Underwater Optical Wireless Networks

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ABSTRACT:

In this paper it has been use optical wireless technique to get high bandwidth efficient services for underwater communication. The main loss caused by underwater communication is due to absorption and scattering. In order to have a long distance transmission we need a dense network configuration. Here we include a series of intermediate nodes acting as relay. Each nodes are kept floating at different depth into a service aquatic medium. The signal get transferred from one node to another and so on. We use an effective path loss model to derive the required transmission range. The modulation used is intensity-modulation direct detection with ON-OFF keying (OOK). To reveal the interaction between various parameters such as error probability, wavelength, node density, transmitted power, data rate etc we use certain numerical methods.

Keywords

multihop transmission, underwater optical wireless networks.

1. INTRODUCTION

Wireless communication today have emerged a lot in its way. Many researchers have been looking forward to make it better and better. In many areas like military, scientific and commercial areas. Underwater communication is used to transfer data signals from one place to another, mapping of sea floor and sensing purpose. Generally we use high radio frequency to transmit data but it cause high attenuation. The frequency dependent attenuation and half duplex operation which are practically used can cause harm to marine animals. So a long distance high range communication network is needed for underwater communication. The advantage of optical communication is used to avoid absorption as we generally use blue/green spectrum for the transfer of signals from one node to another. Speed of the optical waves is high in water. From all the studies it has been noted that a dense network is needed for more efficient underwater optical communication. Each nodes are interconnected and if any two nodes(source and destination) loss the connection entire connection will be drop down. Thus by studying, an efficient network model characteristics and significant parameters are adopted. Generally a 3-D network operation is used.

2. UNDERWATER OPTICAL WIRELESS COMMUNICATION MODEL

2.1. Network model

Generally a 3-D underwater communication network consists of nodes floating at different depth. Each node contains six sensors at 60 degree angled in order to cover all direction. All sensors are placed at bottom at sea by anchors connected with buoy. The buoy can be inflated by a pump. The buoy will push the sensors to the surface of the sea. By arranging the length of the wire that connects anchor and sensor we can adjust the depth. 1-D arrangement can also be constructed by using this technique. 1-D arrangement is considered as a special case of 3-D arrangement.
2.2. Channel model

There are lot of different elements dissolved in sea water and lot of sea plants and marine animals. Around 80% of sea water is comprised of these type of elements in different concentration such as zoo planktons, phyto planktons apart from the marine animals and plants. These components will redirect or transform the transmitting light into the form of heat and there by causing attenuation through the two fundamental physical process namely absorption and scattering. Also the transmitting light is highly sensitive to high wavelength. We uses Haltrin’s model for the analysis. The main absorption factor in the sea are chlorophyll and colored dissolved organic materials such as fulvic acid and humic acid. So an efficient wavelength is designed to avoid the absorption of light by sea plants.

2.3. Link budget

By using empirical path loss models we can estimate the received optical power in line of sight. By considering factors such as transmitter power, telescope gain and losses we can design effective models. The factors which affects the transmitted power are optical efficiencies of transmitter and receiver, perpendicular distance between the transmitter and the received plane, the transmitted beam divergence angle.

2.4. bit error rate calculation

The modulation technique used is intensity-modulation direct detection with ON-OFF keying(OOK). Considering the photons arriving at photon counters and by using poisson model we can calculate the bit error rate. The pulse duration of each received photons are calculated by using planck’s constant and speed of light in vaccum. The BER will depend up on the binary1 and binary0 of the pulse.

2.5. Transmission range

For proper operation of the network the minimum achievable transmission range of each node is determined

3. Connectivity properties

The set of vertices will represent the set of nodes and set of optical links between them. The node degree represents the number of links of a node. That is the number of neighbor nodes within its range. For an isolated node it has null node degree. For a minimum node degree it has minimum value among the node degree. In these wireless network, the poisson point process(PPP) is used in the open technical literature because of its simplicity. A constant node density is created by locating a large number of nodes in a service area. This vertices can be quantified by spatial node distribution model. The existence of path in between two nodes represent that there is a connection between them.

4. Numerical results and discussion

Here, the connectivity behavior of an underwater sensor network in the 300-700 nm spectral region is studied. The transmitted power is in the range of 100 MW and supported data rate will in the range 1 Mb/s. For studies we consider 1-D network with 100 nodes uniformly distributed over a service area. The error probability can be decreased by increasing node density and by decreasing distance between nodes. Optimum wavelength is selected to minimize error rate.
5. Conclusion

To achieve adequate connectivity the optical wireless network should be capable of delivering high data rate services for underwater environment at long distances. The modulation used is intensity-modulation direct detection with ON-OFF keying (OOK). We use the interaction between the node density and various parameters such as error probability, wavelength, transmitted power, data rate etc.

6. Reference


