ERASMUS MUNDUS EUROPEAN MASTER IN VISION AND ROBOTICS (VIBOT): EXPERIENCES, PRESENT AND FUTURE

R. Martí, X. Cufí, J. Salvi

Universitat de Girona
Girona, Spain
{marly;xcuf;qsalvi}@eia.udg.edu

Abstract

The Erasmus Mundus Master on Computer VIsion and RoBOTics (VIBOT) is a common European course organized by the Vision and Robotics European Consortium constituted by the University of Burgundy-Centre Condorcet Le Creusot (France), University of Girona (Spain) and Heriot-Watt University (Great-Britain). The key cognate areas are computer vision and robotics where current research in these domains is particularly dynamic and finds fast outlets in the industrial world where needs are growing and companies' executives are increasingly opened to implementing artificial vision solutions to improve both quality and productivity. The paper presents an overview of the master and the main objectives and actions of Erasmus Mundus programm. We also discuss the master structure and mobility scheme and present the learning outcomes in terms of cognitive and transferable skills and competences. A description of the students is also given, and will be related to the quality assessment results. Quality assurance procedures and actions are also presented. Finally, discussion and conclusions are presented along with future actions within the consortia.

1 INTRODUCTION

The European Master on Computer **VI**sion and Ro**BOT**ics (**VIBOT**) is a common European Course organized by the Vision and Robotics European Consortium (VREC) constituted by the University of Burgundy-Centre Condorcet Le Creusot (France – coordinator, hereinafter "UB"), University of Girona (Spain, hereinafter "UdG") and Heriot-Watt University (Great-Britain, hereinafter "HWU"), as illustrated in Fig. 1.

Fig. 1. Members of the Vision and Robotics European Consortium (VREC).

The main objective is to meet the present needs of industry for quality control and automation of industrial processes as well in the field of health with the increasing importance of medical imagery in all its forms. The key cognate areas of the Master are computer vision and robotics. Current research in these domains is particularly dynamic and finds fast outlets in the industrial world where needs are growing and companies' executives are increasingly opened to implementing artificial vision solutions to improve both quality and productivity. It encompasses the most varied sectors, such as the car, agro-alimentary, and health industries. The continued evolution of these research sectors requires adapted and extremely specialized academic formations. The Masters proposed fills a current gap in European Education for vision and robotics discipline applied to industrial problems, medical vision and 3D imagery.

Therefore, the global objectives of the VIBOT Master, within the framework of the Erasmus Mundus Programme, are:

- To assert Europe as a focus points for higher education and research in the fields of Computer Vision and Robotics by delivering a cutting edge, comprehensive post-graduate level formation of excellence in Computer Vision and Robotics, aligned with the complex needs of research and industry in the fields.
- To foster and enhance strong international relations in academia, both for research and teaching, to the mutual benefit of Europe and Third countries, and to disseminate the values of cultural and scientific exchanges.
- To become self sustained beyond the initial European funding.

In order to achieve the above mentioned objectives the MSc should have a clearly defined and strong academic structure, mobility scheme and learning outcomes. Moreover, additional actions regarding the enhancement of international academia relations and sustainability are of paramount importance in this type of master, both for its international and intercultural nature and for the characteristics of the Erasmus Mundus programme itself.

The paper initially presents an overview of the master and the main objectives and actions of Erasmus Mundus programme (Sec. 2). Subsequently, in Sec. 3, we discuss the master structure and mobility scheme and present the learning outcomes in terms of cognitive and transferable skills and competences. The master quality assurance procedures and actions are also presented, a key aspect for a correct development of the master which helps to identify and solve the problems at the level of quality of teaching, administration support, student facilities and accommodation at each institution. In Sec. 4, a description of the students' country of origin and internationalization aspects is given. Subsequently, Sec. 5 presents academic performance results and quality assurance in terms of student feedback. Finally the paper discusses future actions within the consortia and presents its conclusions.

2 VIBOT AND ERASMUS MUNDUS

2.1 Erasmus Mundus Programme

The Erasmus Mundus (EM) programme [1] was established in 2004 by the European Union to promote the European Higher Education (EHE) system all over the world. The goal is to attract the very best students to Europe and promote the European Union as a centre of excellence in education. The Erasmus Mundus programme recognizes top quality masters, gives around 20 scholarships to the very best students in the world to come to Europe, and also funds fellowships to Scholars and EU Students for short stays abroad.

The first call of the EM programme [2], in which the VIBOT MSc participates, is divided into different *Actions*, which are related to different funding objectives. These Actions have slightly changed in the new call of the EM programme published in early 2009 [3].

Action 1. Forms the basis of the EM programme. Recognition of high quality international MSc Programs with the Erasmus Mundus mention and run by a consortium of High Education Centers with a minimum of three European partners.

Action 2. EM grants. In order to enhance the world-wide attractiveness of the MSc selected in Action 1, this action offers a set of highly competitive grants for students and scholars from third countries (non-European). The number of student grants often varies each year but is around 20 full grants of 42.000 Eur.

Action 3. Association in Higher Education. With the aim of foster internationalization of EHE centers and world-wide collaboration with other HE centers, the selected MSc in Action 1 can apply for collaborations with HE center with third countries. This collaboration will materialize into EU student and scholars' mobility in terms of students taking modules in the 3rd country institution or scholars giving seminars and lectures and establishing research collaborations.

Action 4. This action aims to fund projects in order to foster the interest of European higher education abroad and enhance its attractiveness in terms of MSc studies visibility, EHE student access, international dimension and the recognition of university degrees in third countries. The consortium participates in one Action 4 project, named **EACOVIROE**[4]. The aim is to promote the attractiveness of the field of Computer Vision and Robotics in Europe targeting Asian students and Higher education institutions and European students (Job opportunities, mobilities in Europe). The aim of the project is to create a web portal which contains detailed information of European Higher Education Institutions providing high standard studies in Computer Vision and Robotics and to do a large scale quality assurance survey in the community of Computer Vision and Robotics.

3 STRUCTURE OF THE MASTER

3.1 Academic structure

The two-years study programme proposed is divided into four semesters, each corresponding to 30 ECTS. The first three semesters are taught, while the last semester corresponds to the Masters thesis.

The particular aspect of the Master is that it is kicked off by an induction week in September, held in Le Creusot. This week's purpose is to facilitate the cultural adaptation of the newcomers, and to settle all aspects of their administrative registration and academic induction. It is an occasion for the cohort to meet their peers and the teaching and administrative staff. The Masters ends in June of the second year when students defend their thesis through a public VIVA.

The course provides a coherent and comprehensive syllabus, from the foundations of computer vision and robotics to the cutting edge in research and the latest developments in their applications. More specifically the course is structured as:

The first semester, S1 (30 ECTS), is carried out within the School of EPS (Engineering and Physical Sciences) in Heriot Watt University, Scotland (UK). It covers an introduction to signal and image processing theory and tools, both software and hardware, including the key related area of pattern recognition and artificial intelligence. These technical subjects are supplemented by local culture studies and specific training for drafting documents in English.

The second semester, S2 (30 ECTS), takes place in the Escola Politècnica Superior of the Universitat de Girona, in Catalunya, Spain. The semester focuses on computer vision for Robotics. It covers fundamentals and applications of robotics, as well as specific methods of image analysis (segmentation, object recognition, 3D perception) and specific real time hardware, both relevant to autonomy and remote operation in robots. The semester also includes an introductory study of the local culture and Catalan and Spanish language courses.

The third semester, S3 (30 ECTS), is hosted by the university Center Condorcet in Le Creusot, an antenna of the Faculty of Sciences and Technology of the University of Burgundy, France. The semester focuses on advanced image analysis and pattern recognition for sensor data images, with an emphasis on medical imagery, through the modalities studied (Infra-Red Imagery, Ultrasound Imagery, Radio-Isotopic Imagery and X-Ray Imagery), and the intervention of medical practitioners. A module of "discovery of the local culture" is also provided.

The fourth semester, S4 (30 ECTS), the master thesis, consists in either an introduction to research carried out in one of the laboratories of the consortium or an industry placement in a company involved in vision or robotics technologies. The majority of students are expected to carry out their thesis within one of the consortium universities' lab. However, they can also choose to join another host laboratory/company for their thesis.

3.2 Learning outcomes

The main learning outcomes for the masters are detailed below and are complemented by the modules taught at each semester:

Understanding, Knowledge and Subject- Specific skills of Computer Vision, Image and Signal Processing and Robotics: Broad knowledge of the main areas of the field, including terminology, conventions, underpinning theory, techniques and practices; Critical understanding of the applications of the techniques and systems, as well as of their scope and performance; Critical knowledge, understanding and skills in the mainstream and specialist areas covered by the syllabus.

Cognitive and core skills: Develop and apply skills in critical analysis, evaluation and synthesis, and in the design of projects and experimental models; Deploy advanced problem-solving skills and techniques towards original and creative solutions to general and specialist issues. Develop and demonstrate skills and techniques: in oral and written communication with peers and academic/industrial staff, using a range of appropriate methods to suit different levels of knowledge and expertise within the audience; in the planning and usage of industry standard tools, programming languages and numerical techniques; in the ability to identify, formulate and resolve problems.

Professional Awareness: Demonstrate critical awareness of the current issues within the discipline, and make informed judgments with incomplete or inconsistent data, or where there are no professional/ethical codes or practices for guidance. Work autonomously and within teams, as appropriate, demonstrating a capability for both taking and critically reflecting on roles and responsibilities.

International awareness: Develop and demonstrate the ability to operate and interact successfully and positively within multicultural environments. Gain awareness of international nature of careers in research and industry.

3.3 Quality Assurance

Academic structure and learning outcomes are well understood key aspects in an MSc definition and development. Nevertheless, a successful MSc proposal should also envisage and clearly define quality assurance procedures. In that sense, a common consortia quality handbook has been defined in the VIBOT MSc composed of procedures taken to assure an efficient functioning of the masters. This includes administration procedures but also information and forms regarding students application, evaluation and acceptance and information given to students (i.e. student Visa, residence card, financial aspects). In addition quality assurance includes the implementation of various surveys which aim at questioning students, scholars, teachers regarding the VIBOT program, course content, and administrative support. The results of the surveys are accessible online for all members of the consortia and used in the quality board meetings in order to clarify the weaknesses of the program and the ways of improvement for subsequent years. The MSc also includes the figure of an external quality reviewer, who, in addition to meeting with students and lecturers, has access to the full content of the surveys, and provides feedback and reviews regarding the running of the program.

3.4 Collaborations and funding opportunities.

The MSc VIBOT is mainly economically supported by the EM programme, especially during the initial years of the MSc. Nevertheless, the aim of the consortia is to secure the running of the MSc program beyond the EM programme. Although the aim is to renew the EM mention, the consortia is actively working with close relationship with universities, local and national councils, companies and industrial partners in order to support not only economically but also in the academic aspects of the MSc. Financial support from the universities of the consortia, and local and national councils come in the form of grants covering for registration fees for European students (not eligible for the EM programme) and mobility grants (from several sources, around 3000 Euros per semester).

Another important collaboration has started to be established with companies and industrial partners. The main idea is to get industrial partners involved with the MSc, mainly in two different aspects: as potential institutions hosting last year students to develop the final Thesis or as talent hunters recruiting the best students of the promotion after their graduation. In that sense, the MSc holds the VIBOT day each year during the graduation of the last promotion of students. Companies are invited

to attend in this one day workshop where students present their work done during his MSc Thesis. Companies are also invited to present their interests and the job opportunities their offer to the VIBOT community. For instance the first VIBOT was held in 2008 with more than 25 internationally renowned companies attended VIBOT days [5], with a significant number of theses done in companies during 2009. This industrial support has been confirmed with the success of the 2009 edition [6], and it is aimed that will be a well known and established workshop for the computer vision and robotics industry in 2010, when it will be held in Girona. The feedback from the students has been very positive being a great opportunity for them to meet fellow students from other VIBOT promotions and also have interviews with the industrial partners. Some students were offered internships during the spring break or summer with companies which came during the VIBOT days.

4 STUDENT PROCEDENCE

Being this is an international MSc program where the main funding focuses on supporting students and scholars from non-EU countries, a high level of internationalization is expected. This is confirmed by the number of students and country of origin detailed in Fig. 2 and Fig. 3. In total, and among the 4 different promotions, there have been 99 students from 34 different countries. This international aspect, in addition to the importance of the management of visa procedures with the respective countries of the consortia, adds an important international environment to the MSc in terms of cultures and languages which enriches the student learning experience. As mentioned in Sec. 3.1, the induction week held in September for the first year students, provides an excellent opportunity for them to be introduced to the various aspects of the MSc but also students have the chance to meet and share a week with the second year students, enhancing even further the internationalization and cultural interchange.

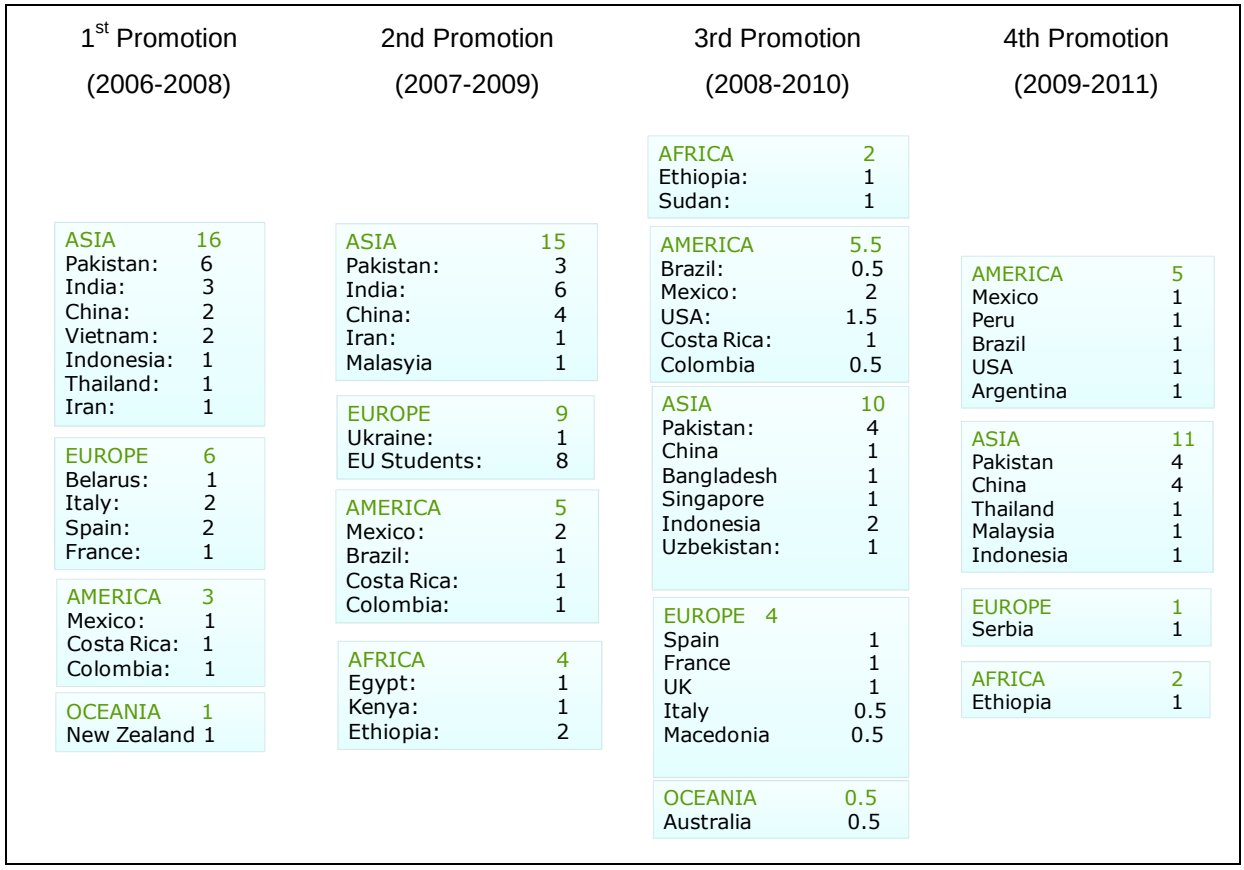

Fig. 2. Detailed student nationalities for each promotion of the VIBOT MSc. Decimal numbers represent students with double nationality.

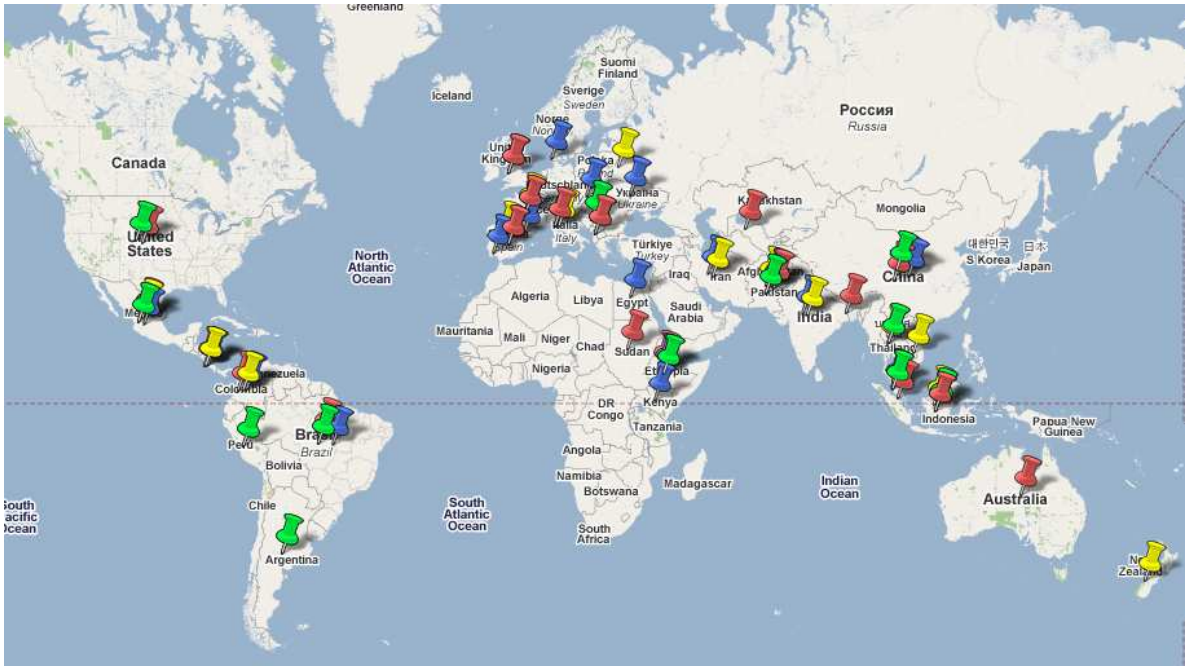

Fig. 3 Student nationality distribution of the four promotions of the MSc VIBOT.

5 ACADEMIC RESULTS AND FEEDBACK

In this section we present two types results regarding the MSc VIBOT development. Initially we show that the overall academic performance of the students in the three promotions graduated so far tends to be of a very high standard, being most of the marks clustered in the higher upper band. As an illustration, Fig. 4 shows student academic marks for various modules taught in Girona where Excelente, Notable, Aprovado and Suspenso stands for A, B, C and D (and lower), respectively.

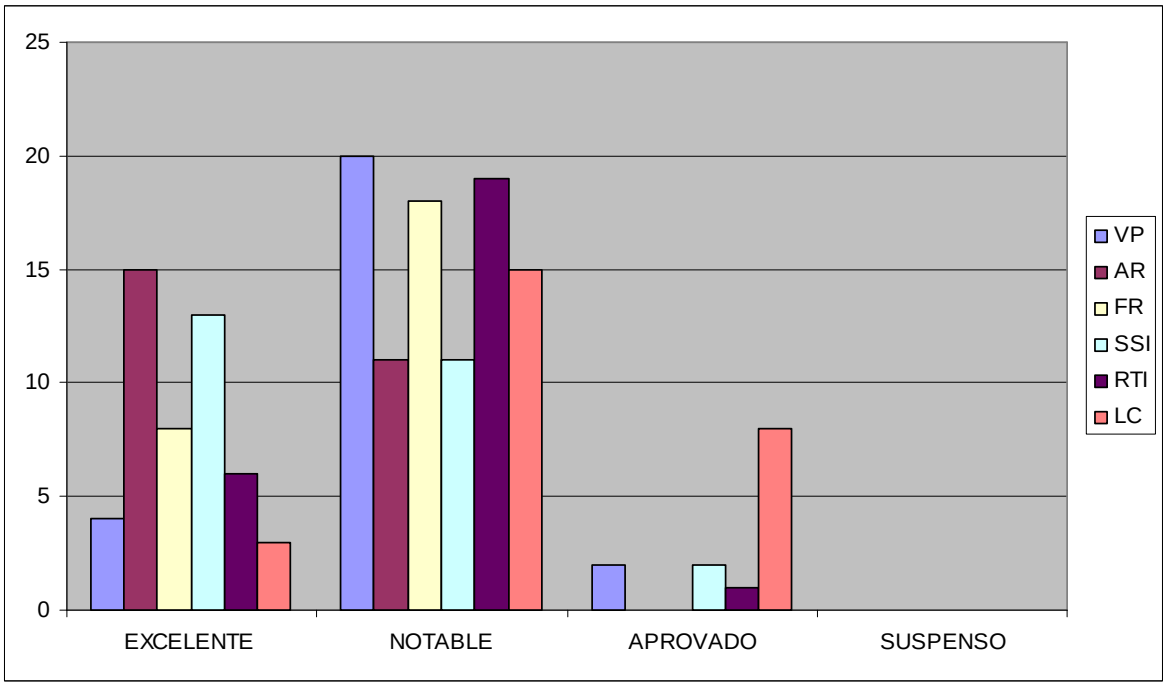

Fig. 4. Academic marks for modules taught in the University of Girona.

Obviously, with these results one still can differentiate between the brightest students but what is clear from this data the academic performance of the students is regarded as significantly better compared to other MSc studies in similar fields and departments. This trend has been experienced in all institutions of the consortia. This fact can be explained by the top level profile of the students due to the highly competitive selection process. Regarding student evaluation, it should be mentioned that it is performed in various ways from weekly assignments, laboratory activities, oral presentations and partial exams and final exams in all modules.

In addition to the previous results, we also evaluate the quality of the VIBOT procedures as detailed in Sec. 3.3. Detailed surveys (around 30 pages long) are filled by students during each semester in order to assure the correct development of the different aspects of the masters, not only academically but also administration, university services, etc. As an example, Fig. 5 shows the overall module feedback results (over 5) for modules held in Girona from years 2007 and 2008. Surveys have been important to detect possible problems and propose solutions for subsequent years. For instance, this is the case of one module in 2007, *RTI*, which greatly improved in 2008. Overall one should also notice the high score in all modules, which illustrates the high quality of the modules taught.

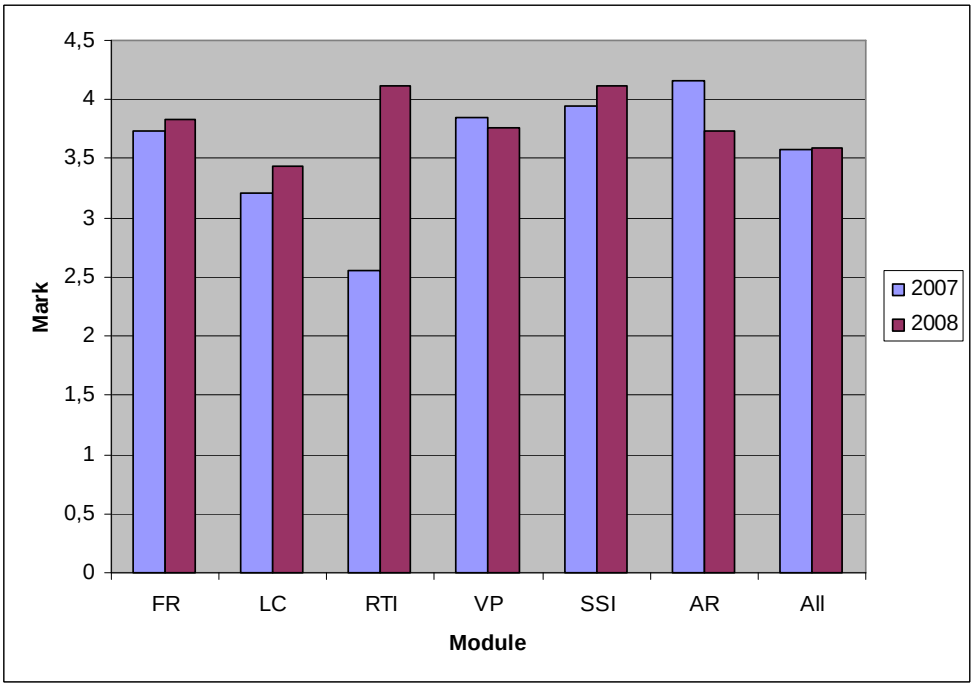

Fig. 5. Overall module feedback results (over 5) for years 2007 and 2008.

6 FUTURE: DOCTORAL PROGRAMME AND MASTER IN PHASE II

The future of the current EM Master is envisaged in two different and complementary aspects related to the new Phase of the Erasmus Mundus Programme: the development of a new doctoral programme and the renewal of the Erasmus Mundus mention for the current VIBOT Master.

The key aim of the doctoral program, named Erasmus Mundus Joint Doctorate in Vision, Optics and Robotics (VISOR) is to produce the next generation of leading engineering researchers to solve important future challenges in engineering. VISOR Research Network consists of seven leading research groups from five different European States: UK, France, Spain, Norway, and Finland. The distinctive characteristic of VISOR is that it encompasses a broad spectrum of scientific and engineering research from fundamental theoretical results to applied engineering solutions that have strong industrial relevance. Individuals within the VISOR Research Network are leading authorities on areas ranging from computer vision, autonomous vehicles, statistical signal processing and robotics to optics, colour science, photonics, image processing, and multimedia technology. VISOR has strong

commitment to serving the needs of scientific industrial communities as well as governmental agencies in Europe.

The VIBOT consortium is also preparing the submission to renew the Erasmus Mundus Mention for the master in the new Phase. Although the aim is to maintain the current succesful structure of the master a few improvements will be introduced taking into account the experience gained from the last years in running the master both in terms of teaching and administration issues.

7 CONCLUSIONS

The paper has described the main features of the EM VIBOT MSc, making special emphasis on the MSc structure, student origin and academic and quality assurance aspects. It this clear from the student and lecturers feedback and EACEA agency evaluations (EACEA is the agency in charge of the EM program), that the VIBOT has successfully implemented various innovative procedures such as the industry involvement and sustainability (VIBOT day), student experience (Induction week), which are likely to being followed by other programs in the future. Future directions, as described earlier, will be directed to renew the EM mention in the so called phase II and to naturally extend the MSc to an international joint PhD programme.

References

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