R.F. and Microwaves in Medical Electronics

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Introduction

There are many uses of R.F. and microwaves in medical electronics [1]. This paper will not be able to do justice to all of them. It will begin with a brief survey of the current techniques being used and some thoughts about the future. It will then concentrate on the author's own research work which will illustrate some of the unusual features of the use of microwaves in medical electronics.

Survey of current techniques

One of the features of microwave radiation is that it is not reflected as much by the mismatch of impedance between the air and the soft tissues as electromagnetic radiation at much lower frequencies. Another feature is that the conductivity of the soft tissues is much greater at microwave frequencies and so most of the power transmitted into the tissues is dissipated in the first few centimetres of the tissues and not much at a greater depth [2].

One of the therapeutic applications is to use microwave power to heat these tissues above the normal body temperature [1]. If the temperature is raised to 10° C or more above the normal temperature of 37° C, then cells will die fairly rapidly. Cancerous cells often run hotter than normal cells and so that they reach their terminal state quicker. So by applying microwaves to the body, the surface cancerous tumours can be treated without the awful side-effects often associated with ionising radiation treatment and chemotherapy. However, in order to focus the microwaves onto the tumour, which may be typically less than one centimetre square, a large antenna is required unless the frequency is raised. However if the frequency is raised too far the penetration of microwaves into the skin is also much reduced. An application of these principles is the use to treat women by using microwave heating to corterise the inside surface of the womb. This is carried out using a coaxial microwave applicator, which heats just the region round the tip. Another application for the treatment of throat cancer will be described late on in this paper. The ionising radiation used so extensively in cancer treatment in hospitals is normally produced by a linear accelerator, which uses microwaves to accelerate electrons up to energies equivalent to 1 MeV. A large number of microwave engineers are involved in this sophisticated microwave application.

Another microwave technique, this time used for diagnostics, is radiometry [3]. This can used to locate hot spots near or below the surface, which may well be cancerous tumours. Although Infra-red cameras are excellent for surface temperatures, because of the penetration of microwaves it is possible to see further

inside the tissues. However, the same principle applies as before, that the higher the frequency the greater the resolution but the less the penetration.

By far the most discussed aspect of microwaves in medical electronics is the effect of mobile phones. A large number of measurements have confirmed that the amount of heat, which enters the head, is negligibly small and the body can cope with it easily. However it is in the realm of non-thermal effects that all the controversy starts. A growing number of people now blame mobile phones for brain tumours, headaches, sickness, and many other ailments. It will take a lot of research to investigate these claims and not surprisingly the money for this research is not being encouraged by the large mobile phone industry. All the mobile phone emissions are within the limits for microwave radiation. In general, the only real evidence we have available in the U.K. for these limits, are the many long and successful lives over 60 years or more of many of our microwave engineers. Besides a tendency to be somewhat absorbed by their subject, most of them appear to be otherwise outstandingly normal.

One of the associated effects of heat is the dilation of the arteries and the subsequent increase in blood flow in the region. This is used by physiotherapists who use radio frequency waves to heat up the whole body often at a depth of several centimetres. The increase in blood flow does accelerate healing and in some cases restores the healing process. For instance there is evidence of swelling being reduced using pulsed radio frequency power and the healing of skin ulcers [4],[5]. The radio frequency energy is applied to the body through a coil placed above the skin of in some cases with electrodes. At the moment the exact mechanism for these effects is not known although some interesting suggestions have been made [6],[7].

A treatment for throat cancer.

The author has been involved with a group of medical physicists at the Royal London Hospital to develop a treatment for throat cancer. This disease is normally fatal about six months after diagnosis. This group have designed a coaxial probe with a helical antenna at the end for applying heat to the throat [8]. The length of the antenna is made equal to the region of the cancer. The power required is about 30 W at 915 MHz and so far tests have shown that just the surface cancerous region can be heated leaving the normal cells, which are at a greater depth, intact. In order to expand the throat a small balloon is used and the whole process can be monitored using probes inside a standard catheter. So far measurements on phantoms have proved very impressive and it is expected that the next stage of the research will involve clinical trials leading up to its final use on patients. The treatment is anticipated to take only minutes and will be a unique method for this area of cancer therapy.

Conclusions

The present medical applications of microwaves are not very numerous but it is quite likely that they will increase in the future. Many of the body functions however occur at frequencies well below radio frequencies and a bandwidth of around 1 kHz is usually sufficient for most of them. However, with the increasing frequencies used in computers approaching the microwave band, there could well in the future be specialist implants with microwave circuits in them. The art of medical electronics is

to take existing electronic techniques and apply them in the medical area. The specialist skill of microelectronics will be used to investigate and treat the more minute areas of the body and in the future. It is the hoped that these new techniques will eliminate some of the more barbaric treatments that are used at this present time.

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