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論 文 要 旨

THESIS SUMMARY

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要旨（英文 800 語程度）
Thesis Summary（approx.800 English Words ）

Nowadays, several researchers are paying a great attention to Wireless Sensor Networks (WSNs) technology since it simplifies the establishment and lowers the cost of autonomous systems, e.g. environment surveillance systems, from the conventional systems with wired-cable solutions. Therefore, low latency and high reliability systems are required for future applications of WSNs. Since WSNs consist of numerous sensor nodes distributed in the target areas, the deployment of relay nodes is necessary to help sensor nodes, which cannot directly connect to the sink, to transfer data. One of the efficient ways to deploy relay is to construct multi-hop relay networks as supporting backbone to the WSNs. To maximize the network performance, however, network designers still confront with challenges in deploying multi-hop networks in WSNs, especially the determination of optimum relay placement and the exploitation method of Multi-Input Multi-Output (MIMO). These two issues have been investigated in several researches based on theoretical models, which are almost impractical since they do not consider the effect of shadowing caused by obstacles typically existing in realistic environments. Therefore, the main contribution of this dissertation is to provide the deployment methodology of multi-hop relay networks in practical environments, mainly subject to optimize the relay node placement and network performance.

In this dissertation, we conduct the study of deployment of wireless multi-hop networks in practical environments in three considerations, i.e. two-hop MIMO relay networks, multi-hop MIMO relay networks and multi-hop MIMO relay networks as backbone for WSNs.

In the first consideration, we study the design of two-hop MIMO relay networks in perspective of solution for shadowing solving. Here, we performed the propagation measurement experiment in L-shaped corridor environment where shadowing is considered to be dominant. By this study, we found that by applying relay node in strong shadowing environment, the network capacity can be significantly improve from the direct transmission from the source to destination node. In addition, the recently proposed two-way relaying scheme is proved to be an efficient relaying scheme to improve the network capacity. Finally, we found that the optimum relay location is where relay node is in Line Of Sight (LOS) to

both source and destination nodes.

In the second consideration, we extend our study to the design of multi-hop MIMO relay networks in a practical shadowing environment. Different from two-hop relay networks, co-channel interference among nodes limits the network performance, so that we apply the theoretically proposed MIMO Two-Way Multi-hop Networks (M2WMNs) scheme as well as transmit power control scheme to deal with interference problem. In this study, we perform 3D ray-tracing simulation in the U-shaped corridor environment to evaluate the performance of M2WMNs and verify the optimum relay placement. By this study, we found that the network employing M2WMN and power control scheme shows its efficiency against the conventional one-way relaying network in terms of end-to-end capacity. In addition, in high transmit power regime, since high transmit power improves the connection between nodes against shadowing and interference can be adjusted by the transmit power optimization scheme, the optimum relay placement for M2WMN with power control scheme is not where all nodes are in LOS to each other as the conventional one-way relaying scheme and M2WMN without power control scheme.

In the third consideration, we aim to apply the analogy of relay deployment learnt from the above studies to propose a deployment methodology of multi-hop relay for WSNs in practical environment. In this study, we conduct 3D ray-tracing simulation in a factory environment as a representative of the actual automation systems. The idea of deploying multi-hop relay network is to estimate the minimum number of relay nodes to cover all sensor nodes and verify the optimum relay location based on three dimensional data of environment geometry and the pre-assigned locations of sensor and sink nodes. In order to achieve this objective, the main concept of the proposed method is to find the locations which minimize the effect of shadowing effect in the network to connect all sensor nodes in the network to the sink node. Consequently, the numerical results show that the proposed method can effectively improve the network performance in terms of packet error rate and also the time required for sequential communications in the WSN can be reduced. In addition, by applying two-way relaying scheme into the network, the network performance can be improved as well.

All in all, this dissertation extended the study of wireless multi-hop relay networks conventionally based on theoretical channel model to practical shadowing environment. By performing propagation channel measurement and 3D ray-tracing simulation, the network performance of several relaying schemes and optimum relay placement in various kinds of environment were investigated. Finally, the criteria of multi-hop relay network deployment for WSNs in practical environments was designed.