


# Cloud-based Toolbox for Computer Vision

Sidi Ahmed Mahmoudi

University of Mons, Belgium
sidi.mahmoudi@umons.ac.be

**Abstract**

*Nowadays, images and videos have been present everywhere, they can come directly from camera, mobile devices or from other peoples that share their images and videos. The latter are used to present and illustrate different objects in a large number of situations (public areas, airports, hospitals, football games, etc.). This makes from image and video processing algorithms a very important tool used for various domains related to computer vision such as video surveillance, human behavior understanding, medical imaging and database (images and videos) indexation methods. The goal of this project is develop an extension of our cloud platform (MOVACP) developed in the previous edition of eNTERFACE'16 workshop. The latter integrated several image and video processing applications. The users of this platform can use these methods without having to download, install and configure the corresponding software. Each user can select the required application, load its data and retrieve results, with an environment similar to desktop. Within eNTERFAC'17 workshop, we would like to improve and develop four main tools for our platform: 1. Integration of the major image and video processing algorithms that could be used by guests to perform their own applications. 2. Integration of machine learning methods (used for images and videos indexation) that exploit the uploaded data of users (is they accept of course) in order to improve the results precision. 3. Fast treatment of data acquired from IOT systems. 4. Development of an online 3D viewer that could be used for the visualization of 3D reconstructed medical images. 4. Fast treatment of data acquired from distant IoT systems.*

***Keywords*** cloud computing, image and video processing, video surveillance, medical imaging.

## I. Principal investigator

1. Dr. Sidi Ahmed MAHMOUDI from the Faculty of Engineering at the University of Mons. Belgium

## II. Candidates

- Dr. Fabian LECRON, PhD, Faculty of Engineering at the University of Mons. Belgium.
- Mohammed Amin BELARBI, PhD Student, Faculty of Exact sciences and Mathematics, University of Mostaganem, Algeria.
- Mohammed EL ADOUI, PhD Student, Faculty of Engineering, University of Mons, Belgium.
- Abdelhamid DERRAR, Student in Master 2, University of Lyon, France
- Pr. Mohammed BENJELLOUN, PhD, Faculty of Engineering, University of Mons, Belgium.
- Pr. Said MAHMOUDI, PhD, Faculty of Engineering, University of Mons, Belgium.

## III. Dates

- Sidi Ahmed MAHMOUDI: from 10 to 28 July.
- Mohammed Amin BELARBI: 3 or 4 weeks.
- Abdelhamid DERRAR: 3 or 4 weeks.
- Mohammed EL ADOUI: not yet defined.
- Fabian LECRON: not yet defined
- Mohammed BENJELLOUN: not yet defined
- Said MAHMOUDI: not yet defined.

Notice that these dates are not definitive. They can be lightly changed during next months. Otherwise, we are actually discussing with other collaborators to joint our group.

## IV. Project objectives

The goal of this project is to develop an extension of our cloud platform (MOVACP) developed in the previous edition of eNTERFACE workshop. The latter integrated several image and video processing applications. The users of this platform can use these methods without having to download, install and configure the corresponding software. Each user could select the required application, load its data and retrieve results, with an environment similar to desktop. Within eNTERFACE'17 workshop, we would like to improve and develop four main tools for our platform:

1. Integration of the major image and video processing algorithms that could be used by guests to perform their own applications. Indeed, we will integrate the CPU and GPU based functions of image and video processing algorithms. Each guest can combine these primitive functions to develop his own application in the cloud platform without having to download, install and configure the corresponding software. Moreover, guests can select the graphic processing units (within the cloud architecture) if their applications require a high intensity of computation. We plan also to integrate a responsive forum page to collect the feedback of users.

2. Integration of machine learning methods (used for images and videos indexation) that exploit the uploaded data of users (if they accept of course) in order to improve the results precision. In this case also, we would like to offer for users the possibility to exploit supercomputer clusters (such as NVIDIA DGX-1 supercomputer[1]) that proposes a built system for deep learning and accelerated analytic, which deliver high performance that can be equal to 250 conventional servers. This system is so complete since it integrates hardware, deep learning software and execute popular accelerated analytic applications.

3. Development of an online 3D viewer that could be used for the visualization of 3D reconstructed medical images. This viewer is so useful for the medical applications that are already integrated in our cloud platform "MOVACP".

4. With the development and employment of cloud computing, various modern applications such as social networking, cloud storage, IoT data and video surveillance are emerging rapidly. It is not uncommon to find multimedia databases containing thousands or even tens of thousands of images, videos and sounds, whether targeted for a professional field (medical, security, journalism, tourism, education, museums, etc.) or just for individuals which accumulate personal data such as: memories, travels, family, events, movie collections, etc. These applications lead to a dramatic growth of the generated volume of data. In order to accurately and quickly access to desired images for users from these huge databases, we propose to use the mobile graphic cards (GPU Tegra [2]), in order to accelerate the treatment of this huge data. Moreover, we plan to develop a system that collects different data (temperature, humidity, images) which are connected to microprocessors such as Raspberry, Arduino, Dragon board, etc. This allows to capture, treat, and visualize the related data within graphs, histograms, 2D or 3D image, etc.

## V. Background information

The background information of our project is related to two main domains: multimedia processing and cloud-based processing.

### V.1 Multimedia processing :

within our cloud platform, we have integrated several applications related to motion analysis, video surveil-

[1] nvidia deep learning. http://www.nvidia.fr/object/deep-learning-system-fr.html

[2] TEGRA Processors. http://www.nvidia.com/object/tegra-x1-processor.html

lance and medical imaging domains such as:

1. Real time motion tracking and analysis in multi-user scenarios [1];
2. Highlights detection from tennis games;
3. Medical image segmentation in MR images [2, 3];
4. 3D image reconstruction from 2D radiographs [4];
5. 3D Bone analysis : mineral density (BMD) and microarchitecture computation [5, 6];
6. Left ventricle tracking on 2D echocardiography.

These applications are detailed in our previous report of eNTERFACE'16 MOVACP project [7].

## V.2 Cloud-based processing

A first version of the cloud architecture is already developed [3]. The latter consists of monitoring computer vision applications in cloud platform. It can be presented within four parts: web page and interface, users registration and connection, server management, virtual machines management.

### V.2.1 Web page and interface

We developed our MOVACP web application using the famous platform Symfony[4]. This platform was launched in 2005, and today it represents a stable environment and one of the best platforms existing to build Open-Source Projects. To provide a special style for our web application interface, we used Bootstrap [5]. It is the most popular HTML, CSS, and JS framework for developing responsive and mobile projects on the web. Thanks to JavaScript we got within our web application an excellent interaction with the users.

### V.2.2 Users registration and connection

The Symfony Security component provides a flexible and powerful security framework that allows loading users from configuration or a database. The FOSUserBundle (Friend of Symfony User Bundle) is used to make this step quick and easy to store users in a database.

In our application, we provide a secure platform at the level of user's registration and connection by using FOSUserBundle. Because it contains many features, like user registration, confirmation email, password reset support, etc. All these features are provided automatically by FOSUserBundle. The process of configuration is summarized in Fig. 1.

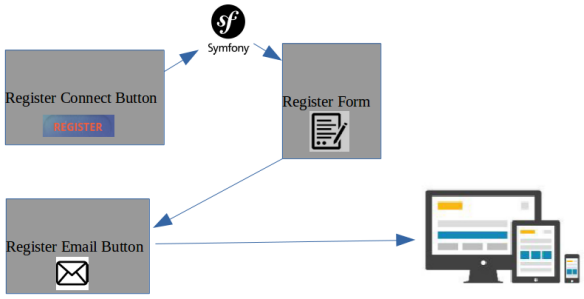


*Figure 1: Secure connection within Symfony*

### V.2.3 Server management

Our web application is installed in the Linux virtual machine (Ubuntu) by using apache web server, and also MySQL as database. Each virtual machine has a static IP address, so we have assigned the static IP address as the IP of our platform (web application). The server uses two ways to communicate with the other virtual machines (clients): SSH and SFTP. Otherwise, our server is protected by Microsoft and Amazon security system from dos attack, etc.

### V.2.4 Virtual machines management

To ensure good performance of our applications we have used different virtual machines provided from Microsoft azure and Amazon AWS, they are running on windows and Linux. The virtual machines are configured as client to communicate with the server by using SFTP and SSH. We have installed the entire package that our application needed in the different virtual machines. When the client (user) selects an application, the server selects the appropriate virtual machine that disposes of the required application. After that, the

[3]MOVACP. www.media-process.com
[4]Symfony. www.symfony.com
[5]Bootstrap. http://getbootstrap.com/

server sends the input data by using SFTP; then run the application by using SSH and finally the virtual machine sends the results with SFTP to the server. Fig. 2 shows the general architecture of our cloud application. As shown in the figure, we use different virtual machines as client with different operating systems since we have some applications running on windows and others running on Ubuntu.

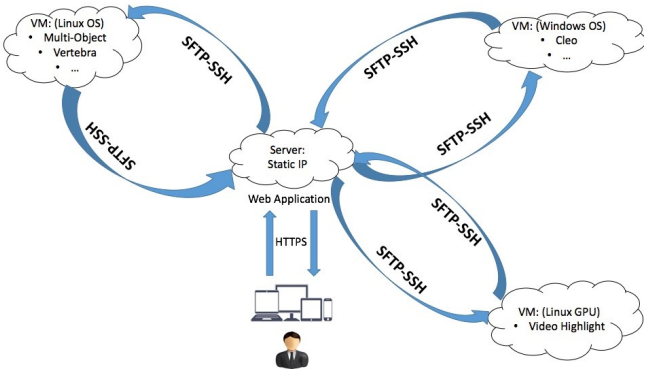


*Figure 2: The general architecture of MOVACP platform*

# VI. Detailed technical description

## VI.1 Technical description

The technical description of our work can be presented three main work packages:

### VI.1.1 Work Package 1: cloud-based image and video processing algorithms

1. Integration of the major image and video processing algorithms that could be used by guests to perform their own applications.

2. Integration of machine learning methods (used for images and videos indexation) that exploit the uploaded data of users (is they accept of course) in order to improve the results precision.

3. Development of an online 3D viewer that could be used for the visualization of 3D reconstructed medical images.

### VI.1.2 Work Package 2: GPU-based high performance computing

1. Offer the possibility of exploiting the graphic cards (GPUs) within virtual machines (in the cloud) to offer fast treatments mainly for high intensive applications. We plan also to develop an IoT system in order to provide a fast treatment of data acquired within distant IoT captors.

### VI.1.3 Work package 3: extra-security option

Integration of a data extra-security option for users that prefer to have a maximum security of their data such as doctors.

## VI.2 Resources needed

The main resources needed for our project are:

- A desktop PC that will be used as server for our cloud platform. Once the platform completed, it will be hosted in cloud. If possible, we prefer to have a desktop PC with a programmable nvidia graphic card. The latter will be used for accelerating high intensive applications.

- Three or four screens that will be users by the team developers in order to have a better visualization of the programming tools. Notice that the team members will develop on their own laptops.

## VI.3 Project management

The project management consists of adapting our work on the three work packages described above. These work packages will present three sub-projects and each one is managed by a sub-project responsible as follows:

1. Cloud-based image and video processing algorithms: this sub-project will be supervised by our team member Ir. Mohammed EL ADOUI. Indeed, Mohammed EL ADOUI disposes of a good experience in this domain. He was an active member in the previous edition of eNTERFCACE workshop within MOVACP project.

2. GPU-based high performance computing: this sub-project will be supervised by the team leader Dr. Sidi Ahmed MAHMOUDI. Indeed, Sidi Ahmed MAHMOUDI disposes of a good experience in this domain. His PhD thesis was done in this domain, he was also an active member in the previous edition of eNTERFCACE workshop within MOVACP project.

3. Extra-security option: this sub-project will be supervised by our team member Ir. Mohammed Amin BELARBI. Indeed, Mohammed Amin BELARBI disposes of a good experience in this domain. He was an active member in the previous edition of eNTERFCACE workshop within MOVACP project.

Notice that each sub-project depends of the other. Therefore, the sub-projects supervisors will be responsible of communicating, the advancements, results and bugs of each sub-project. Each modification or update of our project tasks will be discussed with the team members.

## VII. Work plan and implementation schedule

We plan to start actually (before joining the workshop) on the research, test and analysis of the existing CPU and GPU modules of image and video processing that could be exploited by our cloud platform. Moreover, a research about efficient web 3D viewers and extra security will be done before joining the workshop. The plan that should be followed during the workshop is:

1. **Task 1 (from week 1 to week 3) :** the first task consists of integrating the major image and video processing algorithms that could be used by guests to perform their own applications. The machine learning and the 3D viewer will be also integrated within this step. This task should be developed during the three first weeks.

2. **Task 2 (from week 2 to week 4) :** the second task consists of providing the possibility to exploit the graphic cards (GPUs) within virtual machines (in the cloud) that could offer fast treatments mainly for high intensive applications. An IoT system will be developed within this task that should be done within two weeks (week 2 and week 3).

3. **Task 3: (from week 3 to week 4) :** the third task consists of integrating a data extra-security option for users that prefer to have a maximum security of their data such as doctors. A forum to collect users suggestions will be also done with this task. This task should be done within two weeks (week 3 and week 4).

4. **Task 4 (week 4) :** the last task consists of collecting the results of the previous ones and test the related performance. Indeed, we plan to apply our validation within several use case applications (described in Section V).

## VIII. Benefits of the research

The main benefits of this research is to offer a complete platform for sharing our scientific contributions related to computer vision domain. Indeed, each collaborator could integrate its application within our cloud platform so that users could test and exploit the required application, load its data and retrieve results, with an environment similar to desktop. Moreover, the guests can use our cloud platform for developing their own applications by combining the provided CPU and GPU-based image and video processing applications. Medical applications are also well adapted since a 3D viewer will be integrated. As result, guests could develop or exploit the shared applications without having to download, install and configure the corresponding software. With this platform, the scientific researchers could be able to develop and share easily their applications faslty and in a safe way.

## IX. Profile team

### IX.1 Leader

The project leader is Sidi Ahmed Mahmoudi, which received the graduate engineering degree in computer science from the University of Tlemcen, Algeria, the master degree in multimedia processing from the Faculty of Engineering in Tours, France, and the PhD

degree in engineering science from the University of Mons, Belgium, in 2006, 2008, and 2013, respectively. Currently, he is a researcher at the University of Mons, Belgium. His research interests are focused on the efficient exploitation of parallel (GPU) and heterogeneous (multi-CPU/ multi-GPU) architectures for faster processing of high definition images and videos. He also participated in national (ARC-OLIMP, Numdiart, Slowdio, CLEO) projects and European actions (COST IC 805). Sidi Ahmed Mahmoudi is author or co-author of 5 international journals, 3 book chapters and more than 30 conference and workshop papers. The project leader has participated in two previous editions of eNTERFACE workshops (2014 and 2016).

## IX.2 Staff proposed by the leader

- Fabian Lecron received the computer science engineering degree from the Faculté Polytechnique de Mons (FPMs), Belgium, and the managementsciences degree from the Facultés Universitaires Catholiques de Mons (FUCaM), Belgium, respectively in 2008 and 2011. He obtained a Ph.D. degree in applied sciences at the University of Mons (formerly Faculté Polytechnique de Mons) in 2013. He is now postdoctoral researcher at the University of Mons (UMONS), Belgium. His main research areas are computer vision, image processing, collaborative recommendation, and data mining.

- Mohammed EL ADOUI received the Master degree in computer science (computer graphics and Image processing) from the University of Moulay Abdellah in Fez, Morocco, in 2015, and the basic license degree in Mathematics and Computer science from the Faculty of Science in Oujda, Morocco in 2013. Currently, he is a PhD student at the University of Mons, Belgium. His PhD that started in December 2015, is focused on Quantifying Tumor Vascular heterogeneity of breast cancer, using Dynamic Contrast-Enhanced Magnetic Resonance Imaging (DCE_MRI).

- Mohammed Amin BELARBI is PhD Student from the Mathematics department, Faculty of Exact Sciences and Computer Science, University of Mostaganem, Algeria and from computer science department, Faculty of Engineering, University of Mons, He started his PhD the in University of Mostaganem, Algeria and University of Mons in 2014 (Co Tutelle). He holds a master's degree in engineering information system in 2013 and Computer Science degree in 2011 from University of Mostaganem. His research interests are Multimedia Retrieval, Indexing videos and images. Mohammed Amin BELARBI has participated in previous edition of eNTERFACE workshops (2016).

## IX.3 Other researchers needed

For our project, we would like to collaborate with researchers interested to the domains of secure cloud computing, image and video processing and 3D visualization. The researchers are invited to develop the cloud platform and also include their applications if they want to share or validate (apply tests with different data sets) the related results.

## References

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