MMIQQA

Overcoming the hurdles to a large-scale adoption of multimodal microscopic imaging

The examination of objects through a microscope has been common practice since the 19th century and has led to numerous breakthroughs, both in life and physical sciences. Over the years, the microscope has evolved significantly – up to the point where it has now become 'multimodal'. In spite of its great promise, however, multimodal microscopy still faces quite a number of challenges in terms of image acquisition, (pre-)processing, analysis, compression and visualization. Each of these challenges has been tackled as part of the MMIQQA project.

Multimodal microscopic imaging includes both *intermodal* imaging (combining different devices that apply different imaging modalities – such as 'light' versus 'differential interference contrast' microscopy) and *intramodal* imaging (with the imaging modality remaining constant but using different parameters – such as contrast or focus).

As part of the MMIQQA project, each of the consortium partners brought forward the specific challenges they had been experiencing with multimodal microscopic imaging – thus covering four scientific domains: forensics, pathology, biotechnology and neuroscience. Following challenges were mapped, and provided the foundation for the MMIQQA research effort:

- The consortium partners in the pathology and neuroscience domains found that storage and visualization of high-resolution 2D and 3D multimodal imagery is highly impractical because of the lack of appropriate and quick (de)compression techniques;
- Biotech experts particularly experienced difficulties in terms of image processing: today, lab technicians need to recreate microscopic images by hand – which can take up to 20 minutes per image, and which hugely limits the number of experiments that can be conducted;
- In the forensics domain, challenges were twofold – covering both image acquisition (how to acquire high-quality images with a high color reliability) and analysis (quickly and accurately comparing images with forensics samples in a database).

THE OUTCOMES

1. New compression and display approaches that make for cost-effective storage and easy consultation of multimodal microscopic imagery

Today, multimodal microscopic images need to be deleted after a while to free up disk space for newer images; there is just no way of storing these very heavy images in an economical way for later data-mining. In the framework of MMIQQA, novel compression methods were developed that address this specific concern, leveraging graphics processing unit (GPU) assets to make storage of multimodal imagery practical and economically viable – without compromising image quality.

The team also investigated the development of a new graphical layer that allows pathologists to link images, and to quickly zoom in on specific areas – without any delay – thus overcoming the latency issue that is typically associated with using and consulting digital images.

2. A brand-new method to acquiring and processing images in a semi-automatic way that is an order of magnitude faster than today's methods

MMIQQA has led to the development of new hardware and software that allows the semi-automatic acquisition

and processing of multimodal images. Whereas lab technicians today need to manipulate their microscopes manually and recreate images on a piece of paper (which equals on average 20 minutes per sample), the MMIQQA approach enables them to simply put the sample under the microscope and hit the start-button. Images are acquired in less than a few minutes – followed by a short control cycle. In practice, this means that more - and bigger - experiments can now be conducted within the same amount of time. Additionally, the MMIQQA technology allows to image a larger field of view, so that larger surfaces can be studied and statistical relevance is increased.

3. New tools to help forensics experts solve complex cases

In order to accurately investigate burglary and hit-and-run car accidents, image acquisition without the slightest color distortion is key. Yet, while color calibration solutions for a.o. medical acquisition exist already, this is not yet the case for microscopic image acquisition. As part of the MMIQQA project, that software for high-quality calibration and new color calibration charts have now been developed, in combination with new matching software that compares images with a database of calibrated paint samples. This should help forensics experts generate better shortlists (of car models, for instance) based on paint samples found on a crime site.

NEXT STEPS

The MMIQQA research results show high potential for the start of new collaborative research efforts, the expansion into new application areas, and the commercialization of the underlying technologies:

- The database of calibrated paint samples, for instance, can now be used to investigate real cases; as such, not only societal value is created – in a next step, the concept could also be exploited internationally.
- MMIQQA's color calibration algorithms could be commercialized pretty easily; the technology would not only make a major difference for companies that build microscopes, but could also be leveraged by manufacturers of digital cameras.
- From a standardization perspective, a number of opportunities have been identified too – with some of the MMIQQA research findings qualifying to be included into the JPEG standards.
- Last but not least, a follow-up project with the same consortium partners has just been initiated: BAHAMAS – a project that aims to lead to the development of an innovative platform for the storage, processing and analysis of big data. In so doing, the project seeks to optimize the value chain for the use of 3D electron microscopy, forensic particle analysis, high-throughput video and multispectral images.

FACTS

NAME	**MMIQQA** (Multimodal Microscopic Imaging: Quality, Quantification and Acceleration)
OBJECTIVE	Overcoming the hurdles to a large-scale adoption of multimodal microscopic imaging
TYPE	ICON project
DURATION	01/01/2013 – 31/12/2014
PROJECT LEAD	Frans Cornelissen, Janssen Pharmaceutical Companies
RESEARCH LEAD	Hiep Luong, iMinds - IPI - UGent Valérie De Witte, iMinds - VISIONLAB - UAntwerpen
BUDGET	1.855.000 euro
PROJECT PARTNERS	Barco, DSC Laboratories, Janssen Pharmaceutical Companies, Nationaal Instituut voor Criminalistiek en Criminologie
RESEARCH PARTNERS	UZGent - ICT Department Vlaams Instituut voor Biotechnologie
IMINDS RESEARCH GROUPS	ETRO - VUB IPI - UGent VISIONLAB - UAntwerpen

WHAT IS AN ICON PROJECT?

iMinds is the digital research center and business incubator for Flanders, Belgium. Its ICON research projects are agile and demand-driven, combining academia and industry partners. ICON projects typically have a duration of two years, yet quickly adapt to the rapidly-evolving digital landscape. ICON partners intend to use the project results in their products or services.

MMIQQA project partners:

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