Survey on Wireless Technologies in Industrial Application

T. Gobika[#1], T. Nandhini[#2], S. Suseela[#3]
[#1],III[year] IT Student, Department of Information Technology,
Periyar Maniammai University, Vallam,Thanjavur, India.
[#2],III[year] IT Student, Department of Information Technology,
Periyar Maniammai University, Vallam,Thanjavur, India.
[#3],Assistant Professor, Department of Computer Science and Engineering,
Periyar Maniammai University, Vallam,Thanjavur,

Abstract - Wireless technology is rapidly growing, and is playing an increasing role in the lives of people throughout the world. In addition, ever-larger numbers of people are relying on the technology directly or indirectly. Wireless technology is certainly able to improve our life quality. Wireless solution can be time saving, easier to use and more mobile. In this survey the different wireless technologies used in industrial applications are considered such as RF, Bluetooth, Wi-Fi, Li-Fi, and Zigbee. Also some of its attributes, mainly the standards, protocols, bandwidth, battery life, data rate, and maximum transmission range of technologies are discussed.

Keywords-RF, Wi-Fi, Bluetooth, Li-Fi, Zigbee

I. INTRODUCTION

Wireless technologies have been available for decades. In the last several years wireless technologies have been making their way to the factory floor. The main advantages for using a wireless solution in industrial applications are greater mobility. Wireless technologies are possibility to move devices and connect to smart phones and tablets freely without cables. It can eliminate expensive and maintenance heavy transmission media such as flexible cables, swivels. Bypassing long distances and areas where cables cannot physically fit. Wireless technologies are fast and easy installation and commissioning. It has high flexibility if there is a need to modify an installation. Increased personnel safety by not having to be physically close to a device during configuration and maintenance, flexible human interface devices (HID),easy integration of devices into the network.[1]RF is any frequency within the electromagnetic spectrum associated with radio wave propagation. When an RF current is supplied to an antenna, an electromagnetic field is created that then is able to propagate through space. Many wireless technologies are based on RF field propagation Bluetooth a standard for the short-range wireless interconnection of mobile phones, computers, and other electronic devices.

ZigBee is an IEEE 802.15.4-based specification for a suite of high-level communication protocols used to create personal area networks with small, low-power digital radios, such as for home automation, medical device data collection

Wi-fi a facility allowing computers, smartphones, or other devices to connect to the Internet or communicate with one another wirelessly within a particular area.Li-Fi The term LiFi was coined by pure LiFi's CSO, Professor Harald Haas. It refers to light based communications technology that delivers a high-speed, bidirectional networked, mobile communications in a similar manner as Wi-Fi. Li-Fi is a category of Optical Wireless Communications (OWC).[2]Wireless technologies are applied in various wide applications throughout the world. For communicating over the world, wireless communications communicates via satellite. In the closed environments or limited range applications like school, colleges, offices, factories, and industries, we communicate or transfer the data with the help of wireless sensor networks such as RF modem, Bluetooth, Wi-Fi, Zigbee and Li-Fi etc. The primary advantages of wireless sensor networks are,

- Reliable
- Authenticated
- No use of cables
- Lesser cost than wired.

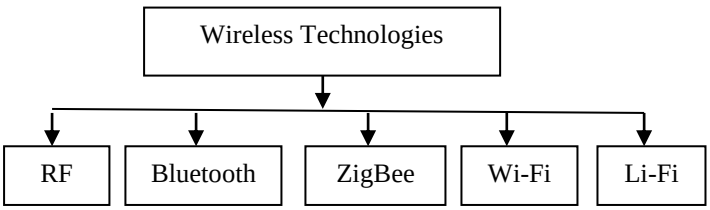

Figure1.Wireless Technologies

The figure1 says that various wireless technologies such that RF, Bluetooth, ZigBee, Wi-Fi, Li-Fi. Those wireless technologies are mainly used in industrial applications.

II. RF MODULE

An RF module (radio frequency module) is a small electronic circuit used to transmit and receive radio signals . RF modules are widely used in electronic and designing radio circuitry.

RF modules are most often applied in medium and low volume products. Depending on consumer applications such as wireless alarm systems, industrial remote controls, smart sensor applications, and wireless home automation systems. Commercially available RF module frequencies are 433.92 MHz, 315 MHz, 868 MHz and 915MHz. These frequencies are used because of national and international regulations governing the use of radio for communication.[2]

The performance of an RF module will depend on a number of factors such as an increase in the transmitter power and larger communication distance. However, this will also result in a higher electrical power drain on the transmitter device, which will cause shorter operating life for battery powered devices. Likewise, using a higher transmit power will make the system more prone to interference with other RF devices and also by increasing the receiver sensitivity will also increase the effective communication range, but will also potentially cause malfunction due to interference with other RF devices. The performance of the overall system may be improved by using matched antennas at each end of the communication link, such as those described earlier.

The system is normally measured in an open-air line of sight configuration without any interference, but frequently there will be obstacles such as walls, floors, iron construction to absorb the radio wave signals, then the effective operational distance will in most practical instances is less than specified.

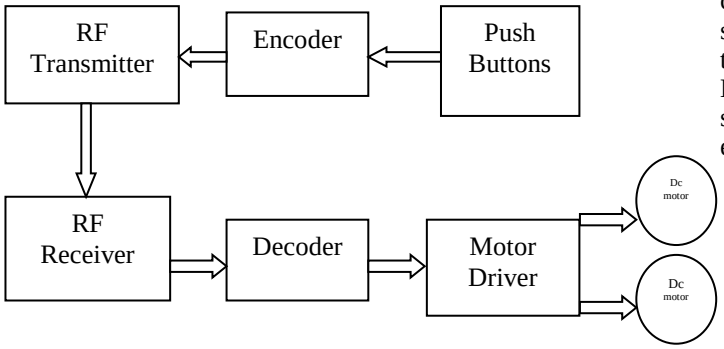

Figure2.RF

Specification

Frequency range: from 50 MHz to as high as 860 MHz,

RF channel spacing: 6 MHz,

Cross-modulation level: Not greater than -40 dBc within the design bandwidth.

Transit delay from headend to most distant customer: <= 0.800 msec (typically much less).

Applications

Radio Frequency heat is used for a variety of heating and drying applications, including:

1.Ceramics

2. Foam

3. FiberGlass

4.Composites

5.Textiles

6.Food Tempering & Pasteurizing

7.Wood and

8.Paper.

Advantages

Used in various medical applications

It is used in radar for object detection.

It is used for satellite communication

It is used in microwave line of sight communication system

III. BLUETOOTH

Figure3 shows that the Bluetooth connection. Bluetooth operates based on the features of Adaptive Frequency Hopping (AFH) and Forward Error Correction (FEC). It provides a universal short range wireless capability. It operates in the 2.4 GHz frequency band and the devices within 10m of each other can share the data up to 720Kbps of capacity. This technology is also an authenticated one by sending the acknowledgement from the receiver to the transmitter before making the connection between devices. But its limitation is up to eight devices can communicate in a single network and it asks the confirmation about receiving the each data at every time and also it limits the packet size.[3]

Figure3.Bluetooth

Specification

Physical range: Less than 10m upto 100m

Channels spacing:1 MHz apart, starting at 2 402 MHz and finishing at 2 480 MHz.

Data rates: around 25 Mbps .

Applications

Bluetooth is designed to operate in an environment of many users. Up to eight devices can communicate in a small network called a *piconet*. Ten of these piconets can coexist in the same coverage range of the Bluetooth radio. To provide security, each link is encoded and protected against eavesdropping and interference.

1.Data and voice access points

2.Cable replacement

3.Ad hoc networking

Advantages

1. Wireless
2. Bluetooth is actually inexpensive
3. Bluetooth is automatic
4. Standardized protocol
5. Low interference
6. Low energy consumption
7. Sharing voice and data
8. Instant PAN (Personal Area Network)
9. Upgradeable
10. Free of charge

IV. ZigBee

The communication layer of Zigbee is at level 3 and upper layer in the OSI model. Zigbee provides a network topology to let a network of devices communicate between them and to set extra communication features such as authentication, encryption, and the association and in the upper layer application services. A reactive Adhoc protocol has been implemented to perform the data routing and forwarding process to any node in the network. The main application of Zigbee is clustering. Zigbee has a lot to offer in industrial applications such as low cost deployment and redeployment, mesh networking to cover entire industrial plants and factories, an open standard with multiple vendors, battery operation.[4]

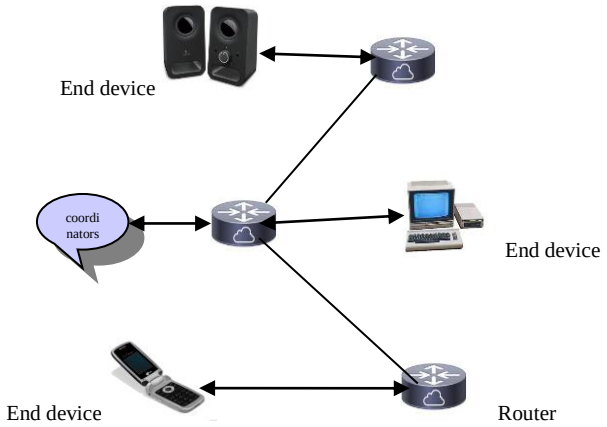

Figure4.ZigBee

Specification

Bandwidth:2.4GHz, 868MHz and 915 MHz.
channel spaced:5 MHz
Data rates : 250 Kbps, 40 Kbps and 20 Kbps as per bands

Applications

ZigBee used in various application in the world.like
Industrial Automation
Home Automation
Smart Metering
Smart Grid monitoring

Advantages

Less channel bandwidth of only 0.3-2Mhz compared to 22MHZ taken by Wi-Fi
Low power consumption
Very robust network
Up to 65,645 nodes
Very easy to add or remove nodes from the network

V. Wi-Fi

Wi-Fi stands for Wireless Fidelity, which refers to wireless technology that allows devices to communicate over a wireless signal. This network is based on the IEEE standard 802.11; including 802.11a, 802.11b, 802.11g and 802.11n, by using the centralized router devices can share the Wi-Fi signal. Wi-Fi networking technology that uses waves to allow high speed data transfer over short distances. In indoor environment, this technology causing problem called multipath interference due to reflection of signals from the walls, furniture and other obstacles. Wi-Fi allows local area networks (LANs) to operate without cable and wiring. It is popular for the home and business networks. Generally, it can be used to provide the wireless broadband internet access for many modern devices such as laptops, smart phones, tablet and computers with authentication. By increasing the number of devices in a single Wi-Fi connection, the strength of the signal provides to each device becomes weak.[6]

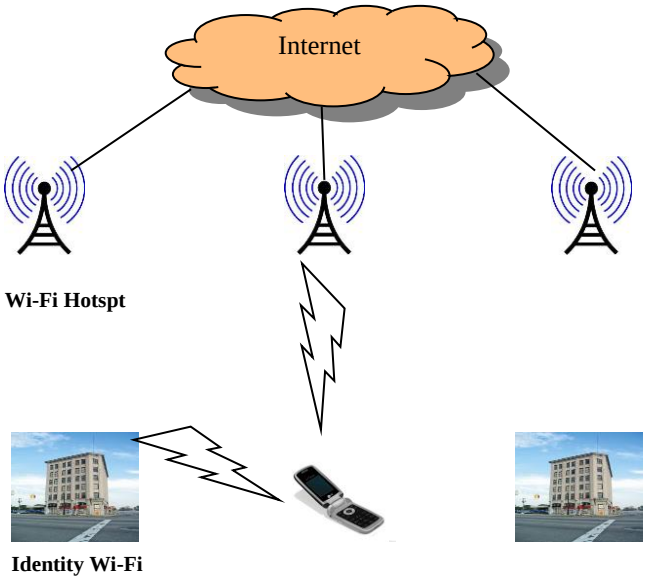

Figure5.Wi-Fi

Specification
Data rate:11 mbps
Bandwidth:2.4 GHz
Channel Spacing:20MHz

Applications
1.A whole city can provide Wi-Fi connectivity by deploying routers at specific rang to access the internet.
2.It seems unbelievable and even inapplicable in the beginning but now in European countries some of the cities are wholly Wi-Fi.
3.In India

Advantage

- Wi-Fi allows LANs to be deployed without cabling for client devices, typically reducing the costs of network deployment and expansion.
- Spaces where cables cannot be run, such as outdoor areas and historical buildings, can host wireless LANs ..
- Wi-Fi has become widespread in corporate infrastructures, which also helps with the deployment of RFID technology that can piggyback on Wi-Fi ..Wi-Fi is a global set of standards. Unlike mobile telephones, any standard Wi-Fi device will work anywhere in the world .
- WPA (WiFi protected access) is not easily cracked if strong passwords are used and WPA2 encryption has no known weaknesses

VI. LI-FI

Due to the increasing demand for wireless data communication, the available radio spectrum below 10 GHz (cm wave communication) has become insufficient. The wireless communication industry has responded to this challenge by considering the radio spectrum above 10 GHz (mm-wave communication)[9].However, the higher frequencies, *f*, mean that the path loss, *L*, increases according to the Friis free space equation($L \propto f2$). Specifically, LiFi could be classified as nm wave communication. LiFi uses light emitting diodes (LEDs) for high speed wireless communication, and speeds of over 3 Gb/s from a single micro-light emitting diode (LED) have been demonstrated using optimised direct current optical orthogonal frequency division multiplexing (DCO-OFDM) modulation Given that there is a widespread deployment of LED lighting in homes, offices and streetlights because of the energy-efficiency of LEDs, there is an added benefit for LiFi cellular deployment in that it can build on existing lighting infrastructures.[7]

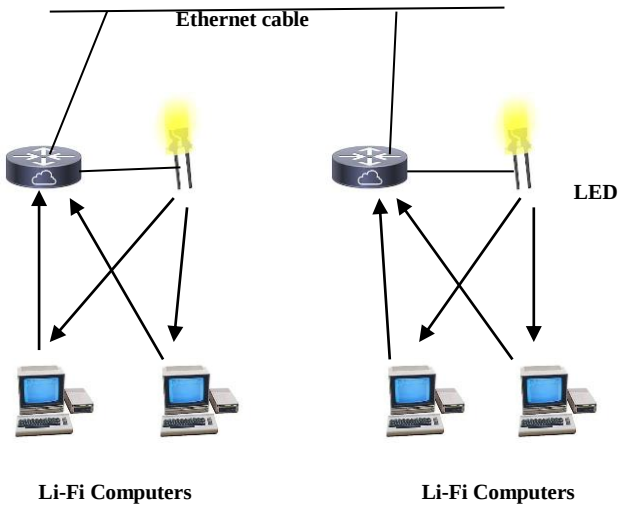

Figure6.Li-Fi

Specification
Data rates:1.25 Mbit/s to 96 Mbit/s.
Channel spacing:free space
Bandwidth:10mbps

Applications[8]
1.Smart lighting
2.Mobile connectivity
3.Hazardous environments
4.Vehicle & Transportation
5.Defence & Security
6.Hospitals & Healthcares
7.Wifi Spectrum Relief
8.Aviatio
9.Underwater Communications
10.Location Based Services

Advantage

1.Efficiency
2.Availability
3.Security

TABLE I: COMPARISON OF KEY FEATURES OF COMPLEMENTARY PROTOCOLS[2]

FEATURES	RF	BLUETOOTH	ZIGBEE	Wi-Fi	Li-Fi
Power Profile	Years	days	Years	Hours	Hours
Complexity	Simple	complex	Simple	Very complex	More complex
Nodes/Master	2.4GHz	7	6400	32	Billions
Latency	Enumeration upto 49 buttons	Enumeration upto seconds	Enumeration 30ms	Enumeration upto 3 seconds	Enumeration upto milliseconds
Range	3 kHz to 300 GHz	10m	70m-300m	100 m	More than 10 Gbps
Extendability	Yes	No	Yes	Roaming possible	No
Data Rate	22.5 Kbps	1Mbps	250 kbps	11mbps	10Gb

The table1 contains the key features of RF, Bluetooth, ZigBee, Wi-Fi and Li-Fi. The features are power profile, complexity, nodes/master, latency, range, extendability and data rate.

VII. CONCLUSION

ZigBee has a great deal to offer in industrial automation applications such as low cost deployment and redeployment, mesh networking to cover entire industrial plants and factories, an open standard with multiple vendors, battery operation. The different Zigbee products are designed as per to function and survive in industrial settings like high RF noise floor, temperature extremes, rough handling.

VIII. REFERENCES

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