DESIGN AND DEVELOPMENT OF A FIBER BREAK MONITORING SYSTEM IN OPTICAL FIBER COMMUNICATIONS

By

AHMAD ASHRIF BIN A BAKAR

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirement for the Degree of Master of Science

October 2004

DEDICATION

In the name of Allah, Most Gracious and Most Merciful

For the sake of Islam

Abstract of the thesis presented to the Senate of University Putra Malaysia in fulfilment of the requirement for the degree of Master of Science

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Chairman: Associate Professor Mohamad Khazani Abdullah, Ph.D.

Faculty: Engineering

Fiber optic cable has been used widely in network communications system. It has being a favorable choice since it offers many advantages, such as immunity to electrical interference, lightening, high bandwidth and security. Due to the massive deployment of optical fiber cable, networks based on this medium needs significantly good monitoring and protection scheme to ensure its availability, especially for critical networks. Current approach uses a system known as Remote Fiber Testing System (RFTS) or Remote Fiber Monitoring System (RFMS). RFMS allows an operator to remotely monitor the condition of a fiber cable by using Optical Time Domain Reflectometer (OTDR). The requirements to place OTDR permanently for continuous monitoring force the line owners to place a high investment to the system. Moreover, placing OTDR is overkill since most of the faults in the fiber optic cable are due to the fiber break.

This thesis presents a new approach of monitoring and detecting fiber break by using a simpler device, significantly less expensive yet gives an appropriate measurement to the distance break in place of the OTDR–based RFMS. The design and development of the system, namely Fiber Break Monitoring System (FBMS) will continuously monitor the optical signals in the live fiber cable. The device automatically measures the distance when it detects the break. The distance is measured by analyzing the propagation time of the Fresnel reflection, occurred at the end of the surface break to be detected by the detector module inside FBMS.

The study is carried out in both simulation and experiment. The typical performances for analyzing the performance of FBMS are the length resolution, event deadzone, sampling resolution, accuracy, dynamic range and pulsewidth. Those performances were compared to the typical OTDR. This study has proved that FBMS is practicable for a real time monitoring, detecting a fiber break and giving an acceptable result to the distance measured.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

REKA BENTUK DAN PEMBINAAN SISTEM PENGAWASAN GENTIAN OPTIK PUTUS BAGI KOMUNIKASI GENTIAN OPTIK

Oleh

AHMAD ASHRIF BIN A BAKAR

Oktober 2004

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Kabel gentian optik telah digunakan secara meluas di dalam sistem komunikasi rangkaian. Dewasaini, kabel jenis ini menjadi pilihan utama. Ini adalah kerana, gentian optik menyediakan lebih banyak kelebihan berbanding jenis kabel yang lain antaranya, kebal terhadap ganguan medan elektrik, kilat, punyai jalurlebar yang amat luas serta ciri keselamatan. Disebabkan penggunaan kabel gentian optik yang semakin pesat, rangkaian berasaskan gentian ini memerlukan suatu skema pengawasan serta pemantauan yang baik bagi memastikan kelancaran penggunaannya, terutama pada rangkaian yang kritikal. Pendekatan yang diambil buat masa ini adalah dengan menggunakan suatu sistem yang dikenali sebagai Remote Fiber Testing System (RFTS) atau Remote Fiber Monitoring System (RFMS). RFMS membenarkan pengoperasi mengawal keadaan kabel gentian optik ini secara jauh dengan menggunakan Optical Time Domain Reflectometer (OTDR). Keperluan bagi meletakkan OTDR secara tetap di dalam sistem bagi memantau kabel

secara langsung memaksa pemilik jalur menyediakan pelaburan yang amat tinggi. Tambahan pula, meletakkan OTDR secara tetap pada sistem komunikasi rangkaian adalah amat tidak munasabah disebabkan kebanyakan daripada kerosakan yang berlaku di dalam kabel gentian optik adalah hanyalah disebabkan kabel gentian yang patah yang mana tidak memerlukan bagi alat yang terlalu sofistikated.

Tesis ini membentangkan suatu pendekatan baru bagi memantau dan mengesan gentian yang patah dengan menggunakan suatu peranti yang mudah, murah dan memberikan bacaan yang memuaskan bagi pengiraan lokasi gentian yang patah untuk menggantikan sistem RFMS yang berasaskan OTDR. Reka bentuk dan pembinaan system yang dinamakan Fiber Break Monitoring System (FBMS) ini akan memantau isyarat cahaya secara langsung di dalam kabel gentian yang sedang digunapakai. Peranti ini akan membuat pengiraan secara terus apabila berjaya mengesan patah. Lokasi patah dikira dengan menganalisa masa yang diambil oleh pantulan Fresnel untuk kembali ke modul pengesan di dalam FBMS yang mana pantulan Fresnel ini berlaku di permukaan gentian yang patah.

Kajian di dalam tesis ini dijalankan dengan menggunakan kaedah simulasi dan eksperimen. Jenis-jenis prestasi yang dikaji untuk kualiti FBMS adalah resolusi jarak, ketepatan, resolusi sample, jarak dinamik dan lebardenyutan. Kesemua prestasi ini dibandingkan dengan kualiti OTDR yang biasa. Kajian ini membuktikan bahawa FBMS ini amat praktikal bagi pemantauan gentian optik secara langsung, mengesan kabel yang patah serta memberikan pengiraan lokasi yang memuaskan.

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I certify that an Examination Committee met on…..…….2004 to conduct the final examination of Ahmad Ashrif bin A Bakar on his Master of Science thesis entitled "Design and Development of Fiber Break Monitoring System (FBMS) in Optical Fiber Communications" in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

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DECLARATION

I hereby declare that the thesis is based on my original work except for the quotations and citations, which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.

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