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Trends in Optical Fibre Communication

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Abstract:

In modern development communication becomes the most important part of human life. The process of communication involves the generation of information, broadcasting, reception and then interpretation. Fibre optics is the most vital media transmission system for the overall broadband system. The capacity of transmission of wide data for long range is the main requirement in present days. To transmit light signals over long distance thousands of optical fibers are arranged in bundles in optical cables. By using the system of fibre optics the supreme transmission bandwidth with insignificant latency are provided to the telecommunication networks which the main requirement for the system. Fibre Optical system has many advantages still scientist are working in this fields for more development and remove the challenges. The new type of optical fibre are able to provide bandwidth which is 21 times more than the current available network. This paper provide overview of fiber optic communication systems in which from evolutions of fibre optics system to future trends all are discussed.

Keywords: *Optics, Communication, Transmission, Future Trends*

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Introduction

Over the past four decades the development of optical communication system is continuous and now it represents as one of the most mature industry. The main motivation behind the broad application of fiber optics communication is fast and high growing users and business for more media broadcast ability with the innovation of fiber optics. A single optical fiber over long separations allowed more information to be passed. Today users are interested in the speed and the service quality which gave them a good experience of communication. It is important to remember that under a user's requirements there are lots of communication levels. The smooth operation of the system is ensured by the telecommunication operator, which express the challenges of a continuous growth in data traffic that must be transferred as fast as possible.

The technology of optical fiber communication permits high capacity, ultra-high speed, and long distance transmission. In the future, it is believed that the need for information that will be transmitted in the field of automobile technology will increase fast. It is not only in the information system but in the case of safety systems and control systems, the requirement of increase in network data rates is necessary.

Research in the field of the optical fiber is still incomplete even it has many associated benefits of using optical fiber for communication like low interference, low attenuation, high capacity of information, over a longer distance the reliability is also very high, longer life-span with the easy maintenance system. With these, all benefits many challenges are also faced and researches are working to solve the problems associated with these challenges. The present optical communication system is challenging but the future optical system is intended to be more robust. (Essiambre, 2012; He *et al*, 2014; Tatsuno, 2005; Batagelj, 2014)

Evolution of Optical Fibre System

In 1970, Corning glass work developed the first optical fiber. At the same time for transmitting the light from the fiber links, GaAs semiconductor lasers were invented. The first and original framework of fiber optic was invented in 1975. This fiber optical system uses GaAs semiconductor lasers which works at 0.8 µm wavelength, 45Megabits/ second-bit rate with the spacing of repeater is 10km.

The second era of fiber optics was developed in the early 1980's, in this In GaAsP semi-conductor lasers was used with the 1.3 µm wavelength. These fiber optic systems were operating by 1987 on single-mode fiber with a 50km spacing of repeater and the rates of the bit are up to 1.7 Gigabits/second.

In 1990, the third era of fiber optics was developed and it works on 1.55 µm wavelength. On a solitary longitudinal mode fiber with a spacing of repeater 100Km, these systems were working at 2.5 Gigabits/ second-bit rate.

For repeaters, the use of optical speakers as a substitution comes with the fourth era of fiber optics system and to the rates of information wavelength division multiplexing (WDM) is used. At an information rate of 5 Gigabits/second more than 11,300Km transmission was submarine linked by 1996.

To further increase the data rates, the system used is Dense Wave Division Multiplexing (DWDM). Also, the idea of optical solitons, which is the heartbeat or pulse can protect the shape by balancing the negative impacts of scattering. (Rajpoot *et al*, 2017; Idachaba *et al*, 2014 and Poovizhi and Manivasagam, 2016)

Principles of Fibre Optics Communication

To transfer information from one point to another fiber optics communication system is used. It is a communication technology which uses light pulses for transferring the information. The information that is transmitted is in digital form which is generated by using computer systems, telephones, cable television, etc. optical fiber is made from low loss materials mainly silicon dioxide is used. The optical fiber is a non-conducting dielectric cylindrical waveguide, the transmission of light is along its axis. The core and cladding is the innermost and outermost part cladding is cover with outer medium and have lower reflective index than the core. The optical transmission of light is done by the process of the phenomena Total Internal Reflection (TIR)

This system consists of an optical transmitter which converts the input data (electric signal) into optical signals. To transfer the optical signals to the receiver, a cable is used which contains numerous bundle of optical fibers and to reconvert the optical signal back into the original electric signal optical receiver is used. Optical amplifiers are also used to amplify the power of the optical signals.

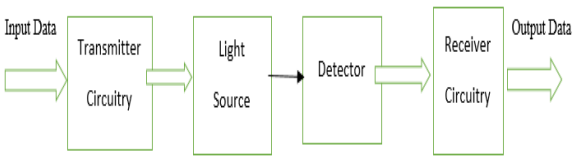

Figure 1: Basic of Fibre Optics Communication System

Fiber optics communication is categorized in two forms:

- Step index
- Multimode graded-Index fiber

Step Index

It is a type of fiber with sharp boundaries between core and cladding of optical fiber which clearly defined the indices of refraction. The entire core of optical fiber uses the single index of refraction. Step index contains two modes:

- Single Mode Step Index
- Multimode Step Index

Single Mode Step Index: It has 8 to 9 microns core diameter, which permits only one line mode or path.

Multimode Step Index Fiber: the core diameter of multimode step index fiber is 50 or 62 microns or sometimes more and allows varied lightweight ways. It also causes modal diffusion in this some modes take longer to pass through the fiber other than the environment, noise immunity, etc.

Multimode graded-Index fiber

Farther from the center of the core the refractive index is gradually decreased which refers to graded index. The speed of some light rays slows down because of the increase in the refraction, allows that all the rays of light to reach the receiving end at approximately the same time, reducing dispersion. (Bhatnagar, 2016; Idachaba *et al*, 2014 and Poovizhi; Rajpoot *et al*, 2017 and Manivasagam, 2016)

Benefits OF Fibre-Optic Communications

The fiber optic communication system has so many advantages which include:

Longer Distance Signal Transmission: Due to high signal transmission and low attenuation power over metallic based system fiber optical transmission has the power to transport the signals long distance. The basic system of fiber optics is able to send signals up to 5km over multimode fiber and over single mode up to 80 km without repeaters. The information sent by the most modern fiber optics system is digitally and the digital fiber optics system can be repeated or renewed virtually indeterminately.

Transmission of Multiple Signals: The bandwidth of fiber is more than 70 GHz using typical off-the-shelf Fiber-optic transport equipment. Using a combination of time-division multiplexing (TDM) and optical multiplexing many forms of audio and video signals can be transported.

Small Diameter, Light Weight, and Long Length: The higher capacity building channels are facilitated by the small size and diameter of a single fiber. It is possible to make and manufacture much longer length in fiber optics then metallic cable. Due to the limitation of space in electronic news gathering and mobile vehicles fiber is the only cable of choice in the field production for news events and sports.

Noise Immunity: On copper cable, the signal traveling are prone to electromagnetic interference. Because of the effect of electromagnetic interference, the photo travel down a fiber cable is immune. The signals of fiber optics do not radiate any noise or interference.

Ease of Installation and Upgrade: The equipment used for the installation of coaxial and copper cable is the same which is used for the installation of optical fibers. The installation of the optical cable is easier and less expensive, because of its long length and some other modifications like the small size, limited pull tension and radius bend of the fiber cable. The termination kits of fiber optics are also available that requires no special polishing and epoxy. To terminate both single modes fiber optic cable and multimode fiber optic cable epoxy free connectors are available in the market in which the connectors are already polished.

Low Transmission Loss, Large Bandwidth: In the production of optical fiber cable the recent development exhibit very low transmission loss in compare of the best copper conductor. Because the frequency yield by the optical carrier is extreme greater potential transmission bandwidth than metallic cable systems. Optical fiber system also proved its information carrying capacity which is far higher to the copper cable system.

System Reliability, Security and Low Cost: To enhance the reliability of the system and to reduce the maintenance of time and cost, few repeaters are used with conventional electric conductor system. The nature of optical fiber is dielectric which makes it impossible to detect the signal which is being transmitted through it. Retrieving the fiber requires interference which is easily detectable by the surveillance security and this makes this fiber more attractive towards the governmental organization, banks, and various other agencies. (Chinenye, 2017)

Application of optical fiber

Because of the increase in the number of application of optical fiber demand for this fiber is increasing. The application of telecommunication is spreading widely from universal network to a single desktop computer. The receiving and sending of data, videos, or sounds from distance between a meter to thousands of kilometers are all included in the application of optical fiber.

- The service of CATV (cable television) is delivered by fiber optic network to an optical node in which distribution and transformation of electric signals are provided to subscribers with the help of a coaxial cable network.
- Architectures: the system of fiber optics communication is divided into three main categories:
    - Point to point links
    - Distribution networks

- Local area networks

Point-to-point links: It is the simplest form of an optical fiber communication system. The main role of this link is to transmit information in digital bit form with high accuracy from one place to another. The required application decides the length of the link and if the link length avoids certain value, then the compensation should be required rely on the wavelength of operating to prohibit the signal from coming too weak should be detected with an operative method.

Distribution networks: the physical fiber and optical devices that distribute signals in telecommunication networks to the users.

A local-area network (LAN): in this network cover by computer is small. A single site or a building like collage and schools are the examples of Local-area network (LAN).

Wide area network (WAN): As the name suggests it covers a wide area of network i.e. geographically large in the area are known as WAN. It consists of two or more local area networks and it is simply a scattered communication network for the transmission of image, data, video, etc. (Osman et al. 2018)

Future Trends in Fiber Optics Communication

It is confirmed that fiber optics is the future of data communication. With the advancement in technology and with the increment in demand, the progress of fiber optic communication has been driven. It is expected it is required to proceed in future and it will get in the long run, with the development of innovative and progressive communication technology. Some portion of intended forthcoming trends in optical fiber communication is as follow.

- **All-Optical Communication Networks**:

An all fiber-optic communication is imagined which will be entirely in the optical domain and contribution a rise to the optical communication network. In such types of networks without any electrical manipulation, all the signals will be prepared in the optical domain. Currently switching and the processing of signals take place in an electric domain. Before they can be prepared optical signs should be first converted to electrical flag and then directed to their goal. Then after the making and routing, signals are again changed or reconverted to optical signals which are communicated over long distances to their endpoint. This optical to electrical conversion and the other way around results in the included dullness of the network. Therefore, there is a limitation to achieving very high data rates and other network benefits.

- **Multi – Terabit Optical Networks:**

The way for multi-terabit transmission is covered by Dense Wave Division Multiplexing (DWDM). The overall need for increased bandwidth has encouraged the interest in developing the multi-terabit optical networks. Currently, four terabit networks consuming 40 GB/s data rate joint with 100 DWDM channels exist. Scientists are trying to achieving higher bandwidth with 100 GB/s. Even it is possible to achieve greater transmission capacity with the reduction in the cost of fiber optics components.

- **Intelligent Optical Transmission Network:**

Currently, the growth of traditional optic networks are not capable to adapt the rapid growth of future data services because of the randomness of dynamic distribution of bandwidth, traditional optical networks depend on the physical configuration of connectivity of the network, which is time-consuming and unable to take the demand of modern network. In optical network development the trend of future is intelligent optical network with the application like special protocol for network management, traffic engineering, dynamic resource route allocation, wavelength wholesale, bandwidth on demand, etc. before the intelligent optical system is applied to all the types of network it will take some time and firstly, it should be applied to long-haul networks and to the edge of network.

- **Ultra – high Haul Optical broadcast:**

In this ultra-high haul optical broadcast system, the limitations are executed because of the transmission medium imperfection, which is the subject of research. The cancellation of outcomes of dispersion effect has encouraged the researchers to study the possible benefits of soliton propagation. For further proceedings in this field, there is a need to understand the interactions of electromagnetic light wave and the transmission medium is also necessary for further infrastructure toward with the most favorable conditions for a light weight pulse to propagate.

- **Polymer Optic Fibers:**

Polymer optic fiber system offers numerous advantages if compared to other information correspondence arrangements, like glass fibers, copper links, etc. with the examination of polymer optical strands with glass optical filaments, polymer optical strands gives less costly and simple preparing of optical flags. They are more flexible for the interconnections fittings. Because of its advantage over other material various research and development organizations take polymer optical fiber as a transmission media for air ships. It is presumed by German Aerospace Center that "the utilization of Polymer Optical Fibers mixed media strands seems, by all accounts, to be workable for future flying machine applications".

- **Improvements in Laser Technology:**

The extension of the present semiconductor laser to a wider wavelength is another future trend. In some high-density optical system, lasers with shorter wavelength and very high output powers are of interest. Currently, the laser sources which are spectrally formed through the chirp managing to recompense for chromatic scattering are offered. The meaning of chirp managing is that when firing a pulse, the laser is controlled in a way that it experiences an unexpected change in its wavelength, such that the chromatic scattering practiced by the pulse is condensed. The instrument is needed to be developed for the characterization of such lasers. (Bhatnagar, 2016; Idachaba *et al*, 2014 and Poovizhi; Rajpoot *et al*, 2017 and Manivasagam, 2016)

Conclusion

Optical fiber system is the one of the most emerging and fast-growing industry. Optical fiber system changes the way of communication with its benefits. Fiber optics have high bandwidth abilities and low attenuation characteristics which make it ideal for gigabit transmission. As from the evolution of optical fiber system, there is a lot of improvement and development is seen in the system and scientists are still working on the further development of this system. The growth of the fiber optics industry over the past five years has been very quick. There is a lot of analysis is done in the field of the optical fiber to improve the need for higher information rates and advanced switch techniques. This trend is predicted to be continued for more new improved modifications and results. Because the reliable and faster infrastructure is the prime demand of today's growing population.

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