

UWB Supporting Medical ICT Applications

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Abstract—In this paper, the utilization of ultra wideband (UWB) technology is reviewed for medical wireless ICT applications. As a low power technique, UWB is capable to operate in underlay fashion with other existing radio and medical systems. At hospital site, this is one of the major requirements set to the electrical devices. UWB makes it possible to utilize both high and low data rate applications and accurate positioning.

Index Terms—Medical facilities, positioning, wireless communication.

I. INTRODUCTION

AT hospitals, the major concerns in wireless access mechanisms are related to co-existence issues with other radio and medical systems, and also to guaranteed data security. By adopting wireless technologies in different processes at hospital management, the work load from supporting tasks could be redirected to nursing. In addition, technologies that are supporting ubiquitous data access are giving added value for doctor's work. The latest, and in the best case, real-time patient data is always available when needed. Last but not least, wireless technology provides a way to cable replacement between medical sensors and monitoring devices. All these features give great improvement to nursing itself but also benefit hospital's finance.

This talk discusses the possibilities to utilize ultra wideband (UWB) technology in medical applications. Due to the very low power spectral density that UWB signal has, its utilization at hospital environment should not be a threat to patients' safety. Low emitted UWB signal power level does not cause harmful impact to human body nor interfere sensitive medical devices.

II. WIRELESS TECHNOLOGIES IN MEDICAL APPLICATIONS

Improvements in quality of patients' care and efficient hospital administration capabilities reduce overall healthcare costs, e.g., due to remote monitoring of several patients simultaneously. Different wireless technologies give possibilities to telemetry and telemedicine as well.

The nursing processes could, in general, be split into in-hospital and out-patient cares. The latter one is applied, e.g., to home care and rehabilitation patients. In addition, several diseases, such as diabetes, require daily monitoring of the patient's health. Wearable sensors that are creating wireless body area network (WBAN) could be employed in either hospitals or homes, and they can provide real time data. How the measured data is transferred and utilized further in most optimal way gives the base for research work.

III. UWB AND MEDICAL ICT

In positioning and tracking or data transmission applications, different technologies, such as IEEE802.11 –family or UWB, could fulfill the operational requirements. How the technology platform is selected, depends then on the application and its service requirements.

For example, imaging systems could provide huge amount of data. The generated file sizes could easily be tens or hundreds of megabytes. On the other hand, detectors sensing individual vital parameters could provide only tens of bytes to kilobytes of data. In addition, the positioning accuracy requirement could vary from rather coarse magnitude (e.g., floor or room level) to below one meter precision. Not only ward but also ambulatory monitoring defines requirements for the selection of wireless technology. These examples indicate the big variation of technological requirements in hospital applications.

Non-invasive imaging with UWB makes it possible to get very accurate in-body information from patient. UWB radar is much safer than X-ray due to the great difference in the emission power levels.

At homes, services ensuring elderly or after surgery patients to remain independently living in their own homes as long as possible is one target for medical authorities. UWB is one transmission technology to be adopted in wearable sensors to support real-time or frequent vital parameter measurement. On the other hand, home applications require multimode access points to support access to home applications and hospital services.

UWB is a spread spectrum wireless communication technology. This gives a possibility to share the same transmission media with several simultaneously transmissions, i.e., it is a multi-user system.

Fig. 1 depicts an architectural overview of possible wireless medical ICT network that combines hospitals, homes and ambulatory networks and patient monitoring systems. Each of the applications and links gives its own requirements for the wireless connection. Versatile possibilities where wireless technologies and UWB could be exploited are shown in Fig. 2.

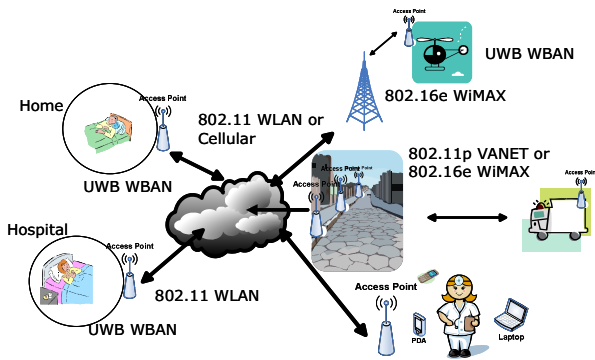


Figure 1. Utilization of wireless technologies at medical ICT applications.

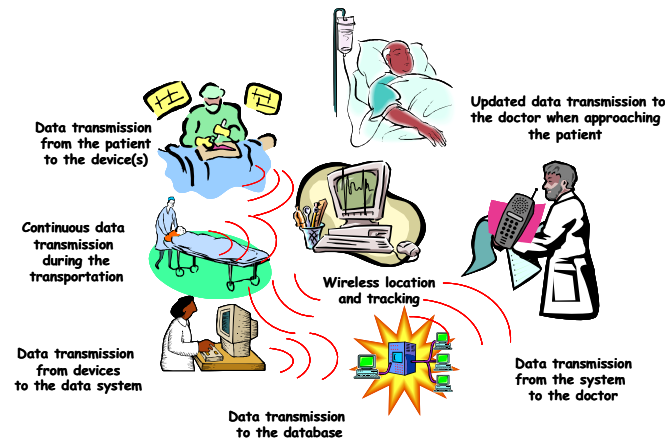


Figure 2. UWB in hospital's wireless playground.

IV. TECHNOLOGY COMPARISON

The hospital level services where UWB could be superior if compared to the other wireless radio technologies are operations where high data rates are required or very accurate positioning information is required.

Because positioning accuracy is inversely proportional to the signal bandwidth, the superiority of UWB over WLAN can be easily seen. WLAN could offer longer ranges but the accuracy is much coarser. With UWB, we could talk about tens of centimeters accuracy, or even better. UWB gives competitive solution for WBAN implementation. In addition, the link between WBAN and access point to backbone or long haul network is most suitable for UWB.

Non-coherent detection used in low data rate wireless body area networks provides also simple and cheap way to implement technology. Table 1 addresses some quantities and properties and views the preference between UWB and WLAN technology with respect to these features.

TABLE 1.
TECHNOLOGICAL COMPARISON: UWB VS. WLAN.

Attribute	Preference
high data rate	UWB
medium and low data rate	WLAN
interference tolerance	UWB
power consumption	UWB
cost	WLAN, UWB
accurate positioning	UWB

V. CONCLUSION

At medical applications, safety and reliability are the most important issues to be taken into account. There is no room for malfunctions in the applications that are closely related to personal health. Seamlessly operating home networks and applications at nursing institutions give base to the real-time monitoring of patient's health condition or recovery.

UWB is one good candidate for the wireless access technology due to its very low power consumption and scalable data rate range. A precise accuracy gives also new prospects to in-body imaging.