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Analysis of under-water Optical Wireless Communication

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Abstract- Underwater absorption, scattering and turbulence processes will introduce attenuation and fading to light propagation and then degrade the performance of underwater wireless optical communications (UWOC). As power consumption is an important issue in under- water missions, it is fundamental to minimize the intensity loss by reducing the beam divergence , data transmission in relatively high turbidity waters appeals for the use of energy-efficient modulations and powerful channel codes at the physical and data link layers. The particular difficulty of developing such model resides in the fact that turbulence highly depends on the operational scenario and also on the water conditions underwater wireless optical communications (UWOC), pulse modulation technique has been widely used due to the high optical power efficiency and relatively low system complexity. Compared with the simplest on-off keying (OOK) scheme, digital pulse interval modulation (DPIM) improves both power efficiency and error performance and requires no symbol synchronization. Polarization shift keying (Polk) is an another appropriate modulation scheme which can effectively restrain background noise. A scheme named, polarized DPIM (P-DPIM) and Po1SK , combining both to further improve the performance, and deriving its bit-error- rate (BER) expression in additive white Gaussian noise (AWGN) channel. UWOC channel suggest that P-DPIM scheme can improve both the power efficiency and error performance as well as communication distance compared with traditional PPM and DPIM schemes.

Keywords- underwater wireless optical communications (UWOC), pulse modulation technique, digital pulse interval modulation (DPIM), on-off keying (OOK) scheme, polarized DPIM (P-DPIM), Polarization shift keying (Polk)

I. INTRODUCTION

An optical fiber (or fibre) is a glass or plastic fiber that carries light along its length. Fiber optics is the overlap of applied science and engineering concerned with the design and application of optical fibers. Optical fibers are widely used in fiber-optic communications, which permits transmission over longer distances and at higher bandwidths (data rates) than other forms of communications. Fibers are used instead of metal wires because signals travel along them with less loss, and they are also immune to electromagnetic interference. Fibers are also used for illumination, and are wrapped in bundles so they can be used to carry images, thus allowing viewing in tight spaces. Specially designed fibers are used for a variety of other applications, including sensors and fiber lasers.

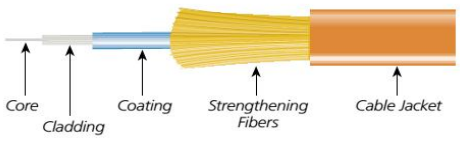

Fig 1 : Structure of Fiber

In fibers, there are two significant sections – the core and the cladding. The core is part where the light rays travel and the cladding is a similar material of slightly lower refractive index to cause total internal reflection. Usually both sections are fabricated from silica (glass). The light within the fiber is then continuously totally internally reflected along the waveguide.

When light enters the fiber we must also consider refraction at the interface of the air and the fiber core. The difference in refractive index causes refraction of the ray as it enters the fiber, allowing rays to enter the fiber at an angle greater than the angle allowed within the fiber as shown in the figure.

An optical fiber transmission link comprises the elements as shown in fig. The key sections are a transmitter consisting of a light source and its associated drive circuitry , a cable offering mechanical and environmental protection to the optical fibers contained inside, and a receiver consisting of a photo detector plus
Amplification and signal- restoring circuitry. Additional components include optical connectors, splices, couplers or beam splitters, and repeaters. The cabled optical fiber is one of the most important elements in an optical fiber link.

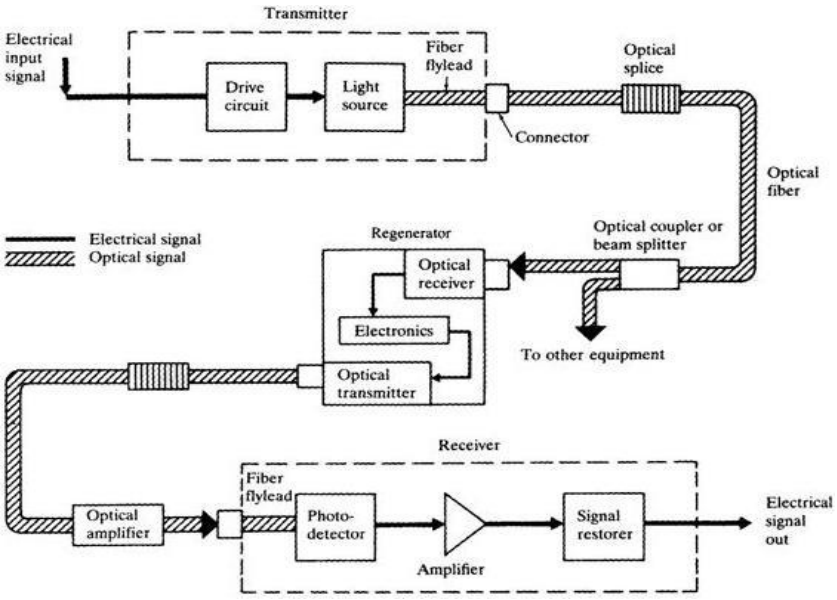

Fig. 2 : Transmission Link

II. OPTICAL WIRELESS COMMUNICATION

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

OWC systems operating in the visible band (390–750 nm) are commonly referred to as visible light communication (VLC). VLC systems take advantage of light emitting diodes (LEDs) which can be pulsed at very high speeds without noticeable effect on the lighting output and human eye. VLC can be possibly used in a wide range of applications including wireless local area networks, wireless personal area networks and vehicular networks among others. On the other hand, terrestrial point-to-point OWC systems, also known as the free space optical (FSO) systems, operate at the near IR frequencies (750–1600 nm). These systems typically use laser transmitters and offer a cost-effective protocol-transparent link with high data rates, i.e., 10 Gbit/s per wavelength, and provide a potential solution for the backhaul bottleneck. There has also been a growing interest on ultraviolet communication (UVC) as a result of recent progress in solid state optical sources/detectors operating within solar-blind UV spectrum (200–280 nm). In this so-called deep UV band, solar radiation is negligible at the ground level and this makes possible the design of photon-counting detectors with wide field-of-view receivers that increase the received energy with little additional background noise. Such designs are particularly useful for outdoor non-line-of-sight configurations to support low power short-range UVC such as in wireless sensor and ad-hoc networks.

Fig. 3 : Block Diagram of OWC

III. UNDER-WATER OPTICAL WIRELESS COMMUNICATION

Nowadays, there is extensive ongoing research activity relating to underwater communications. Traditionally, acoustic methods have been substantial advantage in underwater communication. However, acoustic link suffer the limitation of providing sufficient bandwidth for large amounts of data. Limited communication bandwidth presents a considerable challenge to underwater wireless application. A possible solution to this problem is offered by the introduction of optical communication which offers capacity of high data rates.

Implementing underwater optical link is dependent on the characteristic of ocean water. For under-water communication process we have to take care about different condition that is associated in water. Also, in under –water wireless optical communication recently modulation techniques are used for improvement of efficiency thus it can be useful for different conditions.

A. Modulation Techniques used in Under water wireless communication

In general the modulation methods developed for radio communications can be adapted for underwater acoustic communications (UAC). However some of the modulation schemes are more suited to the unique underwater acoustic communication channel than others. Some of the modulation methods used for UAC is as follows:

- Frequency Shift Keying (FSK)
- Phase Shift Keying (PSK)
- Frequency Hopped Spread Spectrum (FHSS)
- Direct Sequence Spread Spectrum (DSSS)
- Frequency and Pulse-position modulation (FPPM and PPM)
- Multiple Frequency Shift Keying (MFSK)
- Orthogonal Frequency-Division Multiplexing (OFDM)

IV. AREA OF APPLICATION

- **Telecommunications:** Optical fibers are now the standard point to point cable link between telephone substations.
- **Local Area Networks (LAN's):** Multimode fiber is commonly used as the "backbone" to carry signals between the hubs of LAN's from where copper coaxial cable takes the data to the desktop. Fiber links to the desktop, however, are also common.
- **Cable TV:** As mentioned before domestic cable TV networks use optical fiber because of its very low power consumption. It utilizes both single mode and multimode signals within different areas of network.

- **CCTV:** Closed circuit television security systems use optical fiber because of its inherent security, as well as the other advantages mentioned above.
- **Internet:** bandwidths upto 10Gbps, streaming movies in HD, live video conferences are easily possible with optical communication.
- Scientific data collection-Oceanography & geo-sciences (physics/chemistry– marine biology)
- Search and survey-military and non-military, detection of objects & ocean bottom imaging and mapping
- Environmental monitoring-climate recording, pollution control, prediction of natural disasters, oil/gas fields & harbor protection
- Underwater exploration-discovery of natural resources, marine phenomena & deep-sea archaeology

V. CONCLUSION

As power consumption is an important issue in under- water missions, it is fundamental to minimize the intensity loss by reducing the beam divergence , data transmission in relatively high turbidity waters appeals for the use of energy-efficient modulations and powerful channel codes at the physical and data link layers. The particular difficulty of developing such model resides in the fact that turbulence highly depends on the operational scenario and also on the water conditions underwater wireless optical communications. On studying different types of modulation techniques that are used in a optical communication and specially in Under-water optical wireless communication, OOK(on-off keying), PPM(pulse position modulation), PWM(pulse width modulation), DPIM(Digital pulse interval modulation). Using such type of modulation techniques we can enhance efficiency of under-water optical wireless communication.

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