Healthy Aims overview

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Body Sensors Networks 4th International Workshop
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Overview

Healthy Aims is a 23M€, four year EU FP6 project with the goal to develop a number of intelligent medical implants and diagnostic systems, integrating a range of underpinning micro- and nano- technologies.

The medical products undergoing patient trials within the Healthy Aims project provide a benchmark of today’s state-of-the-art worldwide.

There are 25 partners from 10 EU countries, six of which are clinical partners. Their role is to help develop the system specifications, guide the development work and carry out clinical trials on prototypes.
Products being developed within Healthy Aims

- Intra-cranial pressure sensor
- Cochlear implant
- Bladder and bowel electrical stimulators
- Retina implant
- Electrical stimulation (FES) for limb motion
- Glaucoma sensor
- Activity monitor
- Sphincter sensor
Functional Electrical Stimulation (FES) System example

- Sensor system used to determine when the implant should be triggered
- Wireless communication sends signal to trigger the implant
- Implanted, encapsulated electronics generate the electric pulse
- Electric pulse passed into the electrodes which excites the nerve
- Nerve causes muscle movement in the arm

Motion Sensor

Controller

Implant

Electrode pair placed close to the nerve

Epineurium

Electromagnetic field

Evoked Action Potentials

1mm
Communications from in the body

The implant transmitters must have a wireless method for transmitting data to external receivers.

The data transfer method is defined by the specific application and in some applications includes power transmission.

<table>
<thead>
<tr>
<th>Product</th>
<th>Carrier freq for data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glaucoma sensor</td>
<td>27.3 MHz</td>
</tr>
<tr>
<td>Retina implant</td>
<td>IR</td>
</tr>
<tr>
<td>Electrical Stimulation</td>
<td>403 MHz (MICS)</td>
</tr>
<tr>
<td>Cochlear implant</td>
<td>5 MHz</td>
</tr>
<tr>
<td>ICP sensor</td>
<td>13.56 MHz</td>
</tr>
</tbody>
</table>

On the body communication use Bluetooth or Zigbee
MICS - Communicating data through the body

Implant to Basestation Transmission

Basestation (-78 dBm) (-16 dBm)

Losses (Free Space)

(-45 dBm) (-49 dBm)

Skin

Muscle & Tissue

Antenna Matching Network (-3 dBm) (-91 dBm)

Implant Application

Note: Antenna-Matching Network Circuitry of critical importance

* Basestation Power = 25 μW defined by MICS protocol
Novel electrodes under development

Retina Implant - 3D electrodes

Sphincter Sensor

Cochlear Implant – Modiolus electrode
Encapsulating Biomaterials and functional interface between electrodes and nerves in the body

• Means of improving the connection between the electrode and the nerve cells to optimise charge transfer.

• Biocompatible encapsulating materials to stop water ingress into the implant and prevent leeching of materials from the implant into the body.

![Image: Aligning electrically active neurons to the electrode surface]

![Image: Preventing adhesion of non electrically active cells]

Silicone rubber

Silicone rubber coated with diamond-like carbon (DLC)
Integration – Sensor and electronics

- 3D flexible packaging, with ASIC thinning down to 50\(\mu\)m and flip chip bonding.

Glaucoma sensor contact lens
Embedded software and algorithms

Retina implant system

FES for upper arm

Wrist Extended

Hand Open

Hand Grasp/Closed

Hand Open

OFF

OFF

OFF

OFF

Trigger

Trigger

Trigger

Trigger/Timeout
Implantable Rechargeable Battery

- Implantable power source for the Cochlear & FES systems
- First prototypes now available and undergoing life trials

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
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<tbody>
<tr>
<td>No. of charges</td>
<td>4000</td>
</tr>
<tr>
<td>Life time</td>
<td>10 years</td>
</tr>
<tr>
<td>Dimensions</td>
<td>5 x 10 x 22 mm</td>
</tr>
<tr>
<td>Minimum voltage</td>
<td>3V</td>
</tr>
<tr>
<td>Average current</td>
<td>5mA</td>
</tr>
</tbody>
</table>
Biofuel cell to meet future implant challenges

- A biofuel cell requires no charging - hence ideal for implant applications.

- In this project it will be demonstrated as suitable for powering a pacemaker.
Prototypes going into clinical trials (I)

Activity monitor

Electrical stimulator for hand and wrist control
Prototypes going into clinical trials (II)

Retina implant

Glaucoma sensor

Intra-Cranial Pressure Sensor system
Summary and acknowledgements

Core technologies have been developed and integrated into new medical products.

In year 4 a range of prototype systems are available and will undergo clinical trials.

In addition demonstrators will be produced that integrate a range of technologies. These will move into clinical trials after project completion.

The financial support of the EU FP6 programme is greatly appreciated by the Healthy Aims consortium and has enabled them to develop a range of new medical implants and diagnostic equipment.
Healthy Aims partners