A Passive RFID Implant for Soft Tissue Trauma Monitoring

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Soft tissue damage deep within the human body can occur for a number of reasons:

- road traffic accidents,
- extensive surgery for cancer treatment (e.g. colorectal cancer),
- or shrapnel wounds caused by military combat operations or terrorist attacks.
41,000 people in the UK are diagnosed with colorectal (bowel) cancer each year.

In the Gulf War (1990-91) 80% penetrating wounds on British personnel were caused by fragments from explosive munitions such as shells, grenades and improvised explosive devices, rather than bullets.
### Results

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Dimension (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$t_1^*$</td>
<td>0.7</td>
</tr>
<tr>
<td>$t_2^*$</td>
<td>1.4</td>
</tr>
<tr>
<td>$t_3^*$</td>
<td>2.1</td>
</tr>
<tr>
<td>$t_4^*$</td>
<td>5</td>
</tr>
<tr>
<td>$s_1$</td>
<td>0.7</td>
</tr>
</tbody>
</table>

**Parameter Dimension (mm)**

- $t_1^*$: 0.7
- $t_2^*$: 1.4
- $t_3^*$: 2.1
- $t_4^*$: 5
- $s_1$: 0.7

**Graphs**

- **Forward Transmission (dB)**
  - **Frequency (GHz)**
  - **Ring**
  - **Clover**
  - **0.7mm**
  - **1.4mm**
  - **-0.7mm**
  - **-2.1mm**
  - **full gap**
  - **double full gap**

**Graph Description**

- **Ring**
  - Frequency (GHz): 1-18
  - Forward Transmission (dB): -0.5 to 0.4

- **Clover**
  - Frequency (GHz): 1-18
  - Forward Transmission (dB): -0.5 to 0.4

- **Variations**
  - **0.7mm**
  - **1.4mm**
  - **-0.7mm**
  - **-2.1mm**
  - **full gap**
  - **double full gap**

**Graph Details**

- **Ring**
  - Graphs show transmission characteristics at different frequencies.

- **Clover**
  - Graphs illustrate transmission patterns at various dimensions.

**Conclusion**

- **Rigelsford - Prize Paper 2013**
Thank you!
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Abstract
This work presents the design of a passive RFID tag which can be used to monitor patients who have suffered from soft tissue trauma. Such traumas can occur due to road traffic accidents, extensive surgery due to cancer treatment, or shrapnel wounds caused by combat or terrorist attacks. The subcutaneous RFID implant passively monitors the healing rate of the patient and can be used for the early detection of infection. Unlike conventional designs, as the device is biodegradable, there is no need for further post-operative surgery to remove it. The effect of micro-fractures on ring and clover shaped RFID tags are summarized by experimental results.

Background
Damage to soft tissue deep within the human body can occur for a number of reasons, from road traffic accidents, extensive surgery for cancer treatment (e.g., colorectal cancer), or shrapnel wounds caused by military combat operations or terrorist attacks.

CANCER
Colorectal (bowel) cancer is the UK’s third most common cancer with 5% of the population developing bowel cancer during their lifetime. More than 41,000 people being diagnosed annually and approximately 16,000 people die of the disease each year. Regular bowel cancer screening has approximately 16,000 people die of cancer during their lifetime. More extensive surgery due to cancer treatment, or shrapnel wounds caused by military combat operations or terrorist attacks.

COMBAT
In the Gulf War (1990-91) 80% penetrating wounds on British personnel were caused by fragments from explosive munitions such as shells, grenades and improvised explosive devices, rather than bullets.

Beyond shrapnel damage, tissue healing may also be delayed by metal poisoning from the shrapnel itself.

The Challenge
The problem with all invasive surgery is the route for potential infection. In all such cases it can be very difficult to monitor the healing process within the body after surgery has occurred. Soft tissue damage is not easily monitored using X-Rays, and access to MRI scanners is limited or non-existent in many parts of the world. For abnormal patient recovery, diagnosis of complications may only be achieved through further exploratory surgery after the patient has become acutely symptomatic. Additional surgery is obviously unpleasant for the patient, has an additional risk of infection, and is very costly in terms of time and resources. To mitigate against infection, strong or extensive doses of antibiotics can be prescribed, but it has been widely publicized that the range of currently available effective antibiotics is reducing due to resistant strains of bacterium.

Results
Experimental results have been presented for a non biodegradable ring and clover shaped RFID tag. The results demonstrate that degradation of the shapes can be remotely monitored by tracking changes over a broad frequency range.

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