# OT-20

# Hyperspectral imaging for brain tumour identification in real time


ULPGC
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Fundación Parque Científico Tecnológico

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**TYPE OF RESULT**

- New technology
- **[ New product ]**
- New service
- New knowledge or skill

**COMMERCIAL MATURITY LEVEL**

- Conceptual idea
- Proof of concept (design)
- Validated in a controlled environment
- **[ Validated in a real environment ]**
- Successfully implanted

**PROTECTION LEVEL**

- Non- applicable
- **[ Patent ]**
- Software
- Know - how
- Utility model

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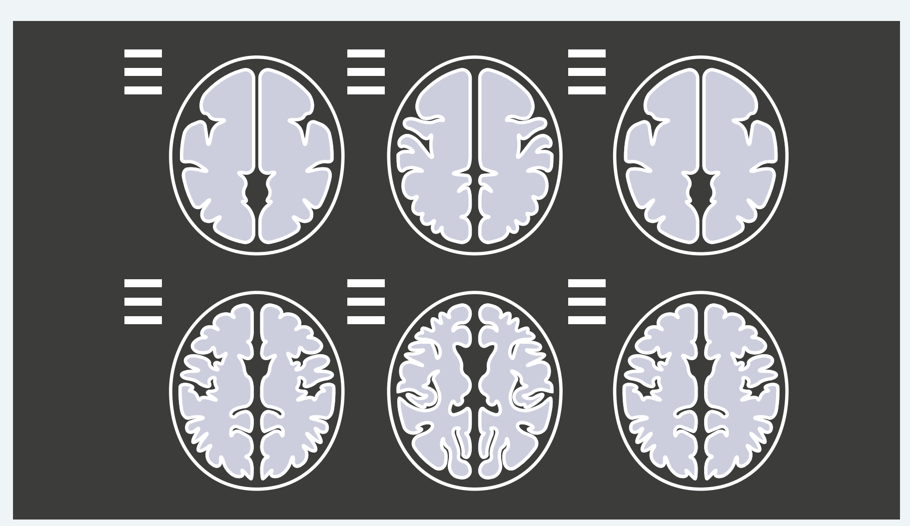
| **Invention title** | METHOD OF NON-INVASIVE DETECTION OF TUMOUR AND/OR HEALTHY TISSUE AND HYPERSPECTRAL IMAGING APPARATUS |
| **File number** | US10964018B2; JP6885564B2; EP3545491B1 |
| **Priority date** | 22/11/2016 |
| **Status** | Granted |
| **Country** | United States of America; Japan; Europe |

## Description of the solution. Problem solved

Unlike many tumours that can be easily identified, brain tumour detection during surgery is a great challenge, especially due to the frequency, aggressiveness and poor prognosis.

Since brain tumour infiltrates into the surrounding normal brain tissue, it is extremely difficult for the surgeon to accurately differentiate between tumour and normal brain tissue to the naked eye. Surrounding brain tissue is critical and there is no redundancy, as in many other organs, where the tumour is commonly resected together with a wide surrounding block of normal tissues in order to avoid metastasis. This is not possible in brain, where it is crucial to accurately identify tumour boundaries in order to resect the minimum amount of healthy tissue as possible. So, for surgeons it is vital to visualise in real time where the tumour is and its boundaries in order to remove it accurately during surgery.+



Hyperspectral imaging is able to capture a vast number of spectral bands in the whole electromagnetic spectrum (in and out of the visual range) of the surface captured by the sensors. Using this information together with customised classification algorithms, it is possible to determine the material or substance captured in every pixel. This technology can be used as a guidance tool during brain tumour resections.

In this sense, the work done allows to exploit the hyperspectral imaging features, developing an interoperational demonstrator that is able to accurately localise malignant tumours during brain surgical procedures. A very precise delineation of boundaries is achieved improving, this way, the surgery results. As a proof of concept, the demonstrator developed is able to generate thematic maps of the exposed brain surface using spectral information of the range between 400 and 1000 nm. These thematic maps distinguish four different types of tissues: normal tissue; tumoral tissue; hyper vascularised tissues (blood vessels) and background. Also, in these maps the tumour boundaries can be easily identified, providing results in less than 10 seconds when using acceleration on high-computing GPUs. This work has achieved excellent results in discriminating between tumour and normal brain tissue in a non-invasive manner, improving thus the results of neurosurgical procedures.

The result is a complete system (cameras, support, electronics, programmes, etc.) that shows in real time the localisation of the tumours to the neurosurgeon.

## Fields of commercial application

The main field of commercial application is medical industry, more precisely, medical instrument industry. Although initially this research was aimed at detecting brain tumours, last results suggest that is possible to detect other types of tumours. Our research group is currently working on detecting skin (melanoma) and cervix tumours. Each application implies a change in instrumentation and algorithms, so this means that each application is a different market indeed. Another commercial application may be pathological anatomy. Recently our research group has bought a microscope that is able to sweep hyperspectrally, which together with our hyperspectral cameras would result in one of the first worldwide hyperspectral pathological anatomy system in range VNIR-SWIR (from 400 nm to 2500 nm). This system would allow to resolve ambiguity among different pathologists, help with diagnosis of many diseases, decrease the human mistakes due to tiredness or routine, as well as to save enormous amounts of money and time in the staining procedures (mainly hematoxylin/eosin).

One of the main applications is early detection of cancer, since the system developed makes easier and accelerates the periodic checking processes (skin and cervix); at the same time, it detects cancer cells in their early stages, that sometimes are imperceptible to the human eye.

## Market opportunity

In the current market there are no instruments based on this non-invasive principle for tumour detection. Although limited research on this area has been done (see some of our articles of review of the state of the art, one of them has been recently published in the prestigious journal Cancer on the 30 May 2019), this technology still faces some challenges, the main ones being:

1. There are no large clinical studies on which medical instrument manufacturers can rely to start producing high amounts of this technology.

2. Although hyperspectral cameras are no-invasive and non-ionizing, they are still expensive. It is expected that as demand increases their price would decrease.

However, our initiative has been selected by the European Union to be part of the Innovation Radar, a platform that gathers all the European projects with major impact and excellence for those researchers' developing innovations of high potential to reach the market.

## Competitive advantage

In the case of neurosurgery, the only alternative method for detecting brain tumours is the fluorescent tumour marker ALA-5 (5 -aminolaevulinic acid), but it has some major inconveniences over the proposed technique:

1. The ALA-5 is an invasive technique. An expensive contrast needs to be injected and some individuals may not tolerate it. For example, it cannot be used with children or pregnant women. Our proposal is completely harmless, non-ionizing and non-invasive.

2. The ALA-5 only detects high-grade tumours. Our proposal detects all grades tumours (1,2,3,4) and even secondary tumours (still in test phase, but with some hopeful results).

3. The ALA-5 requires a special surgical microscope and UV light. It has a similar price as the system here proposed, which does not need contrast.

Therefore, this system based on hyperspectral imaging is a non-invasive technique that would reduce the number of biopsies, fluorescent dyes and tissue staining in pathology.

Also, its accuracy would help surgeons to fully remove the tumour tissue, avoiding future regrowth. At the same time, it reduces the extraction of healthy tissue surrounding the tumour, minimising the safe area that needs to be resected along the tumour. As a result of this, survival chances may increase free from the progression of the disease. Also, the quality of life from patients will be increased since their brain functions will not be so affected by surgery.
Currently ,this system is protected by an international patent (P3756PC00) property of the ULPGC and it covers the following places: Japan; USA and Europe (Albany; Germany; Austria; Belgium; Bulgaria; Cyprus; Croatia; Denmark; Slovakia; Slovenia; Spain; Estonia; Finland; France; Greece; Hungary; Ireland; Iceland; Italy; Latvia; Liechtenstein; Lithuania; Luxembourg; Former Yugoslav Republic of Macedonia; Malta; Monaco; Norway; Netherlands; Poland; Portugal; United Kingdom; Czech Republic; Romania; San Marino; Serbia; Sweden; Switzerland and Turkey).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## Resources needed to be implemented

The system is fully operational and it has been currently used in 36 neurosurgical surgeries during the execution of the project HELICoiD (https://cordis.europa.eu/project/rcn/111274/factsheet/en). These days, thanks to the project ITHaCA (https://ithaca.iuma.ulpgc.es/), which continues with the HELICoiD project, we have introduced once again the prototype during surgeries and we are obtaining new data from new patients.

In a recent visit to the University of Texas, Dallas, it has been agreed with Professor Baowei Fei (director of Quantitative Bioimaging Laboratory) to reproduce our prototype in the Southwestern Medical Center, Dallas, (where 4 Nobel Prizes in Medicine work) in order to increase the number of patients and carry out our first exhaustive clinical research.

In any case, additional funding would be ideal for the following:

1. Acquiring latest generation cameras and develop a new prototype suitable for surgical microscope use.

2. Hiring research staff who could work on a bigger clinical study, generating this way a bigger database to develop new and more precise algorithms.


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