論文 / 著書情報
Article / Book Information

題目(和文)	
Title(English)	Research on Reliable and Energy-Efficient Communications in Wireless Body Area Network Using Human Motion Classification-based Transmission Power Control
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出典(和文)	学位:博士(工学), 学位授与機関:東京工業大学, 報告番号:甲第10673号, 授与年月日:2017年9月20日, 学位の種別:課程博士, 審査員:青柳 貴洋,中山 実,室田 真男,赤間 啓之,西方 敦博,髙田 潤一
Citation(English)	Degree:Doctor (Engineering), Conferring organization: Tokyo Institute of Technology, Report number:甲第10673号, Conferred date:2017/9/20, Degree Type:Course doctor, Examiner:,,,,,
学位種別(和文)	博士論文
Category(English)	Doctoral Thesis
種別(和文)	論文要旨
Type(English)	Summary

（博士課程）
Doctoral Program

論 文 要 旨

THESIS SUMMARY

専攻： Department of	Human System Science 専攻	申請学位（専攻分野）： Academic Degree Requested	博士 (Engineering) Doctor of
学生氏名： Student's Name	Sukhumarn Archasantisuk	指導教員（主）： Academic Advisor(main)	Assoc. Prof. Takahiro Aoyagi
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要旨（英文 800 語程度）
Thesis Summary (approx.800 English Words)

Wireless body area network (WBAN) has emerged to offer a continuous and ubiquitous healthcare monitoring platform. WBAN requires highly reliable communication since it has to support medical applications. However, WBAN devices are small in size for the comfort of users. Therefore, energy capacity is limited for these devices. In addition, WBAN has dynamic channel characteristics caused by human movement. To provide highly reliable and energy-efficient communication in spite of highly dynamic channel characteristics, this research proposes motion-aware temporal correlation model-based transmission power control. Transmission power control is a method to dynamically adjust a level of transmit power of radio transmission. The transmission power control is suitable for WBAN since WBAN has a large signal fluctuation range. In the proposed power control method, the human motion context is considered since the human motion is one of the dominant factors affecting the channel characteristics. Therefore, the human motion classification and transmission power control were developed in this research.

The human motion classification system proposed in this study used only the received radio signal strength, thus not requiring any additional tools such as an accelerometer. Firstly, radio frequency (RF) signals were computed in the time domain to provide features for the classification. After that, feature selection was performed using Garson's method. In Garson's method, the relative importance (RI) score of each feature was computed. Features with low RI score were removed from the feature vector without affecting the classification performance.

The human motion classification consisted of two stages: data pre-processing stage and classification stage. The data pre-processing was a procedure to prepare inputs for the classifier. The data pre-processing included vector extraction, feature computation, and feature scaling. Next, the classification stage determined a class of human motion. In this study, four well-known algorithms, including back propagation, support vector machine, k-nearest neighbor, and decision tree, were used. The human motion classification constructed from WBAN simulation data achieved 63.8-95.7 percent of accuracy rate when it was used to classify 3-5 human motion classes including running, sitting/standing, sleeping, walking and weakly walking.

The human motion classification by WBAN measurement data was constructed to investigate factors

affecting the classification performance. Four factors that were investigated were the window size used in the vector extraction, antenna orientation, classifier algorithm, and receiver location on the human body. It was found that the window size and the receiver location had a significant impact on the classification performance, while the choice of antenna orientation or classifier algorithm did not significantly affect the classification results. For the window size used in the vector extraction, a large window size showed higher classification accuracy than a small window size. For the receiver location, the thigh and upper arm location resulted in higher accuracy rate than the ankle and wrist location.

Next, transmission power control using temporal correlation model (TCM-TPC) was developed. The temporal correlation model was used to estimate the channel condition. Then, the transmit power was selected based on the estimated channel. It was shown that the expected outage probability parameter in the proposed power control can be tuned to trade off between energy consumption and communication reliability. In addition, the proposed power control method was compared with other existing power control methods, namely, reactive transmission power control (R-TPC), channel estimation and transmission power control (ChEst-TPC), and simple prediction-based transmission power control (SP-TPC). The evaluation in a walking scenario showed that the proposed TCM-TPC consumed lower energy than other methods. Furthermore, the TCM-TPC and SP-TPC had similar packet loss rate, which was lower than the R-TPC and ChEst-TPC.

Lastly, motion-aware temporal correlation model-based transmission power control was developed by combing the human motion classification and the temporal correlation model-based transmission power control. The performance evaluation was performed on four motion scenarios including ascending/descending stair, walking, sitting and standing scenario. The motion-aware TCM-TPC generally worked well in the ascending/descending stair, walking, and standing scenarios. However, for the sitting scenario, although the packet loss rate of most links was low, some links experienced high packet loss rate. Therefore, the proposed power control should be applied with another scheme, such as a cooperative relay, to guarantee the reliability. For the energy consumption, the TCM-TPC generally consumed low energy compared to other power control methods. In addition, the proposed motion-aware TCM-TPC had better energy efficiency in a high traffic network than in a low traffic network. These results suggest that the proposed motion-aware TCM-TPC can well compromise between the communication reliability and the energy consumption. Therefore, the proposed motion-aware TCM-TPC can be a great choice for highly reliable and energy-efficient communication in WBAN.