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Applicability of Lifi Technology for Industrial Automation

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Abstract- *Light Fidelity (Li-Fi) is a new technology for wireless communication. Li-Fi technology provides transmission of data through illumination by sending data through LED that varies in intensity faster than the human eye can follow. This paper focus on use of Li-Fi based system in industries and analyze its performance with respect to existing technology. The heart of this technology is a new generation of high brightness LEDs. Requirements for transmitting data in the industrial field are high—key parameters include robustness, low energy requirements, data security, and real-time capability for safety-related functions. At the same time, industrial plants are becoming increasingly complex with more and more sensors, control units, and machines communicating with each other. Because wired systems such as EtherCAT or Profibus can't be used everywhere, wireless systems are often more suitable, especially for moving equipment or mobile machinery. Many wireless technologies such as Bluetooth or WLAN, however, quickly reach their limits in environments with multiple network partners.*

Li-Fi will be compared with Wireless Fidelity (Wi-Fi). In industrial automation systems, production process should be fast and safely. Unlike Wi-Fi, high-speed internet connection is provided using Li-Fi technology. Therefore, applicability of industrial automation systems of Li-Fi technology will be examined.

Keywords- Li-Fi, Wi-Fi,VLC

I – INTRODUCTION

Today, the wireless transmission of industrial data is conducted using radio-based techniques. These include, among others, the WLAN IEEE 802.11n standard with a possible data rate of up to 600 Mb/s or the 802.11ac standard for data rates up to 1300 Mb/s.

Actual net data rates are often much lower in real industrial environments with several network partners and electromagnetic-compatibility (EMC) interferences. In addition, WLAN is viewed as an inappropriate communication channel for real-time applications with security requirements. System susceptibility often results in packet loss and high latency times due to data having to be retransmitted. Therefore, safety applications with fast cycle times can't be reliably operated over WLAN connections.

Further difficulties arise in security protections against eavesdropping breaches. In a radio network, the room serves as a monitoring medium and transmission range is only limited by signal strength. Although they may be weakened, signals can still penetrate machine casings and walls to present problematic issues in terms of privacy as well as security. Without encryption, only one singular device must be in range to access data.Although different encryption methods are available, most require all hardware to meet modern standards. Older devices within the system can pose a security risk. Li-Fi (light fidelity)—the transmission of data via light—eliminates many of these problems and appears to be a viable alternative for the transmission of industrial data.

What is Li-Fi?

Li-Fi uses visible light communication (VLC) and near-infrared communication (IRC) to transmit data. Because

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it's simultaneously used for both communication and lighting purposes, VLC normally uses light-emitting diodes (LEDs) of comfortable white light. IRC, in contrast, typically implements LEDs with supplemental laser diodes *(Fig. 1)*.

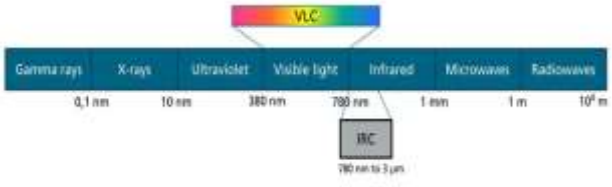

Fig 1- . Laser Diodes

1. At VLC, the frequencies of light used for transmission are between 380 and 780 nm. For IR, the frequencies are between 780 and 3 µm.

Optical transmission occurs between at least two transmitting/receiving units known as transceivers. Transceivers consist of both a receiver and a transmitter able to modulate or demodulate data using a process signal module. Data must be converted from electrical to optical signals in order to transmit. For this purpose, emission intensity is varied with the help of a suitable guidance driver.

In addition to the processing module, the receiver consists of an amplifier and a photodetector. The receiver optic focuses transmitted optical radiation to maximize the signal level. A detector converts the received signal into electrical power, which is then translated into a voltage and strengthened. The signal-processing module demodulates received optical signals.

The distance between the modules and the resulting spot size, also called the field of view, is of particular importance. A narrow field of view typically allows for a higher rate of data to be transmitted over longer distances at a lower bit error rate. To achieve this narrow field of view, however, transceivers must be precisely aligned with one another. Although a larger field of view offers an alternative, a smaller proportion of emitted power hits the receiver. This lower-level signal results in a shorter distance of travel.A variety of wireless solutions have been recommended to provide more data traffic [6]. In 2011, Harald Haas announced a new wireless technology that is called Light Fidelity (Li-Fi) [7]. Although Wi-Fi uses radio waves, Li-Fi uses visible light spectrum. The radio frequency spectrum is 10,000 times shorter than the visible light spectrum as shown in Fig. 2

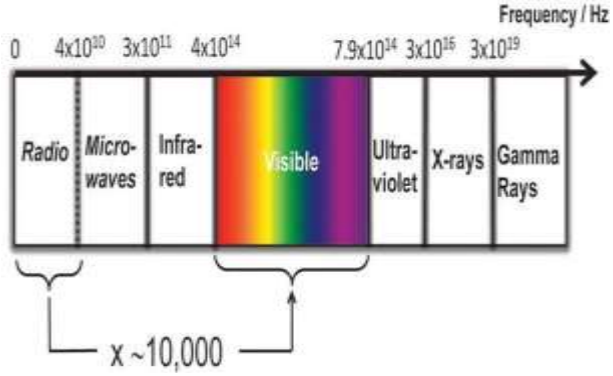

Fig 2. The electromagnetic spectrum

Infrared rays can be used only low power due to eye safety regulation. Gama rays and ultraviolet light can be dangerous for human body. However, visible rays are safe for human body. Therefore, visible light is used for Li-Fi technology.

Although Wi-Fi uses modems, Li-Fi uses transceiver-fitted LED lamps that can transmit and receive information. Li-Fi can transmit more data in a very short amount of time than Wi- Fi seeing as a higher aggregate data rate is possible.

II -THE OPERATION PRINCIPLE OF LI-FI

LiFi is a Visible Light Communications system transmitting wireless internet communications at very high speeds. The technology makes a LED light bulb emit pulses of light that are undetectable to the human eye and within those emitted pulses, data can travel to and from receivers. Then, the receivers collect information and interpret the transmitted data. This is conceptually similar to decoding Morse code but at a much faster rate – millions of times a second. LiFi transmission speeds can go over 100 Gbps, 14 times faster than WiGig, also known as the world's fastest WiFi. A block diagram of the Li-Fi system is shown in Fig. 3. Power supply produces constant power for lamp driver. Lamp driver connect to the internet connection. Switch and LED lamp is connected lamp driver with fibre optics cables. LED lamp acts as a communication source. Microchip, which is located in LED lamp, converts the data into light. High-speed data is transmitted using light beam from LED lamp to photo detector. Receiver detects changing in intensity of the light beam and converts the data into electrical signal . These converted data are transmitted to the technological devices .

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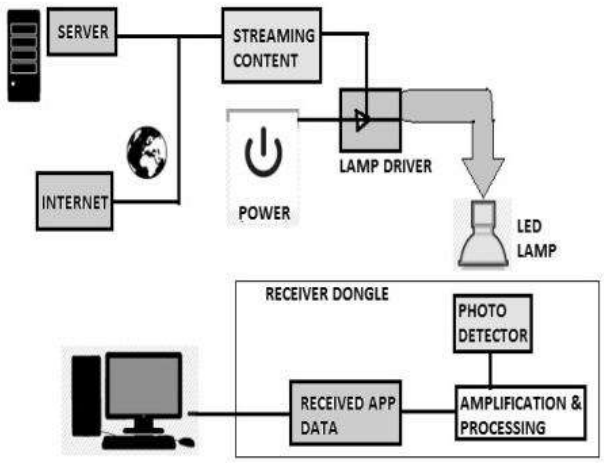

Fig 3- Block Diagram of Lifi System.

III -APPLICABILITY OF INDUSTRIAL AUTOMATION SYSTEMS OF LI-FI TECHNOLOGY

In industrial manufacturing process, it is extremely important that process should be completed fast and safely besides product quality. Therefore, the communications between units are developing day by day in nowadays- industrial automation systems. These developments that mostly depending on usage of protocol are shown data transmission rate and security.

In industrial applications, while monitoring and control are being done in real time benefiting various network topologies. The efficiency of network is an important factor while this topology is chosen. However, it will be useful to take into consideration; the using network topology is used to recognize devices besides data transmission speed may vary depending on the distance between units. Under these criteria, many industrial automation companies are trying to provide with different communication protocols. It offers significant advantages in terms of both cost and speed if data transmission is done wirelessly. Wireless monitoring and control systems are provided a major contribution to the development of the SCADA systems. Wireless communication systems, especially applications are made with web-based or smartphones, has been used successfully. As compared with Wi-Fi, Li-Fi technologies should be preferred because of having high-speed data transmission rate and more secure in wireless communication systems.

In current wireless communication system have a security gap because radio waves can pass through the walls. Security gap is a big disadvantage for industrial automation systems that are working in higher-up security level. Light waves cannot pass through the walls. Therefore, these industrial automation systems are protected using Li-Fi technology.

As mentioned previous chapter, line-of-sight is a big challenge for Li-Fi systems. Some people claim that Wi-Fi is an over light based communication technologies and is not much affected from line-of-sight problem as compared with Li-Fi in a factory environment that includes lots of moving obstacles. Therefore, Wi-Fi systems are more useful than Li-Fi for industrial areas. However, when considering a factory, Wi- Fi connection receivers are positioned in specific locations. The internet connection is delivered to the robotic arms via Ethernet cables. When Wi-Fi systems are replaced with Li-Fi, still receivers are positioned in specific locations and nothing can interrupt light. Therefore, internet connection can be provided without any interruption to the robotic arms or any other devices. Thus, line-of-sight problem are solved. In addition, it can be clearly seen that production process will be faster with using Li-Fi, which is provided high-speed data transmission rate. This system model is shown in Fig. 4.

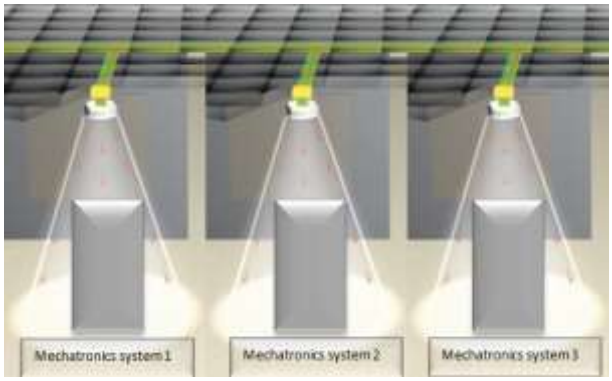

Fig 8. Li-Fi connection system in a factory

IV- CONCLUSION AND FUTURE WORK

In industrial automation systems, safe and high-speed internet connection is an important two factors for production process. Considering the fact that a Li-Fi connection is limited with the area of LED lights, the outside reach to the network is not possible. That leads to a very secure connection. Thus, the Li-Fi technology brings safety connection. This fact might lead to more application fields for future work. For example, the Li-Fi can be used in military networking systems. The control of military devices through Li-Fi may be investigated in future studies. Additionally, the finance departments of companies or banks may use Li-Fi in order to obtain more secure networks.

In addition, all of these, if hybrid model is implemented for real life, this model will be more suitable for industrial automation systems to include Li-Fi and Wi-Fi systems' advantages.

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