INNOSOC Case Study

(selected for Zagreb 2016; extended version)

Case Study title:

Recognition of Patterns of Maleficent Objects on Medical Images

Keywords: medical image; pattern recognition; image processing; colorectal tumor; endoscopy; blood vessels; narrow band imaging

H2020 challenge addressed by the Case Study: Health, demographic change and wellbeing

Introduction to the Case Study

Detecting maleficent medical conditions, especially cancers, is a costly and complicated task. Mostly only a biopsy can determine whether a tumour is cancerous, which causes the patient inconvenience and risk of the operation, as well as extra cost in the medical system. In case of many tumours a non-invasively taken image can also provide information on the nature of the formula, or at least a guidance whether to take biopsy, remove the tumour immediately, or leave it, because the removal is an unnecessary risk in case of a non-maleficent formula.

The **medical staff** is trained to identify maleficent tumours of their specialization field, but an **automatic image processing** can help their decision, moreover in some cases, like the skin cancers, it could add a tool into the hands of the not specialized persons as well. The non-invasive medical imaging [1][2] contains both the visible light techniques (like endoscopes and microscopes) as well as the higher and lower frequency electromagnetic field based imaging (like X-ray and ultrasound reflection based images). In case of tumours many tell-tale signs can be from the variation of the blood vessel structure around the formula [4-6] to the pattern and colour of the surface of the polyp itself [7-10].

Five INNOSOC students, supervised by two INNOSOC lecturers, will collaborate on answering how ICT can be used in image-based cancer detection. These activities will be conducted as a part of the ERASMUS+ blended mobility and will be finalized during INNOSOC Zagreb 2016 workshop in late April 2016.

How this Case Study is related to the selected H2020 challenge?

Medical image processing is one of positive side effects of the **fast proliferation of the ICT into all domains of the society**. For example, it can decrease the workload put on medical staff and help them decide in problematic questions or draw attention to smaller details where problems might be present.

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Cancer detection is still made by humans, and it will remain so, however, a visual aid can increase effectiveness, and a pre-screening can still be carried out by less qualified personnel and intelligent computer programmes instead of fully trained medical specialists.
The aim of this Case Study is to summarize the technologies used in **image-based cancer detection** for some types of cancer and compare the applicability of the techniques to the various cases. It is also necessary to determine whether new image processing methods could be used. In most cases the decision about a formula is taken in a crisp, yes or no way, however, many soft decision techniques can also be applied, completed with a learning algorithm, thus it is also necessary to map the applied training algorithms and their efficiency.
Therefore, this Case Study specifically addresses the **"Health, demographic change and wellbeing"** H2020 challenge.

How this Case Study is related to the INNOSOC project?

This Case Study is tightly connected with innovation, intercultural and ICT.

First, the **innovation** aspect emerges from comparing multiple types of image processing methods used for various purposes that can lead to a common method or a method applied for one type of problem to be applicable in other problems.

Second, although medical image processing is an **international** problem, acquiring images has different aspects in **different cultures**. Additionally, interpreting and communicating the results has various cultural aspects as well.

Third, medical images are processed by **IT devices**, and their transmission has multiple **ICT** tasks from coding, compressing to videoconferences about the results.

Questions that need answers during the Case Study development

- What are image acquiring methods used in tumour classification?
- Are there specially developed imaging techniques for some aspects of tumour detection (e.g., for recognition of surfaces and interfaces of tumours or for enhancing the visibility of the blood vessels)?
- What are the most lethal cancer types in Europe and in the other continents?
- What is the usual diagnose method for the most lethal tumours?
- What type of image processing methods are used in detection or classification of the most dangerous tumour types?
- What type of soft or crisp decision techniques are used in tumour classification? What types of evolutionary or learning algorithms are applied?

References

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Knowledge and skills needed for developing the Case Study

(P: prerequisite; D: desirable, but not necessary)

- Basic knowledge on image taking methods (P)
- Basic knowledge on learning algorithms and soft decision techniques (D)
- Basic image processing (D)
- Basic knowledge on medical imaging (D)

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Figures describing this Case Study

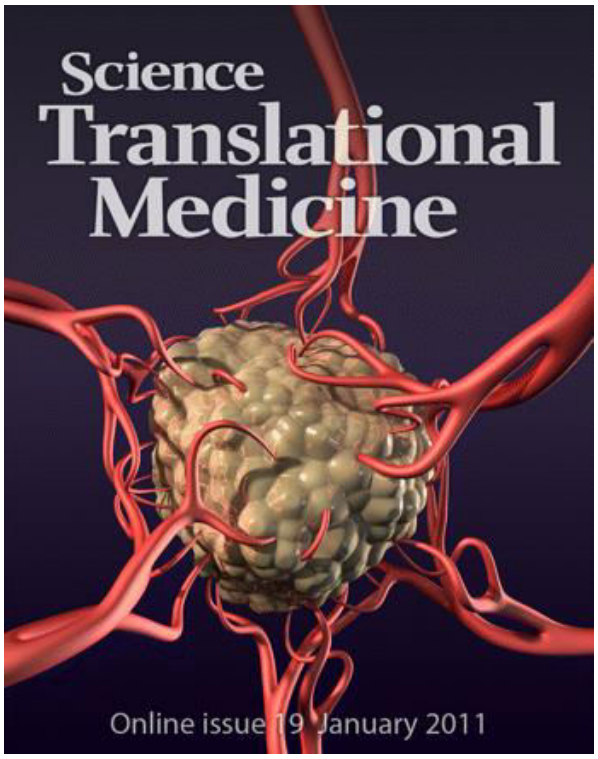

Figure 1. Blood vessels around a kidney cancer
(from: the online cover of Science Translational Medicine, Vol 3, Issue 66 – credit: C. Bickel / Science Translational Medicine)

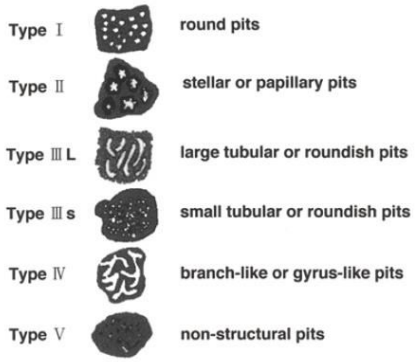

Figure 2. Colorectal polyp pit patterns
(from: Nikolas Eleftheriadis, Haruhiro Inoue, Haruo Ikeda, Manabu Onimaru, Akira Yoshida, Roberta Maselli, Grace Santi, Shin-ei Kudo, "Definition and Staging of Early Esophageal, Gastric and Colorectal Cancer", Journal of Cancer, Vol. 2, pp. 161-178 (2014))

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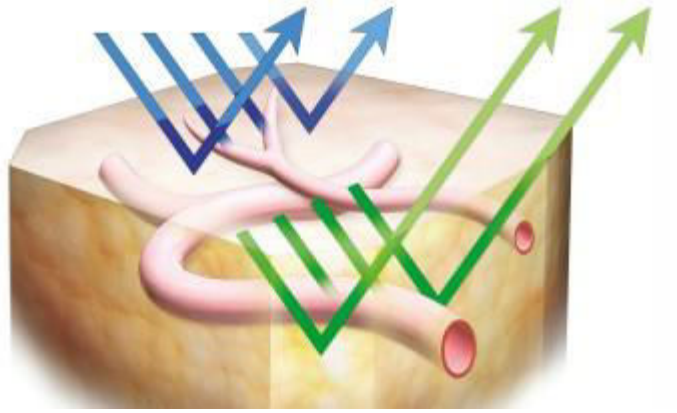

Figure 3. Narrow band imaging light absorption
(from: Olympus, http://www.olympus-europa.com/medical/en/medical_systems/applications/urology/bladder/narrow_band_imaging__nbi_/narrow_band_imaging__nbi_.html)

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