Emerging disciplines - biomedical engineering

Changes of pressure, tension, shear stress, expansion, compression, velocity in the propagation medium… Discussion of an optical fibre? No! The answer is: arteries and the effect of ultrasound waves. The combination of elecrical engineering and medicine began moving beyond just the design of medical equipment to actual treatment, in this case using optical telecommunications-based techniques to treat strokes.

THE FIRST TRANSATLANTIC telephone cable (TAT-1) caused waves of its own. We look back fondly at a particularly well attended Milestone ceremony on a beautiful fall day in Newfoundland.

TERRY MALKINSON HAS BEEN with the *IEEE Canadian Review* since 1998. His "View from the West" column has been a staple since the fall of 2006, along with his insightful summaries in "Engineering Management."

"The field of health care relies increasingly on technology, with biomedical and electrical engineers leading the way"

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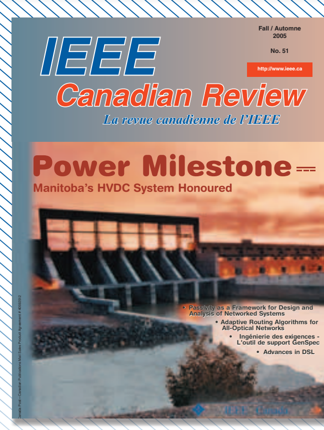

An optical-telecommunications-based technique to disrupt stroke using the artery as an acoustic Biological fiber

by Zoubeir Hajri[1], Habib Hamam[2], Mounir Boukadoum[3] and Réjean Fontaine[1]

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Abstract

Because the number of applications for therapeutic and diagnostic medical ultrasonound systems continue to increase, there is a need to improve the efficiency of these acoustic techniques. In this frame, this paper reports on a new mildly invasive therapeutic method to disrupt stroke. The proposed method is based on the propagation of ultrasound waves inside a carotid artery, which is viewed as an optical fiber. The challenge, then, is to determine the feasability and the efficiency of such technique. The preliminary results of this study are presented. At 1 MHz ultrasound frequency, the penetration depth is about 21.7 cm, which is sufficient to reach and dissolve cerebral clots by transmitting an incident wave relatively far from thrombosis location. To reach this penetration depth, a saturation acoustic pressure of 1.5 MPa must be not exceeded. A temperature rise rate of about 0.46 °C/s for an intensity of 100 W cm^{-2} is observed. Pulsed waves are used to enhance cavitation, which is considered as the most likely and dominant mechanism for blood clots disruption. The project is embedded in the framework of a collaboration project involving three Canadian universities namely, Université de Sherbrooke, Université de Québec à Montréal and Université de Moncton.

Sommaire

Puisque l'utilisation des ultrasons pour des applications thérapeutiques et diagnostiques continue à augmenter, il y a un besoin d'améliorer l'efficacité de ces techniques acoustiques. Dans ce cadre, cet article traite une nouvelle méthode thérapeutique modérément invasive pour le traitement des maladies thrombotiques cérébrales. La méthode proposée est basée sur la propagation des ondes ultrasonores dans l'artère carotide, qui est regardée comme étant une fibre optique. Le défi, alors, est de déterminer la faisabilité et l'efficacité d'une telle technique. Les résultats préliminaires de cette étude sont présentés. À une fréquence d'ultrasons de 1MHz, la profondeur de pénétration est environ 21.7 cm, qui est suffisant pour atteindre et dissoudre les caillots cérébraux en transmettant une onde incidente relativement loin de la thrombose. Pour atteindre cette profondeur de pénétration, une pression acoustique de saturation de 1.5 MPa ne doit pas être excédée. On observe un taux d'élévation de la température d'environ 0.46 °C/s pour une intensité de 100 W cm^{-2}. Des ondes pulsées sont employées pour favoriser la cavitation, qui est considérée comme le mécanisme le plus susceptible et dominant pour la destruction des caillots de sang. Le projet entre dans le cadre d'un projet de collaboration entre trois universités canadiennes notamment, l'université de Sherbrooke, l'université de Québec à Montréal et l'université de Moncton.

1.0 Introduction

Thrombosis is the presence of a coagulated blood clot inside a blood vessel causing a deceleration of the blood flow (Figure 1). When the clot is located in the brain, it may cause a stroke, also called a brain attack (Figure 2). It is well known that this cardiovascular disease represents an important cause of death in the world. The main treatment of stroke is medicines and drug therapy which will thin the blood and make it flow more easily. Furthermore, surgery can be employed to treat acute stroke or to repair vascular damage in the brain [1]. Meanwhile, therapeutic methods based on the application of ultrasound waves have also been used to disrupt strokes in vivo and in vitro. However, there is currently an additional interest in this problem due to progress in bioacoustics.

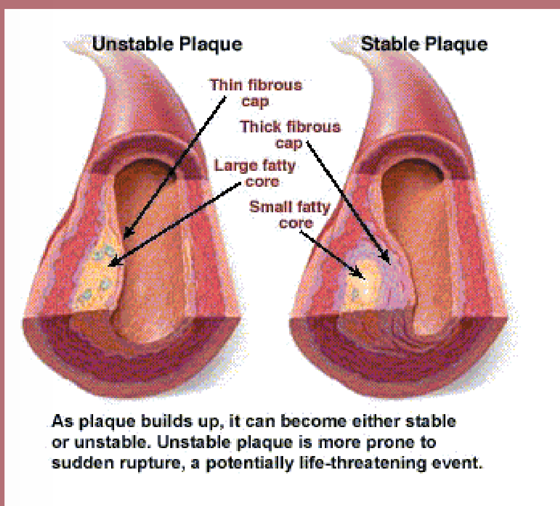


Figure 1: Plaque blocking the artery

It is well known that the ultrasound is widely used in medical diagnosis and therapy. On the one hand, the ultrasound energy is a non ionizing radiation, which does not impose hazards such as chromosome breakage and cancer development. On the other hand, it has several physiological effects based on the increase of inflammatory response, on the repair of the damaged tissues and on the heating of soft tissues.

A number of medical applications such as the ultrasound therapy of the occlusion of blood vessels were proposed. The methods based on the application of ultrasound waves use either an ultrasonic energy guided by a catheter [2], or an ultrasound radiation [3]. The first method has been used to dissolve clots in vitro, in animal models and in patients [2], whereas the second method has been reported in vitro and in animal models [3].

Both techniques have engineering problems. Most of the technical disadvantages of a catheter system are due to its poor efficiency as a RF/W radiation source. Consequently, the power loss in the coaxial cable and its subsequent heating during power delivery lead to a breakdown in the dielectric and the catheter material. In addition, there is the difficulty of designing a unidirectional antenna that can radiate energy into the diseased and not the surrounding healthy tissues. These limitations are unacceptable when a catheter system is used to treat life-threatening venous disorders, stable and unstable plaque, arteriosclerosis, or deep-seated tumor. The technical problems related to the radiated waves take on a different form and concern both diagnostic and therapeutic aspects related to physics and to the engineering of hyperthermia. With this technique, the incident wave undergoes multiple scattering inside the patient's body and, because the evanescent waves are difficult to mea-

To view this article in its entirety please visit www.ieee.ca/canrev/cr49/cr49.pdf

IEEE Milestone: 40th Anniversary of TAT-1

First transatlantic telephone cable system

by Jeremiah F. Hayes
Concordia University

On Sunday, September 24 an IEEE Milestone commemorating the first transatlantic cable was dedicated at the site of a former cable station of the system in Clarenville, Newfoundland. There are approximately 60 of these milestone sites in the world honouring significant achievements in the history of electrical and computer engineering, of Six Milestones are in Canada. In recognition of its pivotal role in the development of worldwide communications, half of the Canadian sites are in Newfoundland. The first successful transatlantic telegraph cable, in 1866, is commemorated by a Milestone at Heart's Content. There is a Milestone at Signal Hill in St. John's honouring the reception of the first wireless signal across the Atlantic by Marconi in 1901. The latest Milestone recognises Clarenville as the eastern terminal of the first transatlantic telephone cable, TAT-1 which entered service on September 26, 1956.

The TAT-1 inaugurated the modern era of global communications. Before TAT-1, voice was carried on unreliable radio channels and text messaging was carried on submarine telegraph cables (the technology of the previous 90 years), which was reliable, but slow and expensive. TAT-1 operated with exemplary reliability until 1978, when advances in technology made it obsolete. An article giving details of TAT-1, as well a history of submarine telegraph and telephone cable can be found in the spring 2006 edition of the IEEE Canadian Review.

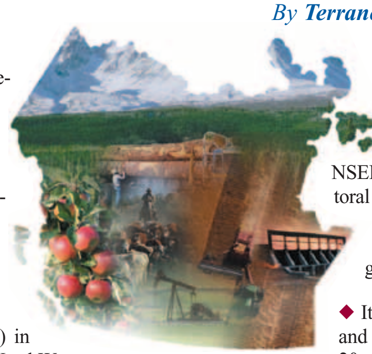
The dedication ceremony, blessed with fine weather, drew about 100 spectators. The roster of speakers began with greetings and best wishes for the political leaders of the community: Mayor Fred Best of Clarenville, Ross Wiseman, MHA, Trinity North and Bill Matthews, MP, Random-Burin-St.George. Dr. Camilla O'Shea from the Clarenville Heritage Society eloquently explained the role of Clarenville in the transatlantic project. The Heritage Society and the town of Clarenville were instrumental in establishing the Milestone. The role of the people of Newfoundland in telecommunications was celebrated by Dr. Wallace Read, a resident of Cornerbrook and the former president of the IEEE. Dr Ferial El-Hawary, President Elect of Region 7 conveyed the best wishes of IEEE Canada. Dr. Jerry Hayes, a former worker on TAT-1, called for a moment of silence remembering the men and women who worked for global telecommunications. The plaque was unveiled by Lloyd Currie and Kathleen Chafe. Ms. Chafe, Chair of the Newfoundland-Labrador Section, did wonderful work as chair of the committee that arranged the ceremony. Gerard Dunphy, IEEE Canada External Relations Groups Chair and a past Chair of the Newfoundland-Labrador Section, was the Master of ceremonies.

A proud and happy moment at the dedication of the TAT-1 IEEE Milestone plaque, September 24, 2006

From left to right: Gerard Dunphy, IEEE Canada External Relations Groups Chair; Dr. Wally Read, IEEE Canada Past President; Kathleen Chafe, Chair of Newfoundland-Labrador Section, IEEE Canada; Dr. Camilla O'Shea, Clarenville Heritage Society; Ferial El-Hawary, President-Elect of IEEE Canada; Ross Wiseman, MHA - Trinity North; Bill Mathews, MP - Random-Burin-St. George; Dr. Jerry Hayes, IEEE Life Fellow, author/historian; His Worship Fred Best, Mayor of Clarenville. *Photo courtesy of Kirk Squires.*

A View from the West

By ***Terrance Malkinson*** *University of Calgary Senate Member*



- The Alberta Energy and Utilities Board (EUB) predicts continued massive growth in the oilsands sector, where more than $100B worth of projects is scheduled for construction in the next decade. Oilsands production is expected to triple in the next 10 years to three million barrels a day. Concerns however have been expressed on the need to improve the infrastructure necessary to support the development, improve transportation to the area, and ecological issues associated with oilsands development.

- More than 500 people met in Edmonton (Alberta) in July at the 16th annual summit of the Pacific NorthWest Economic Region to examine energy workforce issues. http://pnwer.org/meetings/Summer2006/ 06%20Summit.htm. At least $US 100B in energy projects are projected over the next ten years to meet the unprecedented growth in the regions energy sector to accommodate rises in power demand. The projects will require a huge workforce. Indeed a looming labour shortfall in many business sectors is of concern to industry leaders.

- Enmax Energy Corporation and its partners have been chosen by BC Hydro to develop four "green" energy generation projects that will come on-steam over the next three years. Two of the projects are run-of-river hydro plants of 10 megawatts each and the remaining two projects will generate clean electricity using waste heat recovered from gas compressor stations.

- WestLink Innovation Network Ltd (http://www.westlink.ca/) is a university-based network for coordinating activities, bundling technologies and sharing information between its members. One of the strategies offered by WestLink is its technology commercialization internship program (TCIP) that specializes in developing Canada's future technology commercialization leaders. They help develop people who know technology but who also know management and have entrepreneurial skills.

- Industry Canada's office of consumer affairs in Ottawa recently released a 90-page guide which offers step-by-step information on how to adopt Corporate Social Responsibility (CSR). "Corporate Social Responsibility: An Implementation Guide for Canadian Business"(http://strategis.ic.gc.ca/epic/internet/incsr-rse.nsf/ en/Home). CSR is generally understood to be the way an organization achieves a balance or integration of economic, environmental, and social imperatives while addressing shareholder and stakeholder expectations. Corporate social responsibility is a concept that is increasingly being incorporated into good business practice within Canada and globally.

- The Natural Sciences and Engineering Research Council of Canada (www.nserc.gc.ca) recently announced 475 new grants worth $56.7M and 922 scholarships worth $15.9M in the prairie provinces. NSERC supports over 22,000 university students and postdoctoral fellows in their studies. NSERC awards are building a world-class research environment throughout Canada creating the skilled workforce needed to sustain economic growth and job creation.

- It is hoped that the softwood lumber deal between Canada and the US will help revitalize the forestry industry which for 20 years has struggled through closures, downsizing, globalization, and many other pressures. Softwood lumber is one of Canada's largest exports to the United States, with 21.5 billion board feet of lumber shipped in 2005 alone. Those exports were worth $8.5B. This trade matters to both Canadians and Americans. Canada's forestry sector employs approximately 280,000 Canadians, and roughly 300 communities are dependent upon the forestry sector. US lumber producers cannot meet domestic demand for softwood lumber. Canada now supplies over a third of the United States' consumption of this product.

- Alberta-based SemBioSys Genetics Inc. (www.sembiosys.com) a biotechnology company focused on the development, commercialization, and production of biopharmaceuticals and non-pharmaceutical products based on its proprietary technologies recently received is 20th US patent. SemBioSys' management and scientific team members are active contributors to the plant-made pharmaceutical scientific community and have been at the forefront of developing regulations for the production of pharmaceutical producing plants, working with the USDA, the FDA and the Canadian Food Inspection Agency (CFIA).

About the Author

Terrance Malkinson is a proposal manager/documentation specialist, an elected Senator of the University of Calgary, a Governor of the Engineering Management Society, international correspondent for IEEE-USA Today's Engineer Online, editor-in-chief of IEEE-USA Today's Engineer Digest, and editor of IEEE Engineering Management. The author is grateful to the Haskayne School of Business Library at the University of Calgary. He can be reached at malkinst@telus.net.

IEEE Canada representatives at the 735 kV Milestone

From left to right: Ron Potts, Vijay Sood, Gilles Baril, Amir Aghdam, Ray Findlay, Dominic Rivard, André Dupont (one of the HQ pioneers who worked on the project), Bill Kennedy, Paul Fortier, André Morin and Xavier Maldague.

Seated: Mme Denyse Guay-Archambault; Guy Monty, responsable de la construction des lignes à 735 kV.

A plaque honouring the world's first 735 kV transmission line was unveiled at Hydro Québec's Montréal head office on December 13, 2005. Commissioned into service in November, 1965, the line ran from the Manic-Outardes generating complex on the Manicouagan River in north-east Québec to load centres in the south of Quebec. The portion of the line servicing Montréal was 600 km. The father of the 735 kV system is generally considered to be Jean-Jacques Archambault, the Hydro Québec engineer to whom the problem of the vast transmsission distance was brought.