Optical wireless communication

Optical wireless communication is a form of optical communication in which unguided visible, infrared (IR), or ultravoilet(UV) light is used to carry a signal.

OWC can be divided into five categories based on the transmission range:

Ultra-short range: chip-to-chip communications in stacked and closely packed multi-chip packages.

Short range: wireless body area network(WBAN) and wireless personal area network (WPAN) applications underwater communications.

Medium range: indoor IR and visible light communication (VLC) for wireless local area networks(WLANs) and inter-vehicular and vehicle-to-infrastructure communications.

Long range: inter-building connections, also called free space optical communication.

Ultra-long range: Laser communication in space especially for inter-satellite links and establishment of satellite constellations.

Attenuation: 0.39 db/m(ocean)-11db/m(turbid)
speed(m/s):2.255*10 power8
Date rate:gbps
Latency:low
Distance:10-100meters
bandwidth:10-150MHZ
Frequency band:10power 12-10power15
Transmission power:few watts
Antenna size:0.1m
efficiency:30.00bits/joules
Performance:absorption
parameters:scattering/turbidity organic matter

Acoustic waves:

Acoustic waves are used as primary carrier for underwater wireless communication due to their relatively less absorption and long coverage distance. Orthogonal frequency division multiplexing has also been extensively used in underwater acoustic communication to achieve high data rates without the need of complex equalizers These waves are characterized by three major

factors: frequency dependent attenuation, time varying multipath propagation and high latency.

RF waves:

The use of RF waves in underwater wireless communication has been explored for further improvement in data rates as it provides higher bandwidth and faster velocity in underwater environment. Depending upon the system design architecture, the RF waves can range from as low as few tens of Hz to GHz. Electromagnetic waves operating at extremely low frequency (30 - 300 Hz) are extensively used in military applications or in establishing communication paths between terrestrial and underwater bodies. They are used for long distances propagation and are successfully deployed for communication with naval submarines.

For RF system design which involves a communication link between underwater and terrestrial transceiver, any frequency range from MHz to GHz works effectively. Such communication systems are called buoyant RF communication system. Other design configuration involves direct RF communication link between two transceivers submerged underwater or one set inside the water and other set in the air. This type of system design is called direct RF communication system.

Data rate in RF communication can be improved using multiple input multiple output (MIMO) schemes. It has been reported that quadrature phase shift keying (QPSK) modulation scheme with four transmit antennas is capable of transmitting 48 kbps at 23 kHz bandwidth over a distance of 2 km. It requires very large size antenna (the wavelength is 10 km at 30 kHz). Further, in order to compensate for high antenna losses, high transmitter power is required.

Optical waves:

UOWC is capable of exceeding Gbps at a distance of few hundreds of meters due to high frequency of optical carrier.

OPTICAL BEAM PROPAGATION UNDERWATER :

The optical properties of water are divided into two groups namely: inherent optical properties and apparent optical properties. Inherent optical properties are dependent only on the medium specifically the composition and particulate substance present in the medium, whereas apparent properties are dependent on both the medium as well as the geometric structure of the illumination such as collimated or diffused beam. The inherent optical properties include absorption

coefficient, scattering coefficient, attenuation coefficient and volume scattering function which are used to determine the link budget in UOWC. Apparent properties define the directional property of the optical beam and are used to evaluate the ambient light levels for communication near the water surface. The common apparent properties are radiance, irradiance and reflectance. The apparent property can only be formed from regular and stable sources of illumination.

HYBRID ACOUSTO-OPTIC SYSTEM:

The hybrid system system will complement the existing acoustic system by providing high data rate and low latency when operating within optical range and with long range and robustness when operating outside optical range. These AUVs are equipped with both acoustic and optical modems. The acoustic modem is used for long distance communication and the optical modem is used for short distance communication after the alignment is assisted by acoustic communications. Therefore, in hybrid systems, optical transmitters occupy most of the uplink bandwidth by transmitting highly-directional high bandwidth signals. The downlink signal from the base station or ship to AUVs is a low frequency acoustic signal with wide FOV for the purpose of pointing or tracking of the AUVs. The hybrid acoustic optic system has significant advantages in terms of throughput and energy efficiency.
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