

Highly Efficient Environment Aware Wireless Sensor Network

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ABSTRACT: In this demonstration, we introduce a demonstration system of highly efficient environment aware wireless sensor network by considering characteristics of sensing information and spectrum efficiency. In this network, a suitable sensor system is selected from multiple wireless sensor systems by considering the demand of each sensor and surrounding wireless environment. In our demonstration system, we prepare 2.4GHz ZigBee, 920MHz small power wireless system and 460MHz wireless sensor network converting the sensing information to frequency called physical wireless parameter conversion sensor network (PHY-C SN). In order to understand the surrounding wireless environment, we also prepare a radio environment database based on the measurement data of each sensor. In CCNC 2016, we plan to introduce a video of the field test with more than 20 sensor nodes and to exhibit a small demonstration system based on multiple wireless sensor devices and USRPs.

KEYWORDS: Wireless sensor networks, Wireless communication, Sensors, Zigbee, Portable computers, Databases, OFDM

I. INTRODUCTION

Smart city and smart infrastructure have attracted attention for realizing sustainable society using information and communication technologies (ICT). Gathering sensor information from thousands of sensors distributed over the world is a key technology to realize above future world. Currently, packet base wireless sensor networks like IEEE802.15.4/ZigBee are standardized for gathering sensing information through wireless network. The packet based wireless sensor network is suitable for gathering the sensing information with high reliability from small number of sensor nodes. However, if the data payload size is small, the percentage of the header of the packet is relatively large and large amount of spectrum resource is consumed. In order to support future smart world, many kinds of sensors are distributed everywhere with many kinds of applications. Usually, wireless sensor applications require high reliability and the current standardized wireless sensor networks can be utilized. However, some sensor applications do not require high reliable data transmission from each sensor node, like temperature, humidity, and rainfall distribution in the area. In these sensor networks, the statistical characteristic is important but each sensing result from the sensor is not required. In order to support this kind of sensor, we have proposed a highly efficient simultaneous information gathering method from many sensor nodes by converting the sensing information to physical wireless parameters to obtain the statistical information of sensors called physical wireless parameter conversion sensor network (PHY-C SN) [1].

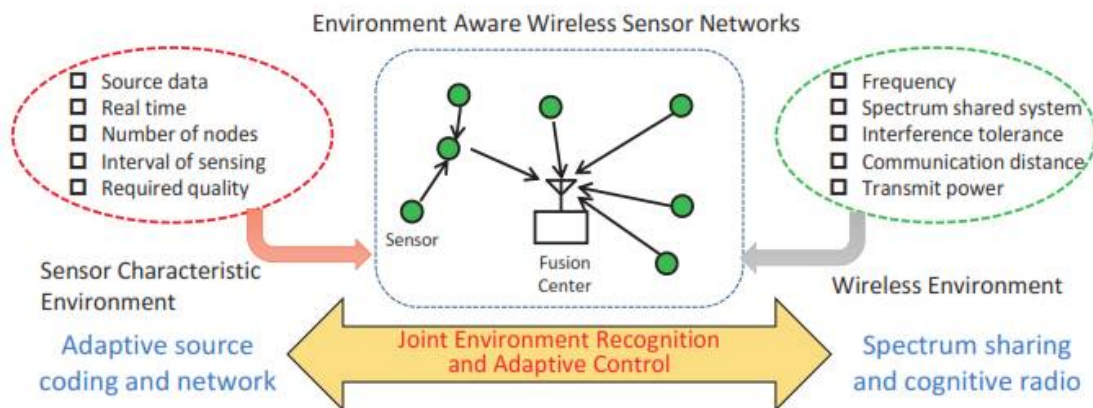


Fig 1:Environment Aware Wireless Sensor Network

From above points of view, we can understand an adaptive Fusion Center Sensor Environment Aware Wireless Sensor Networks Sensor Characteristic Environment p Source data p Real time p Number of nodes p Interval of sensing p Required quality Wireless Environment p Frequency p Spectrum shared system p Interference tolerance p Communication distance p Transmit power Adaptive source coding and network Spectrum sharing and cognitive radio Joint Environment Recognition and Adaptive Control. wireless sensor network design considering required demand of each sensor and surrounding wireless environment is important for future wireless sensor networks. Therefore, we propose a concept of highly efficient environment aware wireless sensor network. In this network, two kinds of environment which are sensor characteristic environment and surrounding wireless environment are considered and wireless sensor networks are adaptively designed for improving efficiency.

Figure 1 shows a concept of our proposed environment aware wireless sensor network. In this demonstration, in order to evaluate our concept, we implement an experimental system of an environment aware wireless sensor network. In this experimental system, we prepare 2.4GHz ZigBee, 920MHz small power wireless system and 460MHz PHY-C SN implemented in the software defined radio platform named USRP. In order to understand the surrounding spectrum environment, we also set a radio environment database which consists of the measurement data of each sensor. We perform field tests by using the above mentioned experimental system to evaluate the effectiveness of the proposed concept. In CCNC 2016, we plan to introduce a video of the field test with more than 20 sensor nodes and exhibit a small demo system based on the multiple wireless sensor devices and USRPs.

II. EXPERIMENTAL SYSTEM

In this paper, we consider a highly efficient environment aware wireless sensor network. In this sensor network, wireless system design considered characteristics of sensing information and surrounding radio environments improves on the performance of gathering sensing information and the efficiency of the frequency resource. The experimental system model is summarized in Fig. 2. In the experimental system, we consider multiple sensor nodes and a fusion center (FC). Each sensing node has multiple sensors and multiple wireless devices. Sensing information of each sensor node is gathered at the FC. The FC is connected with a spectrum management server which consists of a spectrum manager and a spectrum database. The spectrum database gathers and stores surrounding radio environment information measured at multiple sensor nodes through spectrum manager and FC. The spectrum database is

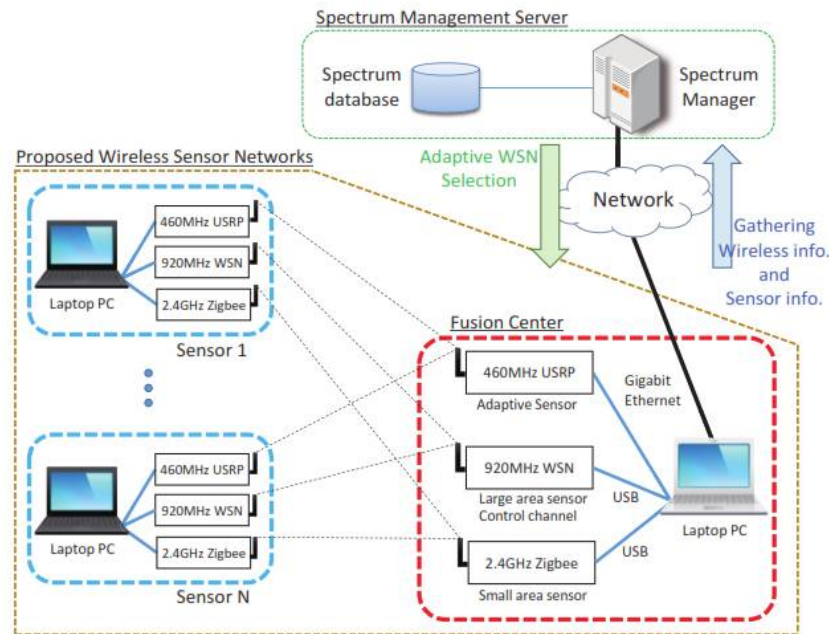


Fig 2: Experimental System

connected with the spectrum manager. The spectrum manager can utilize the sensing information of each sensor node and the spectrum information stored on the spectrum database. By using these information, an appropriate wireless system considering each sensor characteristics is selected.

In our experimental system, we prepare three wireless systems: 2.4GHz ZigBee, 920MHz small power wireless system and 460MHz USRP based PHY-C SN. The 920MHz wireless system is an unlicensed wireless packet communication system standardized in Japan. The maximum transmission power is 20mW and the modulation type is GFSK. Compared with 2.4GHz ZigBee, long range communication can be established due to its frequency. 460MHz USRP based PHY-C SN is a system proposed by authors explained in reference [1]. In this system, the sensing information is converted to a subcarrier index of OFDM and the tone signal whose frequency is decided by the subcarrier index is transmitted from each sensor node. Multiple sensors simultaneously transmit tone signal depending on the sensing information at each sensor. The FC can receive these signals and then the detected subcarrier through a fast Fourier transform (FFT) is regarded as sensing information from sensors. This method can be used for gathering distribution of sensing information from multiple sensors with high spectrum efficiency. While we receive a radio license in 460MHz band for field test in Japan, the frequency band is not limited in 460MHz because software defined radio platform USRP is used for implementation.

III. DEMONSTRATION

We prepare 20 sensor nodes and one FC in a field test. However, it is difficult to bring the total system at the Sensor Nodes Fusion Center 920MHz Wireless Sensor 2.4GHz ZigBee Accelerator Sensor 460MHz USRP Fig. 3. Demonstration equipments. conference site of CCNC2016. Therefore, we prepare a video for introducing our field test at the conference site. In our demonstration, simplified environment aware wireless sensor network with two sensor nodes and one FC is prepared as shown in Fig. 3. Each sensor node consists of a laptop PC with 2.4GHz ZigBee, 920MHz wireless module and USRP. In this picture,

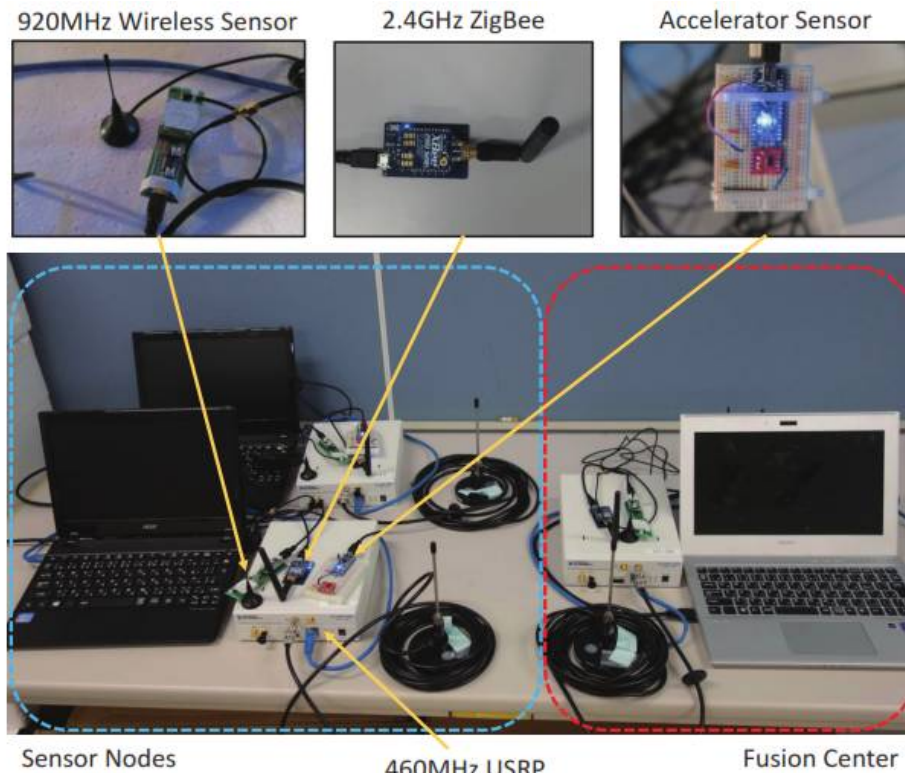


Fig 3: Demonstration System

the accelerator is connected through Arduino to laptop PC as a sensor device. The FC consists of a laptop PC with the same wireless devices. The laptop PC of FC has functions of the spectrum manager and the spectrum database in the demonstration as explained in Sect. II.

IV. CONCLUSIONS

In this demonstration, we introduce a demonstration system of highly efficient environment aware wireless sensor network by considering characteristics of sensing information and spectrum efficiency. In our demonstration system, we prepare 2.4GHz ZigBee, 920MHz small power wireless system, and 460MHz wireless sensor network called physical wireless parameter conversion sensor network (PHY-C SN). We show the proposed concept achieves efficient environment aware wireless sensor network through a video of the field test and a small demonstration system.

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