "108-ZB".

The room after receiving a message by the computer at the reception, starts probing all the available devices in the room. This was performed by the probe match facility in DPWS. This has also been shown in the Fig. 2, where the room receives a message and one by one, it starts probing all the devices and they get activated and return a message indicating their acknowledgment. The
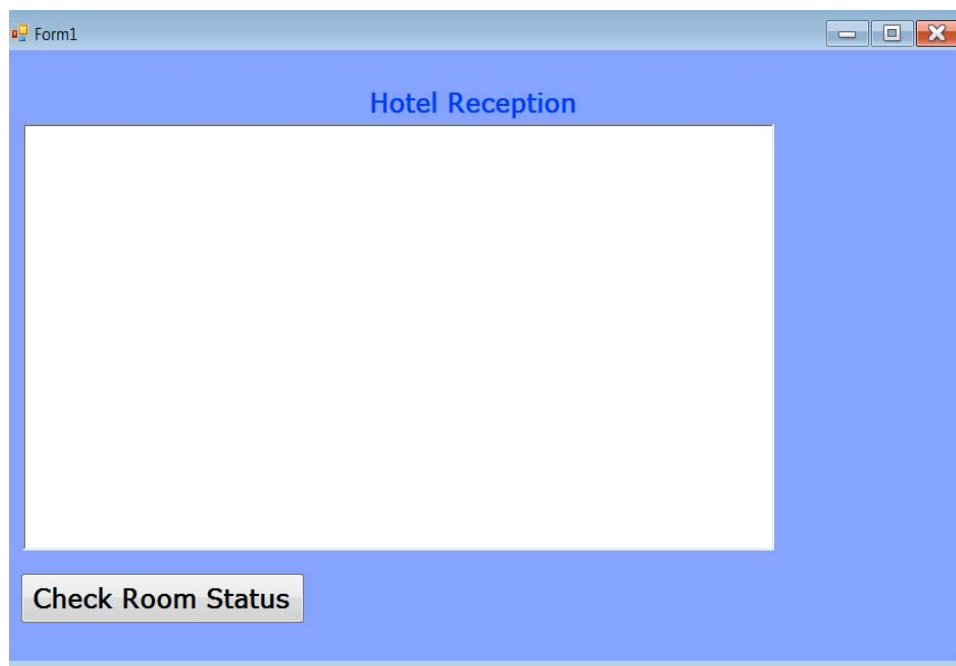
Fig. 1: Desktop application initial screen

device installed in the room would have nothing be blank initially and after every successful probe match, a message would be displayed on the device. In Fig. 2, the screen after all the probe matches have occurred has been shown. After any person enters and presses a key in the device, the screen would look as it has been shown in Fig. 3. The next stage has been shown in Fig. 4 and 5. The occupant in the room can view the various services being provided through that device. One such service is the room service menu. When the button for it is pressed, the menu from the device in the kitchen is retrieved and displayed. The interaction has been shown in the figures and after an order has been confirmed the display screen would be as it is in Fig. 3.
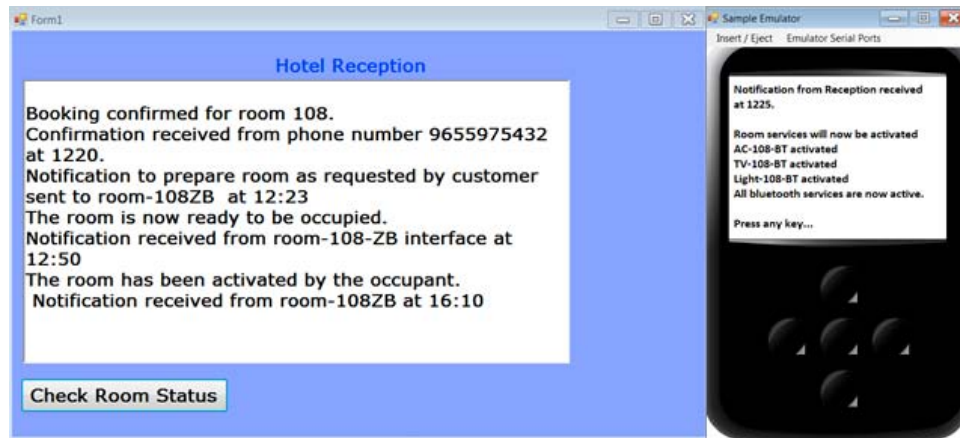

Fig. 2: Desktop application and device in hotel room
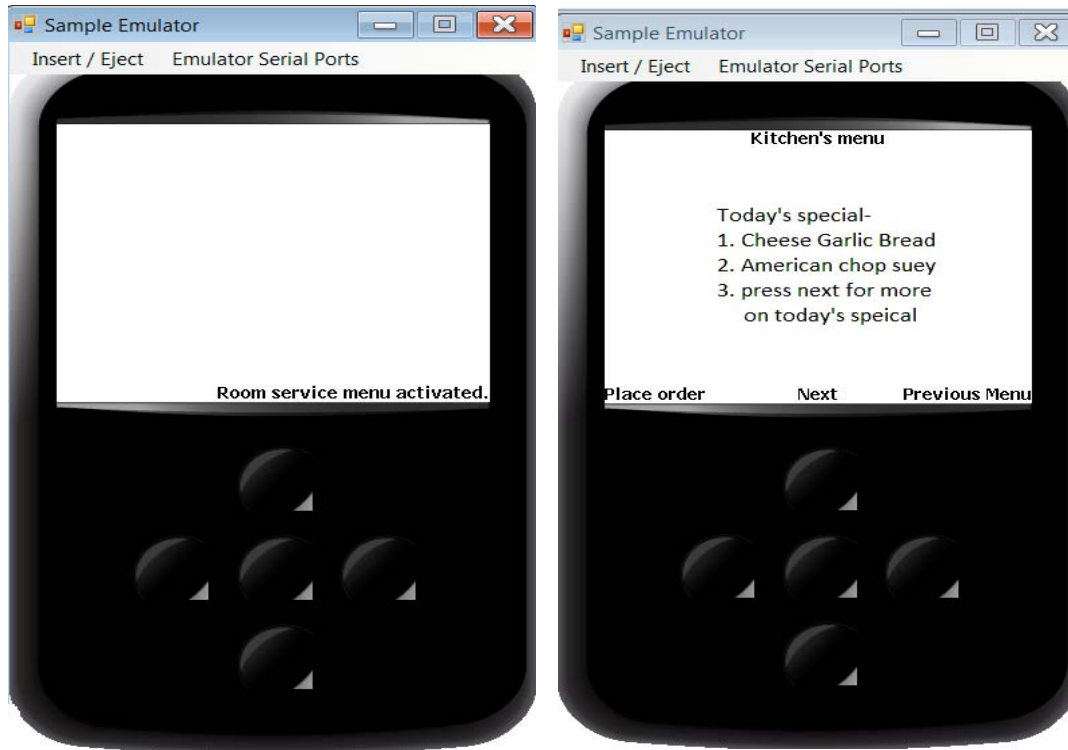

Fig. 3: Room device screen

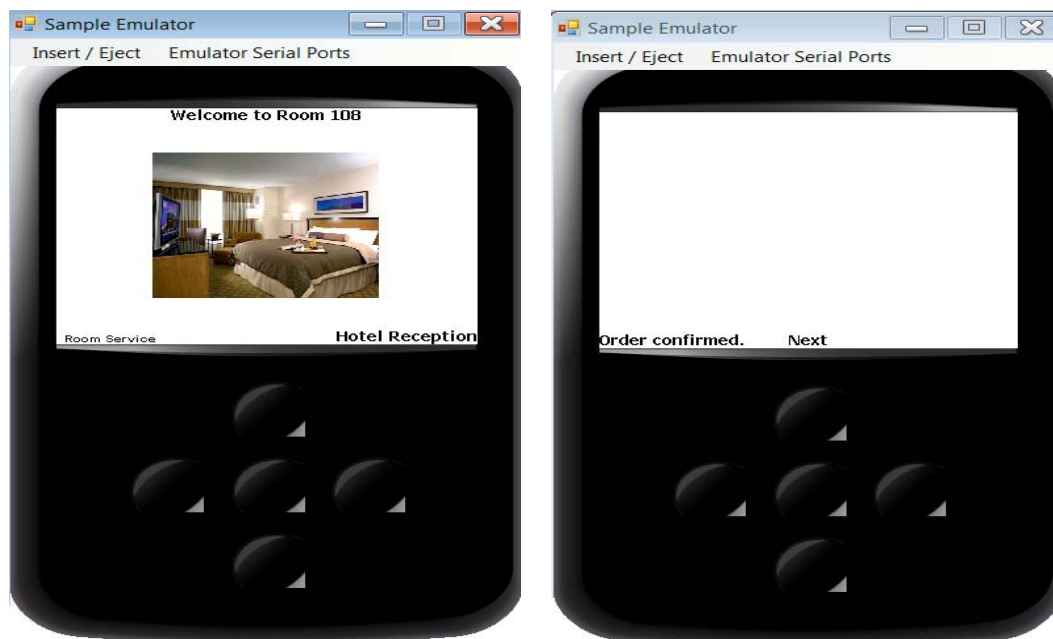Fig. 4: Room service activation and ordering an item

Fig. 5: Confirmation of booking and return to previous screen

FUTURE PERSPECTIVES

The entire system that was presented here was made scalable. The number of services that can be added depends solely on the person implementing this idea. The middleware proves its worth and helps in the seamless transfer of data across various protocols. In the future work, we can further enhance this work with adding databases that are capable of retrieving previous requests of the same customer and thus reduce his efforts with the interface in the room further.

CONCLUSION

Tourism plays its good role in developing any country today by providing another source of revenue. In developing countries especially, it can play a major role. Hotels are part of this industry and they can be developed to a great extent by enhancing the facilities provided to the valuable customers. For this, a scenario is described where we integrate the existing features with wireless technology and automate the services. From the time of the confirmation of the room till the entire duration in which the room is occupied by the customer, a lot of changes have been made to make the entire system smarter and efficient. Technologies such as the cellular phone were combined with protocols such as Bluetooth and ZigBee. This integration was made possible by the use of DPWS, a middleware that caters to these requirements. The results prove that when an implementation such as this are made, the entire industry would be able to use the latest innovations in the wireless world to their benefit.

REFERENCES

Augusto, J.C., H. Nakashima and H. Ghajan, 2010. Ambient Intelligence and Smart Environments: A State of the Art. In: Handbook of Ambient Intelligence and Smart Environments, Nakashima, H., H. Aghajan and J.C. Augusto (Eds.). Springer, New York, USA., pp: 3-31.

Baglietto, P., M. Maresca, M. Stecca and C. Moiso, 2011. Smart object cooperation through service composition. Proceedings of the15th International Conference on Intelligence in Next Generation Networks, October 4-7, 2011, Berlin, Germany, pp: 133-138.

Boukerche, A., D. Efstathiou and S. Nikoletseas, 2012. Direction-based adaptive data propagation for heterogeneous sensor mobility. J. Parallel Distrib. Comput., 72: 778-790.

Chen, M., S. Gonzalez, V. Leung, Q. Zhang and M. Li, 2010. A 2G-RFID-based e-healthcare system. IEEE Wireless Commun., 17: 37-43.

Chen, K.R., Y.L. Lin and M.S. Huang, 2011. A mobile biomedical device by novel antenna technology for cloud computing resource toward pervasive healthcare. Proceedings of the IEEE 11th International Conference on Bioinformatics and Bioengineering, October 24-26, 2011, Taichung, Taiwan, pp: 133-136.

Chung, W.Y., 2012. Multi-modal sensing M2M healthcare service in WSN. KSII Trans. Internet Inf. Syst., 6: 1090-1105.

Fang, S.H., C.H. Wang, T.Y. Huang, C.H. Yang and Y.S. Chen, 2012. An enhanced ZigBee indoor positioning system with an ensemble approach. IEEE Commun. Lett., 16: 564-567.

Gabbanini, F., L. Burzagli and P.L. Emiliani, 2012. An innovative framework to support multimodal interaction with smart environments. Expert Syst. Appl., 39: 2239-2246.

Huang, C.M., H.H. Ku and Y.W. Chen, 2011. Design and implementation of a web 2.0 service platform for dpws-based home-appliances in the cloud environment. Proceedings of the IEEE Workshops of International Conference on Advanced Information Networking and Applications, March 22-25, 2011, Biopolis, Singapore, pp: 159-163.

Kumar, D., T.C. Aseri and R.B. Patel, 2011. A novel multihop energy efficient heterogeneous clustered scheme for wireless sensor networks. Tamkang J. Sci. Eng., 14: 359-368.

Kwon, O., J.M. Shim and G. Lim, 2012. Single activity sensor-based ensemble analysis for health monitoring of solitary elderly people. Expert Syst. Appli., 39: 5774-5783.

Li, X., X. Liang, R. Lu, S. He, J. Chen and X. Shen, 2011. Toward reliable actor services in wireless sensor and actor networks. Proceedings of the IEEE 8th International Conference on Mobile Adhoc and Sensor Systems, October 17-22, 2011, Valencia, Spain, pp: 351-360.

Mao, Y., X. Li and S.X. Yang, 2011. An effective data gathering scheme in heterogeneous energy wireless sensor networks. Intell. Automat. Soft Comput., 17: 1023-1034.

Nadimi, S., R.N. Jorgensen, V. Blanes-Vidal and S. Christensen, 2012. Monitoring and classifying animal behavior using ZigBee-based mobile ad hoc wireless sensor networks and artificial neural networks. Comput. Electron. Agric., 82: 44-54.

Nikolic, S., V. Penca, M. Segedinac and Z. Konjovic, 2011. Semantic web based architecture for managing hardware heterogeneity in wireless sensor network. Int. J. Comput. Sci. Appli., 8: 38-58.

Rashidi, P., D.J. Cook, L.B. Holder and M. Schmitter-Edgecombe, 2011. Discovering activities to recognize and track in a smart environment. IEEE Trans. Knowl. Data Eng., 23: 527-539.

Shin, H., S. Lee, H. Kim, J. Kang and K. Lee, 2012. Extracting signals from noisy single-channel EEG stream for ubiquitous healthcare applications. J. Internet Technol., 13: 85-94.

Shon, T., B. Koo, K. Han, J.J.J. Park and Y. Park, 2011. WiFi auto configuration architecture using Zigbee RF4CE for pervasive environments. J. Internet Technol., 12: 337-346.

Sleman, A. and R. Moeller, 2008. Integration of wireless sensor network services into other home and industrial networks using device profile for web services (DPWS). Proceedings of the 3rd International Conference on Information and Communication Technologies: From Theory to Applications, April 7-11, 2008, Damascus, Syria, pp: 1-5.

Zeeb, E., G. Moritz, D. Timmermann and F. Golatowski, 2010. Ws4d: Toolkits for networked embedded systems based on the devices profile for web services. Proceedings of the 39th International Conference on Parallel Processing Workshops, September 13-16, 2010, San Diego, CA., USA., pp: 1-8.

Zhang, J., A. Huynh, Q.Z. Ye and S. Gong, 2012. A communication reliability enhancement framework for wireless sensor network using the ZigBee protocol. Sensors Transducers J., 135: 42-56.