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Survey on Monitoring Systems for High Voltage Transmission Line Based on IOT

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Abstract: *Electric transmission lines are generally exposed to the natural environment, such as thunder, rain, lightning, and high temperature, which leads to various types of failure and damage during the electric power transmission process. The Internet of Things (IOT) is considered as the third revolution in digital technology after the computer and the Internet, as it has been enabled by recent developments in wireless technologies, sensor technologies and embedded processors, aiming to provide advanced and effective monitoring and control services by using wireless technology and providing data acquisition in Real time. Predicting and preventing disasters that occur to lines, towers and transformers of electric power transmission is one of the most difficult problems facing electric power transmission companies. The advanced sensing and communication technologies used in the Internet of Things can effectively help prevent and mitigate the damage caused by natural disasters to the electrical network components, thereby enhancing the safety, efficiency and quality of the transmission of electrical power and minimizing economic losses. In this survey we present some previous work on designing monitoring systems for transmission lines, transformers and towers in substations based on Internet of Things technology, we intend to analyze thiese studies and its usefulness and reliability in the solution of problems at substations.*

Keyword: *Smart monitoring system; Transmission line; IOT; Automation system; Smart grid.*

1. INTRODUCTION

The Internet of things which is usually abbreviated by the term (IOT) is a term that has emerged recently, meaning the new generation of the Internet that allows communication and understanding between devices interconnected with each other as well as between different devices and physical objects [1]. Internet of things can be divided into three layers: perception layer, network layer, and application layer, as shown in Figure 1, perception layer is divided into two sub-layers: the first to perception the physical world and second to data acquisition [2].

The smart grid is a modern energy infrastructure that uses the Internet of Things to track and manage and create different smart communications in the electrical system, and is considered one of the most significant Internet of Things (IOT) applications [3], scientific research continues to develop the smart grid and provide it with advanced capabilities such as automation, monitoring and communications [4], [5]. Transmission line is a conductive wire, which is designed to transmit the largest possible amount of energy generated with high voltage from one station to another according to the difference of level voltage [6].

Designing a monitoring system for transmission lines based on IOT technology is an important and effective project to maintain high voltage transmission lines, that is considered one of the main equipment in electric power networks. The transmission lines safety is threatened by some factors, such as natural disasters (Frost, wind, hurricane, etc.,), or deliberate damage by humans such as (theft, destruction, etc.,), in addition, the sites of power transmission lines in general are far from cities and residential regions, it is difficult to monitor and preserve it [7]. For these reasons, the work to establish a monitoring system for transmission lines based on the Internet of Things (IOT) is very important to ensure that the monitoring data are sent in a real time to the monitoring center to take the necessary measures and avoid disasters and damages before they happen [7].

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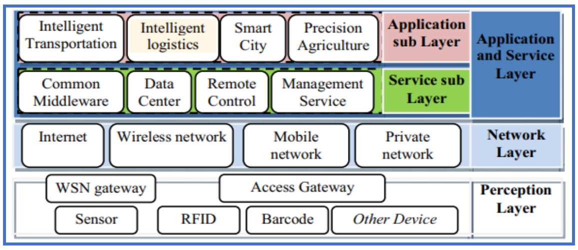

Figure 1 Architecture of Internet of Things [2]

2. LITRETURE VIEW

Qi Huang, and others proposed a monitoring system for the overhead transmission line by relying on optical fiber sensors and forming a network called (FBG) (Fiber Bragg Gratting) that can collect various information to determine the state of the transmission line, as the network consists of a group of optical fiber sensors. Figure 2 is the proposed architecture of the system, the system consists of optical fibers and a set of optical fiber sensors (voltage, temperature, acceleration), a light source that emits light in the fibers, a set of filters to determine the reflected light from different sensors, (OSA) (Optical Spectrum Analyzer) to detect the wavelength shift. By changing the wavelength, the change in temperature, voltage, and acceleration is determined.

The optical fiber sensor for voltage measurement is installed on the transmission line by means of a purpose designed structure, while the optical fiber temperature sensor is wrapped on the transmission line. The optical fiber sensor heads are connected together by single fiber with WDM (Wavelength Division Multiplexing) technology. Thus, the fiber optic sensors can form a network that can effectively transfer data to the control center [8].

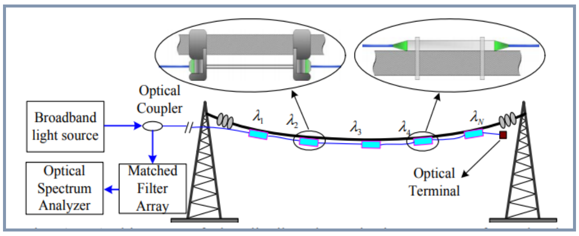

Figure 2 Architecture of monitoring system [8]

E. Cloet, J-L. Lilien, they proposed a system for monitoring the sagging of electric power transmission lines in real time, called this system (Ampacimon), as the sag in transmission lines is calculated by (vibration analyzes) without the need for data on the line's condition or data on environmental conditions. This system helps to enhance network security and prevent power outages. (Ampacimon) is an acronym for (Ampacity Monitoring), the sensor height is (40 cm) and its weight (8 kg), it is an intelligent sensor directly connected to the transmission line, which can determine the sag in the transmission line without the need for other data. This sensor analyzes the vibration of the conductor and detects the fundamental frequencies of a specified range, the largest sag that can be measured at the lower frequencies and vice versa. Similar in his work (pendulum clock). The data is processed by the (DSP) (Data Signal Processor) and then the data is sent via (GSM / GPRS) (Global System for Mobile Communications/ General Packet Radio Service) to a remote server where it is collated and analyzed to give the appropriate readings [9].

Xi Chen, Limin Sun, Hongsong Zhu, and others have proposed a direct online monitoring system using wireless sensors, tilt sensor, accurate meteorological sensor (temperature, humidity, wind speed, sunlight and precipitation). Wind and temperature sensors along the conductor to determine its temperature, each sensor transmits the state of the tower or transmission line to the nearby main node, where data from the information devices are combined, achieve real-time monitoring and send the information to the base station that depends on the basis of (mesh network) using multiple hops, the information is transferred to the monitoring center, the sensor deployment scheme of the power-lines and tower is shown in Figure 3 [10].

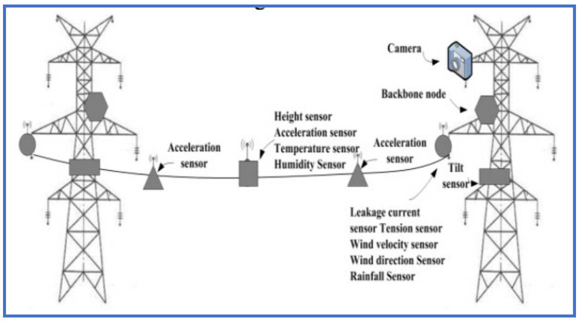

Figure 3 deployment the sensors [10]

Shiguang Nie, Guangyu Qu, and others proposed a system for monitoring ice thickness on electric power transmission lines, by performing a mechanical analysis of ice load on transmission lines and calculating ice thickness by specific calculation methods. The ice monitoring system is based on measuring some metrics such as temperature, humidity, wind speed and direction, as well as measuring the tension that occurs to the overhead transmission line as a result of ice. The proposed system consists of line monitoring station, main central station, expert system software. Transfer data between the line monitoring station and the base station using a (GSM / GPRS) (Global System for Mobile Communications/ General Packet Radio Service) network. The line monitoring station consists of tension sensors installed between the tower and the line insulation wires, inclination sensors, wind speed and direction sensors, temperature and humidity

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sensors, solar radiation sensor, this station derives its operating energy from solar energy, this station collects data and transmits it to the main station using a service (SMS) or (Packet radio) in (GPRS) network. The main station, after receiving data from the line monitoring station, analyzes the state of ice on the transmission line according to the (expert system) program, using the theory of calculating ice thickness, the system alerts the danger when the maximum line tension is exceeded to take appropriate action to prevent the occurrence of disasters, Figure 4 show the system architecture [11].

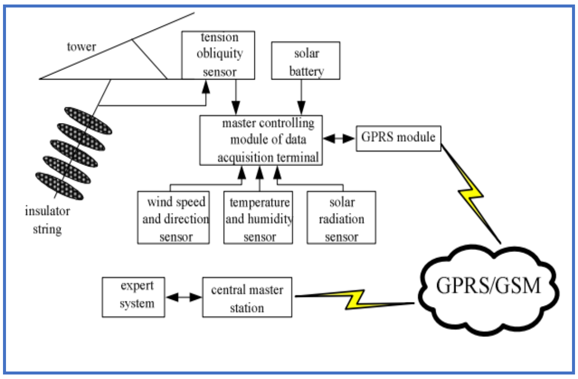

Figure 4 The structure of the system [11]

Zhihang Xue, Qi Huang, and others proposed a system for monitoring ice on electric power transmission lines based on the (FBG) sensor (Fiber Bragg Grating), reflecting the wavelength of the incident light, and the change between the wavelength of the incident light and the wavelength of the reflected light is proportional to the change in the sensor. The proposed monitoring system uses two FBG sensors, the first for measuring line stress, which is fixed by a pair of hooks on both ends of the sensor. The second is to measure the line temperature, which is coiled on the transmission line. Sensors are wrapped in covers to protect them from damage caused by snow and water. These covers contain holes for heat dissipation. At the end of the tower, an insulating chain of fibers is used to avoid electricity leakage. The thickness of ice on the electric power transmission line is calculated by a certain algorithm. All the data collected from the FBG sensor is transmitted to the control center using optical fibers [12].

Feng Ye, Yun Liang, and others have designed a monitoring network for transmission lines and towers by using (OPGW) (Optical Fiber Ground Wire) that are installed alongside transmission lines, the proposed monitoring network consists of hundreds of wireless sensors, Which is multi-hop is deployed over the transmission towers, the OPGW gateway is deployed every few miles and the data is delivered to the monitoring center by the nearest (OPGW gateway) [13].

Trupti Sudhakar Somkuwar, Mahesh G. Panjwani, proposed a system for monitoring and controlling the electric power transmission line using the (WSN) (Wireless Sensor Network). The system reports a failure in the transmission lines and sends data to the monitoring station, and then the monitoring station sends a short message (SMS) to the line operator about the location of the line in which the fault occurred. The system consists of (RF) (Radio Frequency) transmitter & receiver, it is a wireless frequency transmitter, through which a message of power failure is sent to the monitoring station, (Atmega 16) is a microcontroller used to integrate many devices and has the ability to interact with (google map API) to locate the fault and display it on the area map And then sending a text message to the line operator, Relays, that has states like Open (NO) and Close (NC) included with (microcontroller), (Com port), is a logical port to (Meduim.com) the original common name of the port interface on the (PC) (Personal Computer) or (Laptop) and the programming language will determine reading from or writing on (com port), (power supply) to supply power to the system, Figure 5 show the system architecture [14].

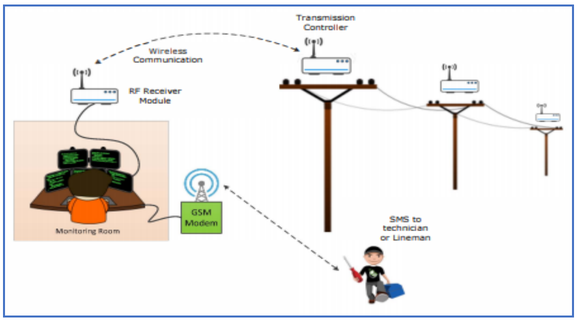

Figure 5 Architecture of the system [14]

Ashish P. Idhol, Anuja S. Nalkande, proposed a monitoring system for power transmission lines based on the smart grid using smart sensors based on wireless communication technology (Zigbee). The system measures voltage, current, temperature, as well as the consumed power, this system gives the ability to monitor transmission lines Remotely, which increases the life of the components of the smart grid, by ensuring the safety and security of electricity transmission operations, this system allows all measurements to be read together on the display in the control center. They use Zigbee communication technology because it is characterized by low energy consumption, coverage area (200 m), and the data rate that can be transferred (20 kbps - 250 kbps). The system consists of a microcontroller (PIC18F4520) (Programmable Integrated Circuit), wireless communication (Zigbee), voltage sensor, current sensor, temperature sensor, display, (relay), and (relay driver). PIC18F4520 converts the sensor readings into digital format and then

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It is displayed on the display screen, (Zigbee) at the transmitting end receives the sensed data and transmits it through its antenna to (Zigbee) at the receiving terminal and then to the computer at the control center. If one of the readings is higher than the normal value that is specified when programming the system, the network will be automatically switched to the off position by using (relay driver & relay) [15].

Hao Tan, Xingang Chen, and others proposed a system for monitoring equipment temperature in power substations. The system relies on a heat sensor (SAW) (Surface Acoustic Wave). This sensor obtains the temperature by measuring the velocity change in a SAW (surface acoustic wave). The (SAW) sensor consists of (Transponder) which is the main device in the sensor and it consists of a piezoelectric crystal and some thick metal strips, (IDT) (Intel Digital Transducer) which is a digital converter, (RF signal) (Radio Frequency signal) is sent by (IDT) through an antenna, a reader that acts as a computer that sends the measured temperature data to the Transponder, and receives the temperature data that is reflected by the RF signal. The (SAW) sensor receives a signal at a frequency of (0F) and generates another signal differently at (1F) and the difference between these two frequencies reflects the temperature. The device is designed to measure the difference between the frequencies of the incoming and outgoing signal and then calculate and output the temperature value. The system is based on the IEC61850 protocol (working to transfer data between devices) [16].

Ravikumar V. Jadhav, Sandip S. Lokhande, and others proposed a system for monitoring the metrics for power distribution transformers using the Internet of Things, and accessing the transformer data in real time. Each transformer in the substation is equipped with an actuator and sensor connected to a device in the monitoring network. The system monitors the primary and secondary voltage on both sides of the transformer, the primary and secondary current from the supply unit, the transformer temperature, the active power and the reactive power. Matlab Simulink is used to simulate a three-phase circuit, and data is stored in the database, and that data is captured in every part of the circuit and analyzed in real time by representing the data in the form of (graphs). These drawings help the operator in identifying information about the transformers and continuous monitoring of all measurements., Which makes the system more reliable [17].

Asha John, Richu Varghese, and others proposed an automation system for a power substation using built-in processors of Raspberry pi to automate a substation (11kv), the proposed system is characterized by a low cost. The substation used is depend on the (SCADA) (Supervisory Control and Data Acquisition) control software. The system consists of meters (for current, voltage, active power, reactive power and power factor). These readings are taken from the (RS485) port that connects to the Rasperry pi in series via (USB) (Universal Serial Bus). Digital and analog measurements can be controlled via (GPIO)(General Purpose Input/Output) pin located in (Rasperry pi), the system is programmed using (Codesys IEC611313-3) platform, (Codesys) can be accessed by wire or wireless [18].

Yu Tia, Zhenjiang Pang, and others proposed a substation monitoring system based on the Internet of Things, monitoring station equipment and operating environment in real time. The system consisted of three parts, the first part is (hardware), divided into (UHF) (Ultra High Frequency) temperature monitoring subsystem to monitor equipment, and substation environmental monitoring subsystem to monitor the operating environment using temperature, humidity, flood, gas and smoke sensors, and the wireless repeater, responsible for sending the sensor data to the communication protocol (IEC60870-101104 protocol), the second part is (network), the approved technology for communication In this system it is (Zigbee) technology, the third part is (software), the data is received via the communication protocol (IEC101 or IEC104) and the data is processed and sent to the monitoring substation [19].

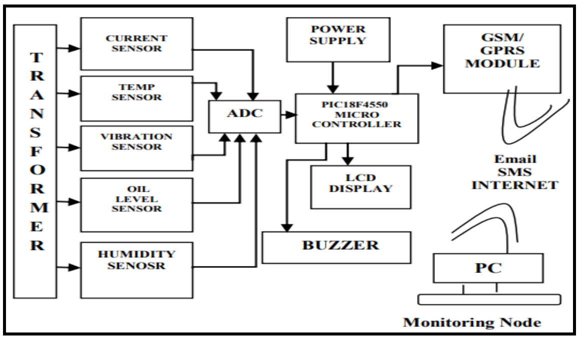

Figure 6 Block diagram of the system [20]

Rohit R. Pawar, Priyanka A. Wagh, and others, have designed a system for monitoring various gauges in power distribution transformers. The proposed system consists of two parts, Hardware, consisting of a (PIC18F4550) controller and various sensors, a current sensor, a temperature sensor, an oil level sensor, a vibration sensor, and a humidity sensor, which are considered as input devices to (RTU) (Remote Terminal Unit). Display all readings on the LCD (Liquid Crystal Display) as well as on the webpage., Software using SQL (Structured Query Language). All analog values obtained from the sensors are sent to the (ADC) (Analog to Digital |Convertor) for conversion into digital, then passed to the controller (PIC18F4550), the controller displays the values on the LCD screen and sends them to the web page that has the IP address. An emergency such as high cur-

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rent, heat, high or low oil level, (SMS) is sent to the engineers via the (GSM / GPRS) (Global System for Mobile Communications/ General Packet Radio Service) unit and a buzzer sound at the (RTU) side, Figure 6 block diagram of proposed system [20].

NA Hidayatullah, AC Kurniawan, and others have proposed a transmission line monitoring system based on (WSN) (Wireless Sensor Network) and (GPRS) (General Packet Radio Services) to be used in remote areas where 3G and 4G networks are not available, such as Indonesia. Figure 7 shown the architecture of the proposed system, is a mixture of (GPRS) and (Zigbee) being low in energy and cost, and has a connection range of (100-1000) meters, collecting data from the sensors to the main node using the (Zigbee) connection and then to the (Cloud) using the (GPRS) connection, the cloud Connected to the Internet and has a specific IP address to receive data and direct it to the monitoring center [21].

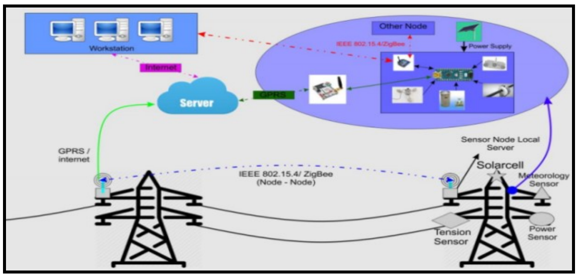

Figure 7 Architecture of the system [21]

Linxi Dong, Haonan Wang, and others proposed a monitoring system that monitors the state of the power transmission tower such as the angle of inclination, temperature, humidity and wind speed, the system relies on the accelerometer sensor that depends on the basis of (MEMS) (Micro-Electro-Mechanical-System) that uses (SHM) (Structural Health Monitoring) technology for monitoring the status of the transportation tower [22].

Jialong Qu, Sitthisak Kiratipongvoot, and others have implemented a practical application of a WPT (Wireless Power Transmission) system to collect and harvest power from high-voltage lines using a domino-resonator system to collect the energy. The collected energy is transferred to the transmission tower that works to monitor Network over the Internet through the use of a series of (PCB) (Printed Circuit Board) technology included in the insulation discs, which gives the ability to isolate between transmission lines and towers in addition to providing (WPT) (Wireless Power Transmission) that has the ability to operate monitoring devices via the Internet [23].

Fatima Alhebshi, Heba Alnabilsi, and others, have conducted several experiments to solve the problems facing power transmission lines and cause threats to human safety, by designing an Arduino connected with various sensors to monitor the transmission and control these problems, the first experiment, using a temperature and humidity sensor (DHT11) And a heating source (spark plug), by exposing the sensor to heat and monitoring it to see if the droop limits of the conductive wire are crossed or not, and if they are crossed, a notification will be sent to the user's mobile device through the Arduino board, then the user will control the cooling system using a fan in Simulation circuit to solve the problem of crossing the threshold limit for drooping the power transmission wire. The second experiment to solve another problem, which is that high voltages in electricity transmission lines generate a large electric field, this means that electricity can go out from the wire to anything near metal, and it may lead to a fatal electric shock, and to solve this problem they proposed a method through the Internet Of Things, using a motion sensor (PIR3-7m) and 5mm LEDs, the distance from power lines is supposed to be 7 meters. For the user to report the problem, then the user can control the LED that is connected to the tower or something close to it and the LED lighting to notify the object that has exceeded the limit (human) that it is in the danger area [24]. Figure 8 shown processing of technological failure in a tower of the transmission line.

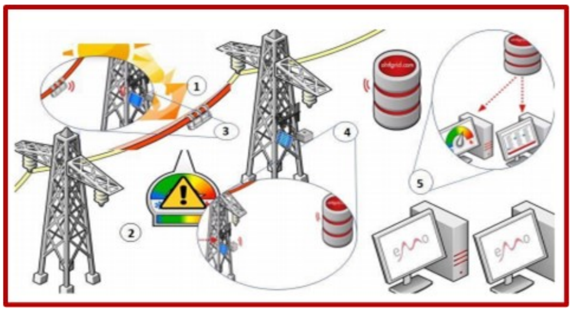

Figure 8 Processing of technological failure in a tower of the transmission line (1. Stretched wire due to heat, 2. notification of technical failure. 3. Sensor, temperature. 4. Receiver and Battery. 5. Center of monitoring) [24]

Shilong LI, Chengxi ZHANG, and others, proposed a system to monitor the oil level in the transducer tank, using the oil level sensor with IoT technology, the oil level sensor is installed in the glass oil tube, and the control unit is in the control room of the secondary station, at a height or Low oil level in transformer system sends alarm signals in real time to control center. Each oil tank in the transformer is equipped with an oil level sensor whose output is (4-20 mA), the current signal for each circuit is divided into two outputs (2 wires), the first output is converted the current signal into a voltage signal which is measured by (Microcontroller Unit) The second output is the current signal is converted to the actual oil level in the transformer and the MCU (Microcontroller Unit)

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XS128 works on comparing the measured value with the set alarm value, if the value is not within the limits of the set value, the MCU will activate the alarm device and display the value on the LCD (Liquid Crystal Display) screen and the measured value and the alarm value are sent to the control center of the secondary station. If the current in the circuit is (4milliamps), then it indicates the oil level (zero), but if the current reading in the circuit is (20 milliamps) it indicates the oil level (the maximum value) [25].

Hassan Jamal, M. Faisal Nadeem Khan, Ayesha Anjum, and others, have proposed a distribution transformer monitoring and protection system, based on the Internet of Things. The proposed system is divided into two units, a (RTU) (Remote Terminal Unit), and a control unit, (RTU) consists of a microcontroller (ESP8266-E12) (Wi-Fi), current sensor, temperature and humidity sensor (DHT22), which collects data continuously and sends it to the monitoring unit that uses the(Thingspeak) platform for real-time monitoring, analysis and control. The data is stored in (Thingspeak) in the form of graphs using MATLAB, the system displays the sensor readings on the LCD (Liquid Crystal Display) screen, and the proposed system sends an alert message to the specified e-mail as well as activating a buzzer to warn about an error, and operating fans for cooling when the threshold limit for the temperature has reached, As well as closing the transformer by relay when any error occurs, Figure 9 shown architecture of proposal system [26].

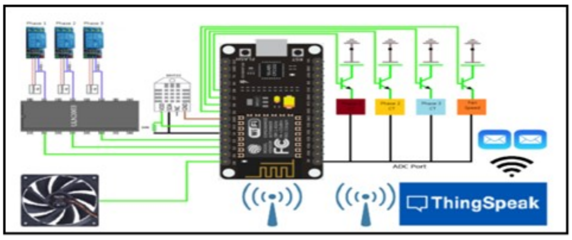

Figure 9 Architecture of the system [26]

Fangming Deng, Pengo Zuo, and others, proposed a transmission line monitoring system, integrating WSN (Wireless Sensor Network) and RFID (Radio Frequency Identification). The monitoring network was divided into four layers. The first layer is responsible for transmitting RFID sensor information to a RRZ node. Using a UHF RFID (Ultra High Frequency) connection between the RFID sensor and the RRZ node, the sensor data collected is transferred to the relay node on the tower using the Zigbee connection. The second layer is responsible for collecting the sensor node information inside the tower to the relay node, a Zigbee short distance communication is used between the sensor node and the relay node, the Zigbee long distance between the relay nodes is used. The third layer is responsible for transferring the relay node information to the substations or Base stations. Fourth layer is responsible for sending the information received by the substations and the station (4G) to the control center [27].

Dragan Mlakić, Srete Nikolovski, and others have designed a "smart meter" to measure voltages and current in low voltage networks, devices used, an Arduino UNO R3 controller, voltage sensors, current sensors, board (Arduino represents a network (Wi-Fi) to transfer data to a subnetwork. The (SCN) (Substation Communication Network) is based on (IEC 61850) protocol (works to transfer data between devices) [28].

Md.Sanwar Hossaina, and others, have designed a monitoring and control system for electrical power substation equipment. The proposed system provides sufficient information to determine the current quality and quantity of oil in the transformers, and when any alarming situation occurs, the operator is provided with a warning message with the corrective action to be taken. The system consists of (Ultrasonic sensor) in order to determine the oil level in the transformer. (Infrared sensor) to sense the quality of the transformer oil depending on the radiation emitted from the oil, the changes such as (color, temperature and humidity) are determined, Actuator, to carry out the tasks required by the operator from a remote location, the Servomotor, linked to the controller and rotates at a certain angle to change the position of the transformer faucet According to the controller command, ATmaga328-P, the controller used and communicates with the (Wi-Fi) unit in a series, ESP8266wifi, the (Wi-Fi) module is series linked with the controller and uses the MQTT (Message Queuing Telemetry Transport) protocol [29].

Tsui Shan Hsu, Huan Chieh Chiu, and others, monitored the sagging of power transmission lines using IoT technology using a (3-axis accelerometer), (MCU) (Microcontroller Unit), communication module, power supply module) with (IOT) technology. The purpose of this study is to develop a real-time monitoring system that continuously monitors sagging transmission lines using the Internet of Things and acceleration sensors to prevent recurring accidents. In this study they used a (161 kv) transmission line (xizhi-Minquan). The monitoring system checks by comparing the sag values measured by the sag sensor with the field measurements (IEEE std, 738-2012). The temperature is the most influential factor in calculating the sag value, so the value is calculated based on the equation of thermal equilibrium [30].

Michal Wydra, Pawel Kubaczynski, and others presented a study on the application of a vision system to monitor the sagging and temperature of overhead transmission lines using LoRa technology for communication and data transmission. The system consists of a surveillance camera, a small computer equipped with a communication unit (LoRa WAN)

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(Low Range Wide Area Network), the system monitors the line by capturing images through the camera and processing them using an image processing algorithm to evaluate the temperature of the transmission wires and send the results to the main node, and then by (GSM / LTE) (Global System for Mobile commuinication/Long –Term Evaluation), data is transferred to the operating system (SCADA) (Supervisory Control And Data Acquisition) [31].

O. Yaman and Y. Bicen, designed a transformer monitoring system based on the Internet of Things using low-cost components, using a microcontroller and a variety of sensors, and the sensor data is saved in the system as well as in the cloud system. The (Thingspeak) platform was used to program the system. Computers or phones are used to monitor data. The proposed monitoring system gives a warning when the measured values have exceeded the safe limit of the operating values. The system consists of an (ArduinoMega2580) microcontroller, (DS18B20) temperature sensor for the oil temperature sensor, (DHT11) sensor for measuring ambient temperature and humidity, a floating magnet level sensor to measure the oil level, (RC) (Resistor-Capacitor) filter is a simple filter that is added to the sensor output in order to provide accurate measurement values and not be affected by external conditions. (Wi-Fi ESP8266.07) unit was used for wireless transmission of sensor data to the cloud, and an (SD) (Secure Digital) card was also used with a unit (RTCDS3131) to store the incoming data from the transformer with date and time information. The data received from the sensors is easily transferred to the (Thingspeak) platform, and the measured values can be monitored via a (20 * 4) LCD screen, as well as red and yellow LEDs that are activated in early warning situations, as well as (Output Relay) is activated to perform the functions set by the operator according to the threshold values, (PushBox) is a free cloud that works with the Internet of Things that can send many real-time notifications to e-mail, this free platform works with the (Wi-Fi ESP8266.07) module, if the data of sensors are exceeded the threshold limit a notification is sent to computers or (Android) devices via the (API) (Application Programming Interface) address of the (Thingspeak account) [32].

Walid K A Hasan, Abobaker Alraddad, and others proposed a system for monitoring transformers and self-protection in case of maintenance delays. The temperature and humidity inside the transformer are monitored as well as the load amount on the transformers using the Internet of Things. The transformer will separate the loads of low importance (workshops, homes, etc) and keep the loads of higher importance (such as hospitals, etc), and if the transformer is unable to keep the important loads, all loads will be separated. The proposed system overcomes the problems of manual maintenance that takes place by placing a person in each substation, and this method is expensive and difficult to work with in addition to it may lead to human error during the measurements The system consists of current sensors, voltage sensors, oil sump temperature and humidity sensors in the transformer,Microcontroller (Arduino NodeMcu), sensor information can be accessed using the (Android) application via the e-mail of Thingspeak.com platform. MCU activates a buzzer for alarm and activate the lights (red, green) if the current load is higher than the transformer's capacity, separates some of loads by using the Relays according to a specific strategy, when overload occurs. Figure 10 shown circuit diagram of proposed system [33].

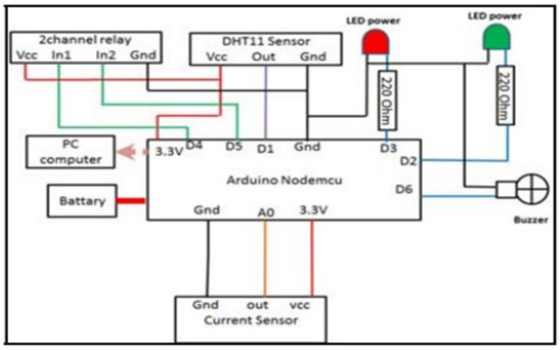

Figure 10 Circuit diagram of the system [33]

Xihai Zhang, Yan Zhao, and others proposed a system for monitoring the tilt of electric power transmission towers, based on (LPWAN) (Low Power Wide Area Network) technology and (NB-IOT) (Narrow Band - Internet Of Things) technology, this system was designed to solve the problem of height Energy consumption, long distance and high cost. All sub nodes include the tilt sensor (MPU6050) and (LORA Module) and the main node includes (NM-IOT). Information is collected from the tilt sensor and then by multiple hops through (LORA Module) it is uploaded to (Cloud Platform) through (NB) -IOT) And when the threshold limit for tilting the tower is exceeded, the Cloud Platform sends an alarm message to the administrators to (mail box) and (mobile terminal) and a short message is displayed on the (Cloud) interface [34].

Rashmi S, Shankariah, and others, proposed a conductor temperature monitoring system for power transmission lines. They used a temperature sensor (LM35), implemented the Internet of Things through the thingspeak platform, and a (WSN) (Wireless Sensor Network) was used to transfer temperature data from one node to another using the NS2 platform. The program for the system is written using (programmers notepad) using (Embedded C) and transferred to the (Atmega AVR) microcontroller [35].

David Kwabena Amesimenu, Kuo-Chi Chang, and others, have designed a system for monitoring the

TABLE I COMPARATIVE BETWEEN THE STUDIES

Reference	Type of Controller Used	How to connect to the Internet	Sensors Used
Qi Huang et. al., (2010)	(OSA) (Optical Spectrum Analyzer)	Optical fiber network	(voltage, temperature, acceleration) sensors
E. Cloet et. al., (2011)	(DSP) (Data Signal Processor)	(GSM / GPRS)	(Ampacimon) sensor
Xi Chen et. al., (2012)	Microcontroller the researcher did not mention its type	(Mesh network)	tilt sensor, accurate meteorological sensor (temperature, humidity, wind speed, sunlight and precipitation)
Shiguang Nie et. al., (2013)	(Expert system) program	(GPRS) network	(Tension, inclination, wind speed and direction, temperature, humidity, solar radiation) sensor
Zhihang Xue et. al., (2014)	Certain algorithm	Optical fibers	(FBG) sensor
Feng Ye et. al., (2015)	(OPGW) (Optical Fiber Ground Wire)	Optical fibers	hundreds of wireless sensors
Trupti Sudhakar Somkuwar et. al. , (2015)	Microcontroller (Atmega 16)	(WSN) (Wireless Sensor Network)	There is not
Ashish P. Idhol et. al., (2016)	Microcontroller (PIC18F4520)	(Zigbee)	(voltage, current, temperature, consumed power) sensors
Hao Tan et. al., (2016)	IEC61850 protocol	(Radio Frequency signal) is sent by (IDT)) (Intel Digital Transducer) through an antenna	Heat sensor (SAW) (Surface Acoustic Wave)
Ravikumar V. Jadhav et. al., (2017)	Matlab Simulink	(Zigbee)	(voltage, current, temperature, active power, reactive power) sensors
Asha John et. al., (2017)	Microcontroller (Raspberry pi)	(SCADA)	(current, voltage, active power, reactive power, power factor) sensors
Yu Tia et. al., (2018)	(IEC60870-101104) protocol	(Zigbee)	(temperature, humidity, flood, gas, smoke) sensors
Rohit R. Pawar et. al., (2018)	Microcontroller (PIC18F4550)	(GSM / GPRS)	(current, temperature, oil level, vibration, humidity) sensors
NA Hidayatullah et. al., (2018)	(WSN) (Wireless Sensor Network)	(Zigbee) & (GPRS)	(meteorological, tension, power) sensors
Linxi Dong et. al., (2018)	(GSM & GPRS) module	(WSN)	accelerometer sensor
Jialong Qu et. al., (2018)	(PCB) (Printed Circuit Board) technology	(WPT) (Wireless Power Transmission)	There is not
Fatima Alhebshi et. al., (2018)	Microcontroller Arduino	(Wi-Fi)	(DHT11, PIR3-7m) sensors
Shilong LI et. al., (2018)	Microcontroller XS128	(Wi-Fi)	Oil level sensor
Hassan Jamal et. al., (2019)	Microcontroller (ESP8266-E12)	(Wi-Fi)	(current, temperature and humidity DHT22) sensors
Fangming Deng et. al., (2019)	WSN (Wireless Sensor Network) and RFID (Radio Frequency Identification)	UHF RFID (Ultra High Frequency) & (Zigbee)	The researcher did not mention its type

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Dragan Mlakić et. al., (2019)	Microcontroller Arduino UNO R3	(Wi-Fi)	(voltage, current) sensors
Md.Sanwar Hossaina et. al., (2019)	Microcontroller ATmaga328-P	(Wi-Fi ESP8266) unit	(Ultrasonic, Infrared) sensors
Tsui Shan Hsu et. al., (2019)	Microcontroller the researcher did not mention its type	Wireless communication module	(3-axis accelerometer)
Michal Wydra et. al., (2019)	Image processing algorithm	LoRa technology & (GSM / LTE)	There is not
O. Yaman et. al., (2019)	Microcontroller (ArduinoMega2580)	(Wi-Fi ESP8266.07) unit	((DS18B20), (DHT11), a floating magnet level) sensors
Walid K A Hasan et. al., (2019)	Microcontroller (Arduino NodeMcu)	(Wi-Fi)	(Current, DHT11) sensors
Xihai Zhang et. al., (2020)	(LPWAN) (Low Power Wide Area Network) technology and (NB-IOT) (Narrow Band - Internet of Things) technology	(LORA Module)	tilt sensor (MPU6050)
Rashmi S et. al., (2020)	Microcontroller (ATMEGA AVR)	(WSN) (Wireless Sensor Network)	temperature sensor (LM35)
David Kwabena et. al., (2020)	Microcontroller (ATMEGA328P\)	(GSM) modem	Temperature sensor (LM35), and current sensor (ACS755XCB150)
Navaneetha K R et. al., (2020)	Microcontroller Arduino	(Wi-Fi)	There is not

status of distribution transformers using GSM (Global Service Mobile) technology, the system is designed to monitor transformer temperature, oil level and three-phase voltage, in case of an abnormal condition. Microcontroller sends a short message (SMS) containing the abnormal values to the mobile phone, and to the central database, and shutdown when the transformer's temperature is above the specified threshold. The system consists of an ATMEGA328P controller, (GSM) modem, power source, temperature sensor (LM35), current sensor (ACS755XCB150), the sensors are installed on the transformer and read the physical quantities of heat and current and convert them into output signals, the voltage regulator generates constant DC output from variable DC power, Transformer that reduces AC voltage from (240V - 12V), rectifier (RS205) whose function is to convert AC power into DC power for use, Figure 11 shown design of the proposed system [36].

Navaneetha Krishna R, Niranjan L, and others have designed a system for detecting the fault location in the transmission line based on the concept of Ohm's Law to detect the fault location as it is reliable, fast and cost effective. The system is characterized by the rapid detection of the fault location, which helps in protecting against accidents or damage to the equipment, as well as the detection of the exact location of the defect that helps maintenance workers to remove continuous faults and to identify areas where faults occur continuously, which reduces the occurrence of faults and reduces the time of power outages. An Arduino board was used, a typical transmission line resistance (500 Ω) for (1km) and a resistance (1kΩ) for (2km) were introduced. Manual error is entered for the purpose of display, (Arduino) works to determine the distance of the fault occurring with the help of developed software, and by using (Wi-Fi) (Wireless Fidelity), the information is transmitted to the control center and the location of the fault is displayed on the LCD screen [37].

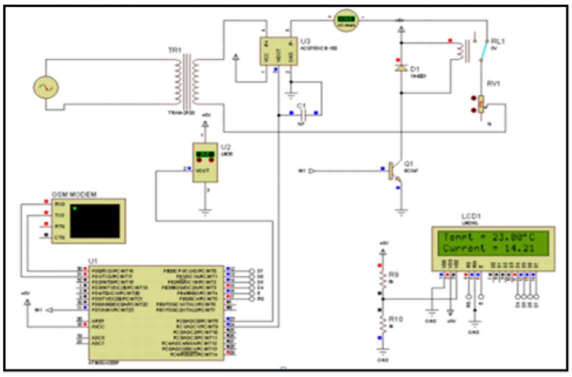

Figure 11 Architecture of the system [36]

Table 1 shows a comparative study of the survey in terms of controllers' type, sensors type, connect to internet, and control.

3. CONCLUSION AND SUGESSTIONS

By reviewing the previous studies in the designed a smart monitoring system for transmission line, it can be concluded that there is no standard method for designing the system, and all the mentioned methods differ in terms of the type of controller, and the type of sensors that used for simulation the practical circuit, and differ in methods of connect to internet. In these systems, some defects have been found in terms of the type of microcontroller used where certain controllers do not have built-in Wi-Fi and the large number of sensors used raises the cost of the designed system. In future, the mentioned systems can be enhanced by using the ESP32S microcontroller, which has a very high speed (16MHz) and huge memory (RAM 512KB) (Flash 16MB), in addition, (448KB of ROM), (520KB of SRAM), as well as has Wi-Fi and Bluetooth embedded in it, and using the PZEM-004T sensor which is distinguished by its ability to read many significant measurements in substations (voltage, current, power, frequency, power factor) together, these suggestions can reduced the cost and increase the efficiency and reliability of the monitoring system

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