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LOCALIZATION OF ENERGY HARVESTING EMPOWERED UNDERWATER OPTICAL WIRELESS SENSOR NETWORKS

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ABSTRACT:

This paper proposes a received signal strength (RSS)based localization framework for energy harvesting underwater optical wireless sensor networks (EH-UOWSNs), where the optical noise sources and channel impairments of seawater pose significant challenges on range estimation. In UOWSNs energy limitation is another major problem due to the limited batterypower and difficulty to replace or recharge the battery of an underwater sensor node. In the proposed framework, sensor nodes with insufficient battery harvest ambient energy and start communicating once they have sufficient storage of energy. Network localization is carried out by measuring the RSSs of active nodes, which are modeled based on the underwater optical communication channel characteristics. Thereafter, block kernel matrices are computed for RSS-based range measurements. Unlike the traditional shortest-path approach, the proposed technique reduces the estimation error of the shortest path for each block kernel matrix. Once the complete block kernel matrices are available, a closed form localization technique is developed to find the location of every optical sensor node in the network. An analytical expression for the Cramer Rao lowerbound (CRLB) is also derived as a benchmark to evaluate the localization performance of the developed technique. Extensive simulations show that the proposed framework outperforms the well-known network localization techniques

INTRODUCTION

Energy consumption is increasing at a very quick rate along with the development and rapid growth of information and communication technology. It has also been reported mobile operators are among the top energy consumers.The energy consumption is growing even more with the deployment of 4G systems worldwide. Thus, there is an urgent need to shift from pursuing high capacity and spectral efficiency to energy efficient design. By reducing power consumption of wireless networks we can improve their energy efficiency. The energy efficiency of 5G networks is expected to be increased 100x times from 1000 mW/Mbps/sec in IMT-2000 to 10 mW/Mbps/sec in IMT-Advance and future IMT . Energy efficiency is becoming a matter of great concern in the telecommunications community due to a number of reasons such as huge data rate requirements, increasing price of energy, ecological impact of carbon, pressure and social responsibility for fighting climate change . This has led to joint academic and industrial research for developing energy-saving techniques like ‘green radio’ project , the EARTH project and so on. Research is also being carried out on the next-generation wireless networks including the third generation partnership project’s (3GPP) long term evolution-advanced (LTE-A) and IEEE 802.16 standard to focus on relaying techniques between the Base station and the Mobile stations as a means to reduce the power consumption as well as to save the operator from incurring the huge cost of deployment of a new base station. From the users’ perspective as well, energy efficiency is the need of the hour. The battery capacity is increasing only 1.5x per decade and has always been a concern for the user. In the future networks, there will be unbounded access to information and sharing of data everywhere and every time with the ever increasing number of energy hungry applications. So, to satisfy users’ demand of battery life, energy efficiency in wireless communication is imperative. Another factor under consideration is the health concern of the user. High power radiated by handsets while in use tend to harm the user in close proximity. Hence, shifting towards more energy efficient techniques becomes all the more important. FOR cellular systems, nonorthogonal multiple access (NOMA) has been studied to improve the downlink spectral efficiency in . In NOMA, a radio resource block is shared by multiple users and their transmission power difference plays a key role in multiple access. In general, a pair of users of different transmission powers is considered to share a radio resource block as in . In practical NOMA schemes, called multiuser superposition transmission (MUST) schemes, are considered for downlink transmissions (with two users). In NOMA is employed for coordinated multipoint (CoMP) downlink in order to support a cell-edge user without degrading the spectral efficiency. In addition, in , an opportunistic base station (BS) or access point (AP) selection is studied for CoMP with NOMA to improve the spectral efficiency. NOMA is extended to multiple-input multiple-output (MIMO) systems in and and capacity analysis of NOMA-MIMO can be found in . While NOMA has been extensively studied to apply to various transmission systems (e.g., CoMP and MIMO), there are also fundamental issues for NOMA. NOMA is based on superposition coding and successive interference cancellation (SIC). Due to SIC, the receiver's complexity can increase at users. Thus, NOMA without SIC in would be helpful to decrease the receiver's complexity at users. In addition, the performance comparison with multiuser diversity schemes (e.g., the opportunistic user selection scheme in is also an important issue in terms of the tradeoff between spectral efficiency and fairness. To address this issue, in NOMA and multiuser diversity schemes are compared when a proportional fairness scheduler is employed. In wireless communications, the power control has been extensively studied to overcome fading In NOMA, the power allocation between users and the power control are also important issues not only to overcome fading, but also guarantee fairness between users. In an optimal power allocation to maximize the minimum rate is studied with known channel state information (CSI). In partial CSI or statistical CSI is considered for the power allocation between users for downlink NOMA.

LITERATURE SURVEY

Optimization of resource management for NOMA transmission has been studied extensively in literature. For instance, the authors of Reference formulated a resource management problem to enhance the sum capacity of two-user NOMA system. The proposed framework first guarantees the minimum quality of service (QoS) of one mobile user and then allocate the remaining power to other mobile user to maximize the overall system capacity. A price based power optimization scheme was presented in downlink wireless network. The objective was to maximize the revenues and average achievable rate of the proposed network by adopting game theoretic approach. To deal with non-convex optimization, they decouple the problem and use alternating optimization algorithm to obtain the efficient solution. The research in Reference provided a low complexity power allocation to enhance the weighted sum capacity in downlink NOMA systems. They considered two cases, namely a two-use case and a multi-user case and exploited low complex and closed form solutions to solve the non-convex optimization yang et al. in Reference proposed a Karush–Kuhn–Tucker (KKT) based solution for power management to enhance the sum capacity of the network subject to a minimum user rate. Ding et al. in Reference investigated the outage performance and ergodic capacity for downlink NOMA network. Under the constraint of interference threshold from the secondary system to the primary system, the power management problem for capacity enhancement and outage probability in two-user cognitive radio NOMA network was proposed in Reference . A proportional fairness scheduling approach was considered for fair power allocation to maximize the sum rate and maximize the minimum of normalized rate in a two-user network . Tan et al. proposed the channel estimation and power management problem for two-user system to maximize the average effective signal to interference plus noise ratio (SINR) of the strong user with bounded average effective SINR of the weak user . To maximize the effective sum capacity with delay QoS constraint, Choi et al. provided a sub-optimal solution based on truncated channel inversion power control in a two-user downlink system .In addition, resource optimization techniques for NOMA in multi-cell communications networks have also been investigated . In Reference a KKT-based efficient power management technique was presented by Khan et al. to enhance the sum capacity of multi-cell multi-user NOMA network. In similar study, a KKT-based closed form solution for power optimization was provided by Yang et al. in multi-cell network to minimize the total system power and maximize the system sum capacity . The study in Reference considered a downlink heterogeneous network (HetNet) based on power multiplexing. The authors formulated a non-convex optimization problem to improve the network capacity and outage probability. They provided sub-optimal algorithm for user scheduling and power allocation. A problem for optimal power allocation was investigated in HetNet based on power multiplexing . The objective of the research was to increase to the network throughput subject to users QoS requirements.

EXISTING SYSTEM

Non-orthogonal multiple access (NOMA) for cellular future radio access

A non-orthogonal multiple access (NOMA) concept for future radio access (FRA) towards the 2020s information society. Different from the current LTE radio access scheme (until Release 11), NOMA superposes multiple users in the power domain although its basic signal waveform could be based on the orthogonal frequency division multiple access (OFDMA) or the discrete Fourier transform (DFT)-spread

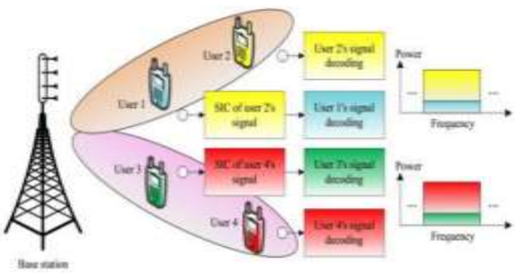
OFDM the same as LTE baseline. In our concept, NOMA adopts a successive interference cancellation (SIC) receiver as the baseline receiver scheme for robust multiple access, considering the expected evolution of device processing capabilities in the future. Based on system-level evaluations, we show that the downlink NOMA with SIC improves both the capacity and cell-edge user throughput performance irrespective of the availability of the frequency-selective channel quality indicator (CQI) on the base station side. Furthermore, we discuss possible extensions of NOMA by jointly applying multiantenna/site technologies with a proposed NOMA/MIMO scheme using SIC and an interference rejection combining (IRC) receiver to achieve further capacity gains, e.g., a three-fold gain in the spectrum efficiency representing a challenging target for FRA. Radio access technologies for cellular mobile communications are typically characterized by multiple access schemes, e.g., frequency division multiple access (FDMA), time division multiple access (TDMA), code division multiple access (CDMA), and OFDMA. In the 3.9 and 4th generation (4G) mobile communication systems such as Long-Term Evolution (LTE) and LTE-Advanced standardized by the 3rd Generation Partnership Project (3GPP), orthogonal multiple access based on OFDMA or single carrier (SC)- FDMA is adopted. Orthogonal multiple access was a reasonable choice for achieving good system-level throughput performance in packet-domain services with simple single-user detection.

PROPOSED SYSTEM

The telecommunication industry has experienced great success and demand in the recent past. The total number of mobile subscribers present are more than half of the global population. Presently, the ICT industry is becoming a major consumer of global energy. This has encouraged researchers to investigate various approaches for power consumption reduction. The motivation is twofold. Firstly, the telecommunication network operators are experiencing energy cost as a significant factor in profit calculations. Secondly, there exists a social responsibility of environmental protection by reducing carbon footprint due to information and communications technology Power consumption of a wireless network can be considered from two different perspectives: power consumed by basestation and power consumed by mobile station. Although the average mobile phone is getting smaller, its functions are growing day by day and as a result energy consumption is also increase to support new applications. The various stages of the life cycle of a mobile device is shown in figure 1. It is the component manufacture and use phase of the lifecycle of a mobile phone which have the greatest environmental impact.

NOMA

NOMA overcomes the near-far problems of the 3G systems and improve the fairness in resource allocation in the 4G systems. NOMA is a multi-user multiplexing scheme that exploits the frequency domain, time domain, and power domain similarly. Compared with the traditional orthogonal transmission, NOMA uses non-orthogonal transmission at the sending terminals, introducing interferenced information deliberately, and realizes the demodulation by the successive interference cancellation (SIC) technology at the receiving terminals . NOMA technologies can still use the OFDM symbol as the smallest unit in the time domain, and insert the cycle prefix (CP) between the symbols to prevent inter-symbol interference (ISI). While, in the frequency domain, the smallest units can still be the sub-channels, and OFDM technologies are used in each subchannels to keep the sub-channels are orthogonal and non-interference with each other. However, the power of each sub-channel and the OFDM symbol is shared by multiple users instead of only for one user. In particular, the signal power of different users on the same subchannel and OFDM symbol is non-orthogonal, which led to MAI for shared channels . In order to overcome the interference, NOMA at the receiver using a SIC technology for multi-user interference detection and deletion to ensure the normal communication of the systems . Thus, the receiver complexity of NOMA has improved compared with orthogonal transmission, but it can get higher spectral efficiency.



OUTPUT RESULTS EXPLANATION

We have considered the x - axis as Energy arrival rate in joule per second whereas y-axis is considered as RMSPE in metres. This graph shows the relation between RMSPE and energy arrival rate with fixed number of active nodes. Below Fig shows that the denser networks can provide a better RMSPE, even for low energy arrival rates. Additionally, based on duty-cycle optimization, energy harvesting increases the number of active nodes in the network and improves the connectivity of the network and the RMSPE,

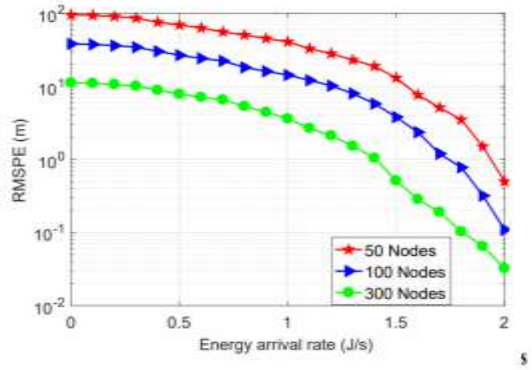


Fig.1. RMSPE Vs. Energy arrival rate with fixed number of active nodes.

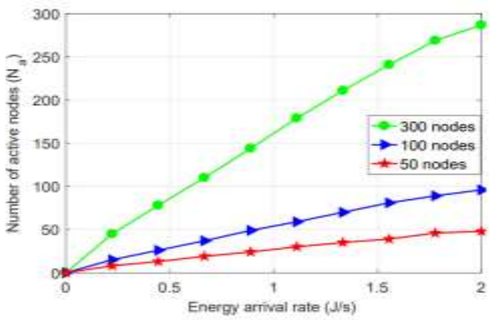


Fig.2. RMSPE Vs. Energy arrival rate with fixed transmission range.

We have considered the x - axis as Energy arrival rate in joule per second whereas y-axis is considered as number of active nodes. This graph shows the relation between RMSPE and energy arrival rate with fixed transmission range. Also we have investigated the impact of the energy arrival rate on the localization performance.

CONCLUSION

We studied the power control policy for NOMA to meet delay QoS constraints using the partial effective capacity. The resulting power control policy could be seen as a generalization of a well-known power control policy, namely the TCIPC policy. From simulation results, we confirmed that given delay QoS constraints can be satisfied. Consequently, it could be claimed that NOMA is applicable to delay-sensitive transmissions with the optimized TCIPC policy. We note that there are other topics to be addressed in the future. In this paper, we assumed perfect CSI feedback. However, in practice, the CSI at the transmitter might be outdated due to the feedback delay, which results in imperfect CSI. An energy-harvesting-based localization technique is developed for underwater optical sensor networks, using RSS measurements. In an aquatic environment, its difficult to replace or recharge the battery of a sensor node. Therefore, designing an efficient and reliable energy harvester for the continuous operation of UOWSN is required. We develop a mathematical model that can harvest energy from multiple sources and distribute it to the sensor nodes. The RSS measurements for underwater optical communications are inaccurate and lead large localization errors. The proposed technique takes into account the energy from the energy harvesting sources, thus making it more robust than other network localization techniques. The proposed method also reduces errors in estimating the shortest paths, in block kernel matrices, by introducing a novel matrix completion technique.

FUTURE SCOPE

The underwater wireless sensor network (UWSN) is a network used to perform monitoring of tasks over a specific region; it is equipped with smart sensors and vehicles that are adapted to communicate cooperatively through wireless connections . The surface sink retrieves the data from sensor nodes.

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