DETECTION & MONITORING OF FIBER FAULT USING INTERNET OF THING (IOT) FOR FIBER TO THE HOME (FTTH)

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ABSTRACT*: *This project was done by using Arduino UNO for an intelligent fault detection system for optical fiber communication. The fault will be detected and the received power supply in optical fiber will be monitored while receiving voltage supply for Arduino UNO. This project was using Arduino UNO which consists of Atmega 328 microcontroller with the sensor unit to detect and monitor the voltage supply. The light sensor output is designed to monitor the received voltage supply of each line connection. The sensor unit consists of an LDR through an operational amplifier. Therefore, if there are any changes in voltage supply for the line connection, the fault message will be detected and displayed on the LCD interfaced with Arduino UNO and at the same the data and time of fault will be transferred to the IoT for the monitoring.

Index Terms: Arduino UNO, Fault Detection, Fault Monitoring, Optical Fiber, Sensor, Fiber To The Home, IoT Thingspeak

.INTRODUCTION

The principle of optical fiber communication is primarily based at the transportation of the electrical signal via an optical power fiber from one source to some other. The light is a shape of an electromagnetic carrier wave that is modulated to perform records. An optical fiber is usually deployed to transmit data. The optical fiber has sufficient benefits over a present copper wire in the long distance because of a great deal lower attenuation and interference. Fiber optic communication systems have commonly been set up over long-distance programs, due to their infrastructure improvement inside towns turned into surprisingly time and hard, and fiber-optic systems had been high price demand and complicated to put in and perform. Besides, fiber is an imperative part of cutting-edge day communication infrastructure and may be determined alongside roads, in homes, hospitals, and machinery.

The optic fiber is a strand of silica primarily based glass surrounded by using transparent cladding and its dimensions are just like the ones of human hair. Light can be transmitted along the fiber over excellent distances at very excessive record costs, supplying an impeccable medium for the delivery of data. Nowadays, optical fiber technology plays a key function in establishing up actual broadband get admission to the top consumer. Monitoring and identification in opposition to fiber faults are important for non-stop provider transport to clients. Consequently, any provider outage because of a fiber fault can be translated right into a super economic loss in a commercial enterprise for the service carriers [1]. The sensible fault-detecting device in an optical fiber detects the fault inside the fiber optic cable in the way of sensor usage. Some of the numerous parameters is to display the obtained output power of each fiber optic cable line. In order to improve the service reliability as well as increase the efficiency and monitoring capabilities in the FTTH-PON network, MATLAB-based Online Central Fault Monitoring System (CFDS) was proposed in [2].

In order to identify the fiber's fault branch, [3] the OLT detection module keeps tracking each ONU's upstream transmission. Consequently, once there is no REPORT message from specific ONU(s) for 2ms after it has been successfully discovered and registered, the detection module will generate alarms alternatively, if the bit error rate (BER) is above a certain threshold level, the OLT will generate the critical event, informing the Central Office (CO) of an irregularity. In addition, [4] investigated fault monitoring and fault identification mechanisms for a transparent optical network in which data travels optically from the source node to the destination node without any conversion from optical to electrical (O / E) or electrical to optical (E/O). Faults such as fiber cuts, laser, receiver, or router failures are detected and isolated by mechanisms and algorithms.

I. METHODOLOGY

The fault detection and monitoring system in an optical fiber are to identify the fiber fault of the line connection located between the splitter and the receiver. Among the various parameters that are going to monitor is the received power of fiber optic cable. However, there are also different parameters that can use for detection and monitoring the faulty in cable. The principle of fault detection which the sensor, converts the light signal into its equivalent voltage, and after receiving the voltage amplitude, it will be going into the Arduino UNO development board for further processing.

Arduino UNO had been selected as a processor that reacts as a microcontroller to control the instruction from the sensor and manage the fiber fault monitoring the IOT system. However, before proceeding with an experiment some instructions need to be constructed. The software that will be used to construct an instruction is Arduino. Then, when the instruction is ready it will be sent to Arduino UNO to store and process the data. The information on fault detection will be monitored as the output of the experiment.

Furthermore, the selection of the correct sensor needs to be considered in order to have a precision value and a good result. LDR will be selected due to budget funding and it is functionality compared to other sensors which are more expensive. Moreover, LDR is easy to find and easy to be replaced at any electronic shop. It is also easy to be installed compared to other sensors.

An op-amp is an IC that operated as a voltage amplification. The op-amp has many other applications such as measurement, signal input, and instrumentation. Moreover, the LCD display also is used to show the information of the fault messages that will be needed to monitor and send through the web server.

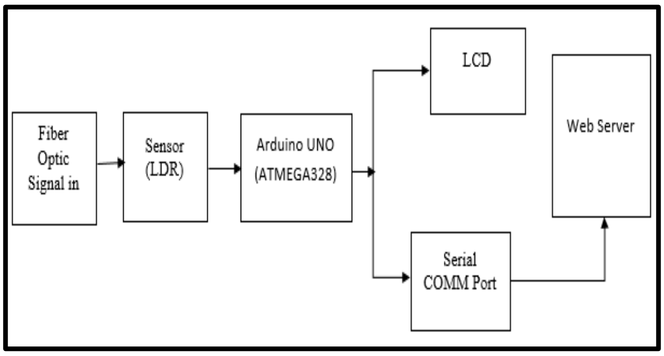

Figure 1 System Block Diagram.

Figure 1 shows the block diagram of hardware setup whereby the sensor, converts the light signal into its equivalent voltage and after amplification, it will go into the Arduino UNO development board for processing. After that, the Arduino will compare the voltage with a threshold voltage, if the output voltage from the LDR is found below the voltage threshold, it will communicate to the Web Server through the Serial COMM Port to indicate the fault signal. Moreover, every period of time Arduino will be getting the voltage from the sensor output, and the value will be displayed on the LCD.

Simulation Overview

Figure 2 shows the laser used to transmit the signal to fiber cable to generate from electrical source to an optical source. For the simulation design, each of the line have different distance which are Line1 = 0.5km, Line2 = 1.0km, Line3= 1.5km, and Line4 = 2.0km. The optical receiver will receive the power from the fiber cable for each line except for line 4 to be as opened connection.

Figure 3 shows the circuit simulation for detection and line monitoring for the FTTH with four receivers. The optical fiber between power splitter as a channel and optical receiver is required to get an analysis for the BER analyzer. The analysis that can be expected from this simulation which is optical power loss between transmitter and receiver, the sensitivity that can be used, and the receiver for observing the eye diagram by using BER analyzer. This simulation aimed to observe on the performance system and propose for the fiber length for each line.

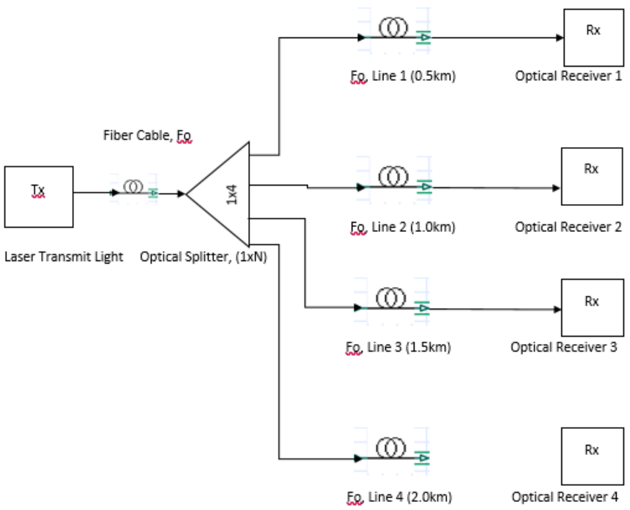

Figure 2. Block diagram for simulation optical test.

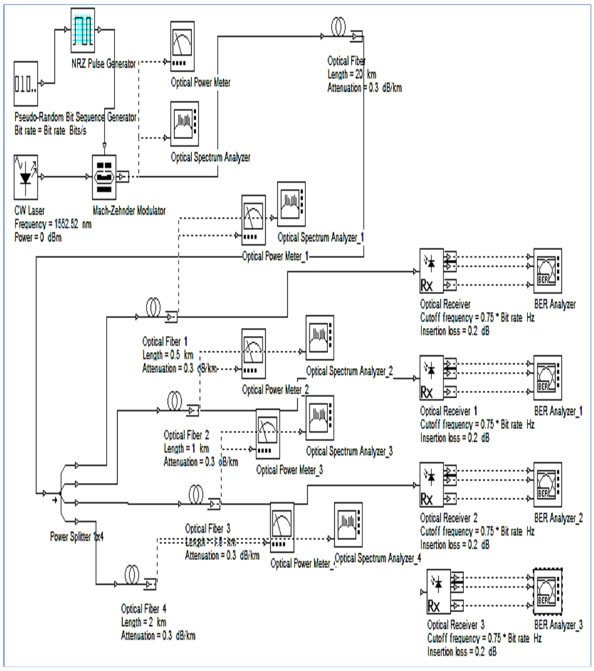

Figure 3: Circuit design Optisystem simulation.

Hardware Implementation

Hardware part is constructed in order to setup for detection and monitoring for fiber line. Figure 4 shows the connections from the transmitter whereby it conducts light source by using the torchlight or laser pointer as a transmitter source. As a voltage from the output light source is detected by LDR, the voltage supply will be more than 3V and it will indicate that the fiber line was in good connections while when there is no light source detected, and it will indicate the connection was in fault situations (No voltage detected). Figure 5 shows the flowchart for hardware implementation.

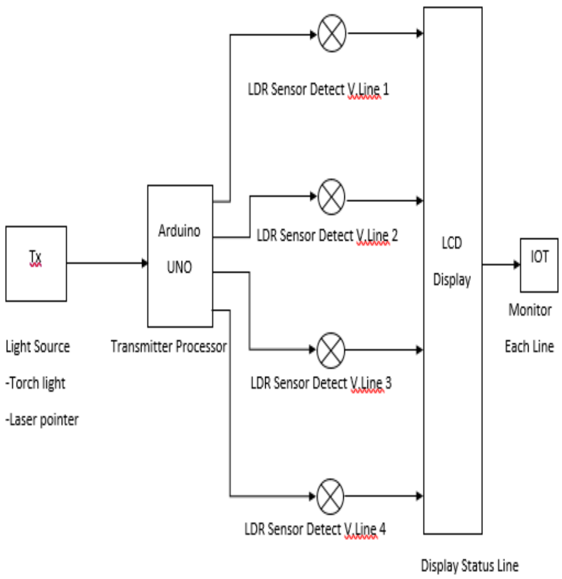

Figure 4. Block diagram for the hardware setup.

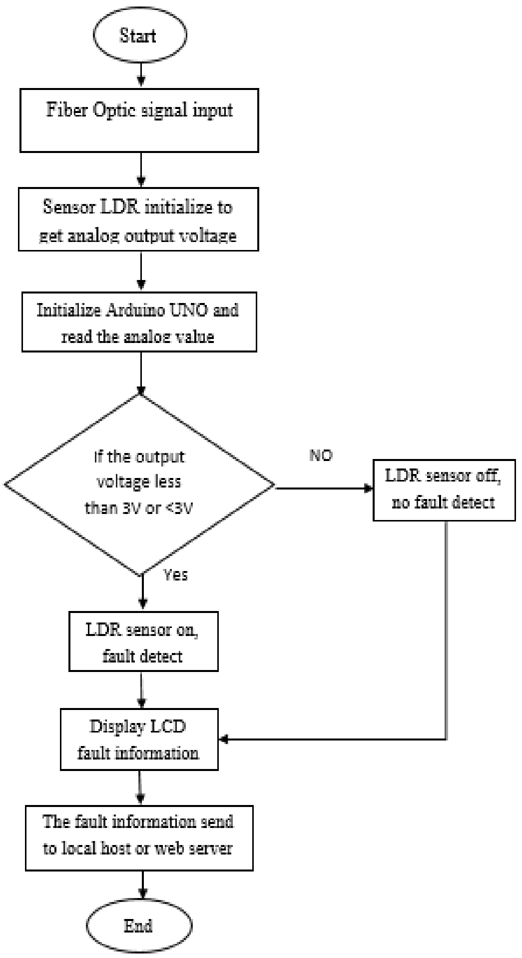

Figure 5: A Flow chart for hardware implementation

II. SIMULATIONS RESULT

Based on the simulation results, the output power loss in dBm is getting higher with the different distance that transmitting to the receiver. As the farther the distance between optical fiber cables to the home receiver, the higher the power loss generate in dBm. In addition, for the maximum factor of Q and the minimum value of BER. The longer the distance between the optical fiber cables and the home receiver is concerned, the higher the values achieved by the maximum Q factor. The distance between the optical fiber cables and the home receiver for the minimum BER, the lower the value for the minimum BER.

The longer the length of the optical fiber cables used, therefore, causes the higher the maximum value Q factor that causes the lower probability of bit errors. Thus, the further the higher distance errors will result such as noise, dispersion, and polarization or bandwidth that can affect the value of the transmitted signal. The simulation result shows the eye diagram for fiber line no. 1 as represented in Figure 6. The length of 0.5km is used in the simulation setup. Table 1 represents the overall readings of BER analyzer for 4 optical line protections.

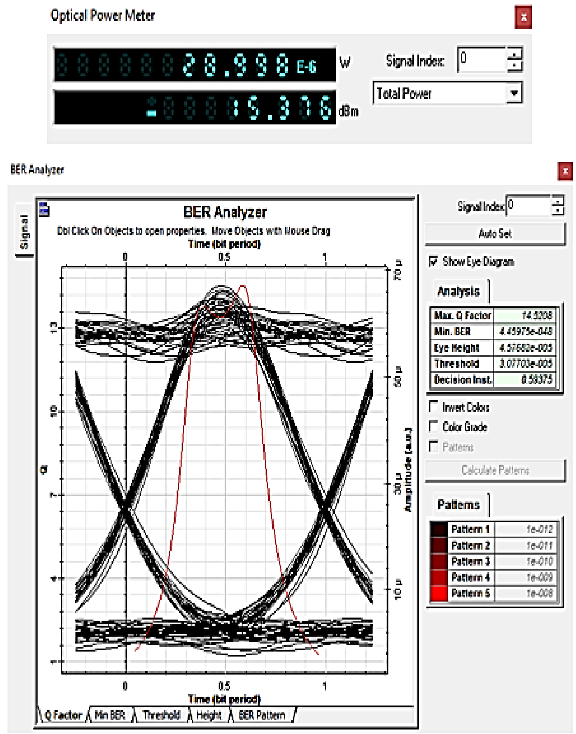

Figure 6: Example result simulation for line 1.

Table 1: Results data for each line simulation.

Line	Distance(km)	Power Loss(dBm)	Max. Q Factor	Min. BER
1	0.5	-15.376	14.5208	4.46E-48
2	1	-15.526	14.1073	1.70E-45
3	1.5	-15.676	14.3129	8.83E-47
4	2	Fault	Fault	Fault

III. HARDWARE RESULTS

The hardware results for each line was obtained by receiving the intensity of light to the sensor output of LDR. The higher the intensity of light will produce a higher voltage which means light as a source of the transmitter that apply to LDR to produce an amplification process along Arduino UNO. Besides, when there is no light transmitted to the sensor which LDR the intensity of light will drop and the voltage output also will drop. For the hardware, the voltage output for the amplification process through the LDR sensor is used by getting a formula which is $V_o=5V/(R_1+R_2)$ multiply the intensity of light. This formula needs to upload through Arduino UNO coding and run as it automatically will read the voltage output value from the light source that transmits along the LDR

Figure 6 shows the line monitoring through IOT for condition 3. Whenever the light is detected in the fiber line, the voltage will produce a higher voltage than the threshold value. Conditions for each line status is classified as shown in Table 2. During the experiment setup, every fiber line is monitored within 60 minutes. Figure 8, Figure 9, Figure 10, and Figure 11 show the monitoring of fiber line 1, fiber line 2, fiber line 3 and fiber line 4 where the monitoring is displayed through IOT applications respectively.

Figure 7: Line monitoring IOT for condition 3.

Table 2: Hardware results for all status conditions.

Condition	Status Line 1	Status Line 2	Status Line 3	Status Line 4
1	Good	Good	Good	Good
2	Fault	Fault	Fault	Fault
3	Good	Fault	Fault	Fault
4	Fault	Good	Fault	Fault
5	Fault	Fault	Good	Fault
6	Fault	Fault	Fault	Good
7	Good	Good	Fault	Fault
8	Good	Fault	Good	Fault
9	Good	Fault	Fault	Good
10	Fault	Good	Good	Fault
11	Fault	Good	Fault	Good
12	Fault	Fault	Good	Good
13	Good	Good	Good	Fault
14	Good	Fault	Good	Good
15	Good	Good	Fault	Good
16	Fault	Good	Good	Good

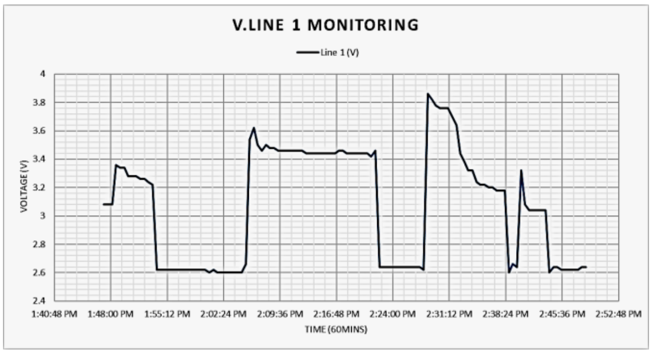

Figure 8: Voltage line 1 monitoring for 60minutes.

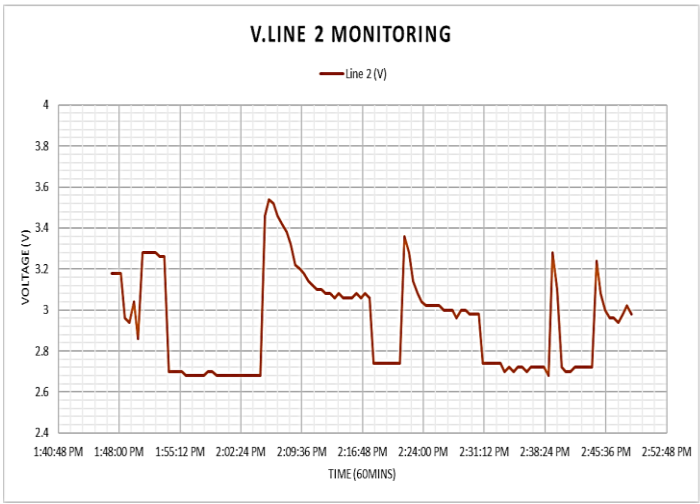

Figure 9. Voltage line 2 monitoring for 60minutes.

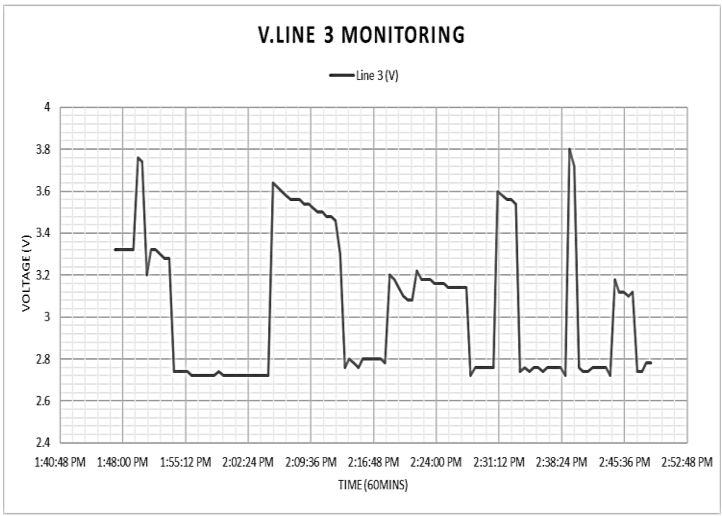

Figure 10. Voltage line 3 monitoring for 60minutes.

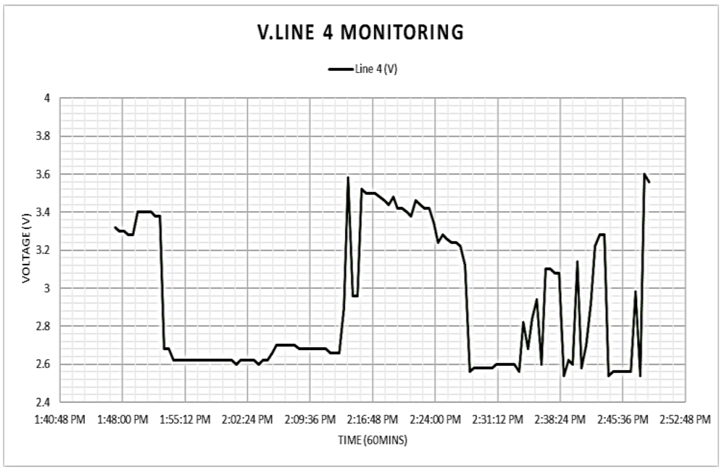

Figure 11. Voltage line 4 monitoring for 60minutes.

Furthermore, there are 16 conditions of fiber line status that can be applied to get possible line status in order to detect faulty of line voltage status. Each line voltage status will be sent to IOT for monitoring purposes. As the voltage output value is more than 3V it indicates as in good condition while the voltage output below 3V indicates a connection fault. The monitoring through Thingspeak open source also indicates the time taken when the connection status has been transmitted via the esp8266 wifi module. Moreover, more than 120 readings of voltage output have been transmitted to IoT and can be monitored every 30 seconds of every line voltage status. The voltage reading observed from the IoT shows an increment and decrement of voltage line taken in 16 conditions that possibly controlled for each line status. The highest peak of voltage indicates the light intensity is very high during that time due to the light is directed through the LDR sensor.

4. CONCLUSIONS

An intelligent fault detection system using Arduino and monitoring through the thingspeak IoT platform in optical fiber is implemented in this paper. The principle of the fault monitoring module is thoroughly explored here. Arduino programming language (C++) is used to obtain the output and also to display the same on the LCD. At the same time IOT platform by using Thingspeak is implemented to monitor line fiber status. This project successfully presented that if there is any fiber disconnect in the FTTH system, which is detected by the voltage drop in a line, then, the time & date of the specific fiber line will be observed through this monitoring system. The measured voltage of LDR sensor will be detected and if the voltage exceeds the threshold value then it will give the failure notification to the system. Other than detecting, the system was able to monitor the voltage line status through IoT medium.

5. Acknowledgement

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