

## **Deliverable: DR. 6.5**

### **Second version of course database**

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#### **Objectives**

This initiative has been addressed not only to help the mobility of students and professors by means of the personal search of information of existing courses, but also to extract information about what is going on in the field of Robotics higher education in Europe.

The collected data is aimed to drawing up some recommendations for the elaboration of future courses and European programs in robotics.

Courses in the database can also be a source of inspiration for new subjects' contents, and probably this will serve to unify these contents.

The database will facilitate the interchange of educational materials between the teachers having similar courses and it can, as well, help the administration in the recognition of foreign courses ECTS.

In this second version of the course database we have wanted to concentrate our main efforts in the compilation of Master Courses in order to extract information to propose a European Master on Robotics.

#### **Contents and Search Fields:**

In order to avoid asking to teachers fulfilling a big questionnaire, we decided to do an Inventory of websites. So the database only contains essential information to perform the searches on it. In this way, all other information about the courses is contained in the course webpage itself, so it can be changed in a dynamic way by the teachers.

The database permits the search of courses based on the following essential information:

- Contents keywords/Topics
- Course language
- Level
- Country
- Material Availability

The curricula in which each course in the Data Base is taught are highly diverse, fact that has motivated the definition of a classification. A new search field has been added to perform useful statistics, associating each subject to one of following big areas:

- Computer Engineering
- Electrical and Electronics Engineering
- Industrial Engineering / Automatic Control
- Mechanical Engineering

## Activities summary:

- During the second year the Data Base has been growing up with new courses most of them from France and Italy
- Big efforts have been made trying to get courses from Germany but it hasn't had a satisfying answer yet.
- Some improvements in the computer platform have been done and some slight changes have been introduced in the questionnaire to fill in
- Study of the statistics of interest and its implementation (see below).
- Detect the relevant data and the ill posed questions about subject contents (keywords), sometimes not too precise due to the great diversity of courses and curricula.
- Follow with the use of the EURON RCDB LOGO in the registered courses webpages. This Logo permits us to know courses' webs number of visits and from where the courses' webs are been visited.



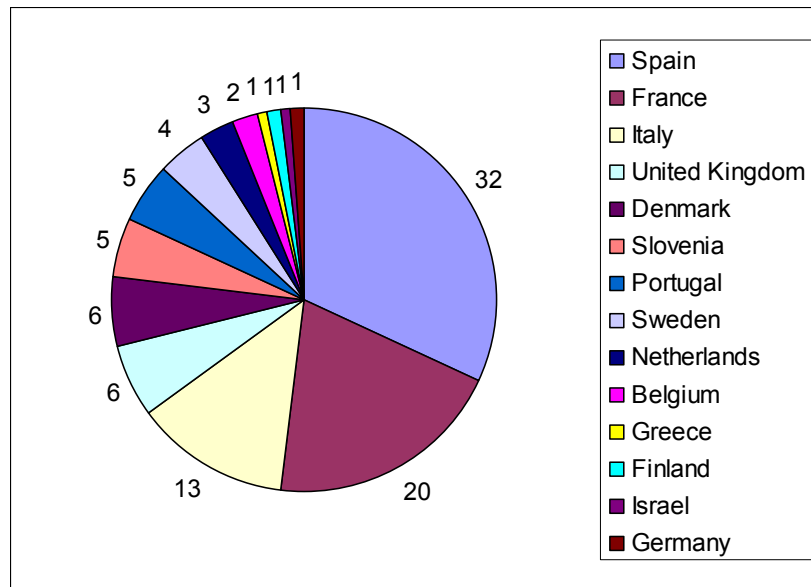
- Corrections in the computer platform. Errors in some searches has been debugged and eliminated.
- Searches results are now presented in a "Google Style" form. Also the resulting list of courses is ordered by number of visits, thanks to EURON RCDB LOGO.
- Analysis of Master courses contents and statistics.
- First evaluation and interpretation of the results, by the steering team.
- Public presentation at the Euron annual meeting, as well as organization of a special session to present the interpretation and discuss on it to prepare the recommendation on a possible common Euron Master Curricula.
- Further work on evaluation of the courses based on statistical data

As a result of the hard work of the general and personalized call, the Courses Data Base contains now **130 courses**. The number of contributions has increased from 100 on May-2006 to 130 on May-2007. The promotion effort has been dedicated to balance the contributions between countries so as to be maximally representative of the whole Europe.

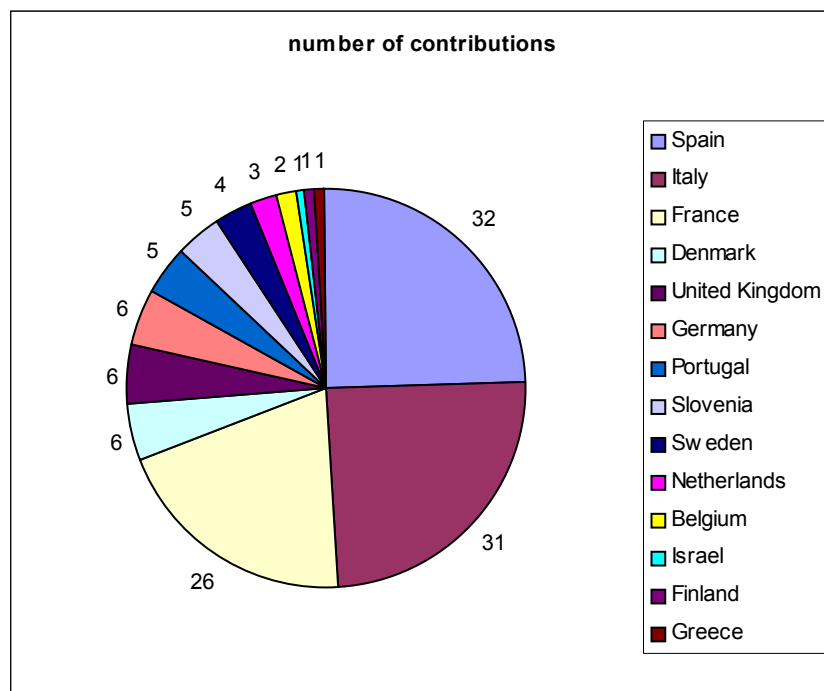
From this increment of data, we observed that the statistics do not change, neither the ratio of topics-degrees, so, we believe that we have data enough to prepare some first conclusions or recommendations. But since the goal is also to know who is who, we will keep collecting courses.

## Statistics of the courses in the Data Base

Fig. 1. shows the evolution in the number of courses available by country from May 2006 until May 2007. The non balanced distribution is due to the fact that some countries have more active members or someone helping to respond to the call. The call is open and from the E&T Key area a continuous work of searching potential people for contributing is being done.



*Fig. 1.a) Distribution of courses by country (May 2006)*



*Fig. 1.b) Distribution of courses by country (May 2007)*

## Information for the conclusions and recommendations

From the courses and data collected, an analysis has been done to know what kind of courses and in which curricula they are taught, and from these information some conclusions on what is being done, and presumably, what would have to be taught in a Robotics curricula has been extracted.

The E&T board elaborated the list of topics representative of most courses contents, taking advantage of the effort devoted to the webook index. The selected topics are the following:

- Fundamentals of Robotics
- Control
- Trajectory planning
- Sensors, Power and Actuators
- Manipulation
- Navigation
- Architectures
- Sensing
- Application Areas
- Biologically inspired
- Human –Machine Interfaces
- Micro- Nano Technology

It has been noticed that some kind of explanation about the detailed meaning of these topics must be established.

As can be seen in fig. 2, the evolution of the declared contents after the incorporation of 30 new courses hasn't varied significantly from May-2006 to May-2007, so, we believe that it should be possible to prepare some first conclusions or recommendations.

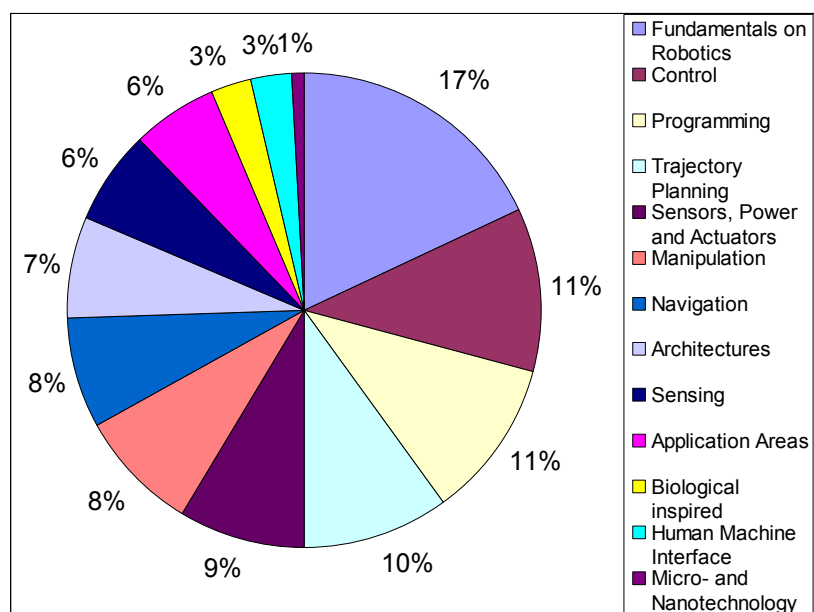


Fig. 2.a) Percentage of relevant topics in the robotic courses (May 2006)

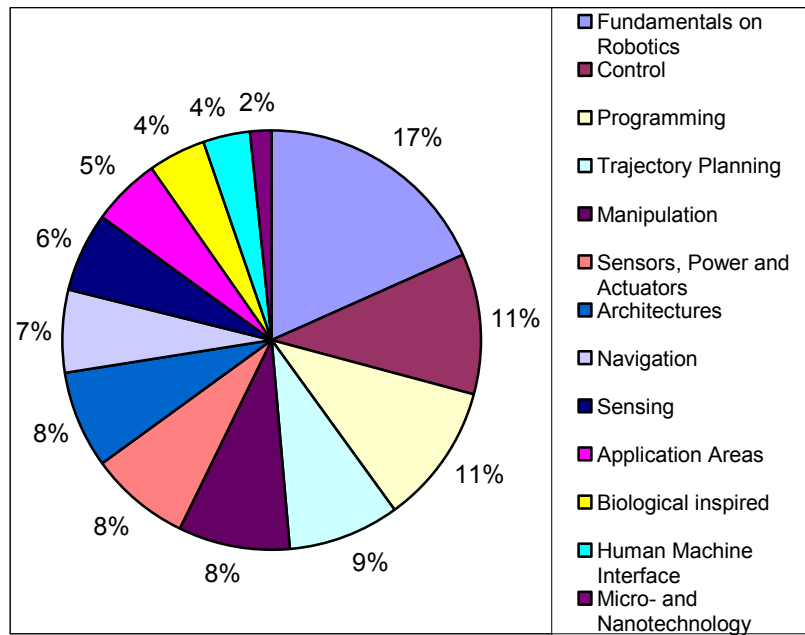


Fig. 2.b) Percentage of relevant topics in the robotic courses (May 2007)

However, some differences can be observed between countries. Fig. 3 shows the distribution of declared topics by country.

As can be observed, *Biological Inspired* and *Human Machine Interface* are relevant topics in Italy, (they appear in a big percentage of courses), compared with Spain and France.

Another difference is the case of *Manipulation* which seems not to be a relevant topic in Spanish Subjects' Contents.

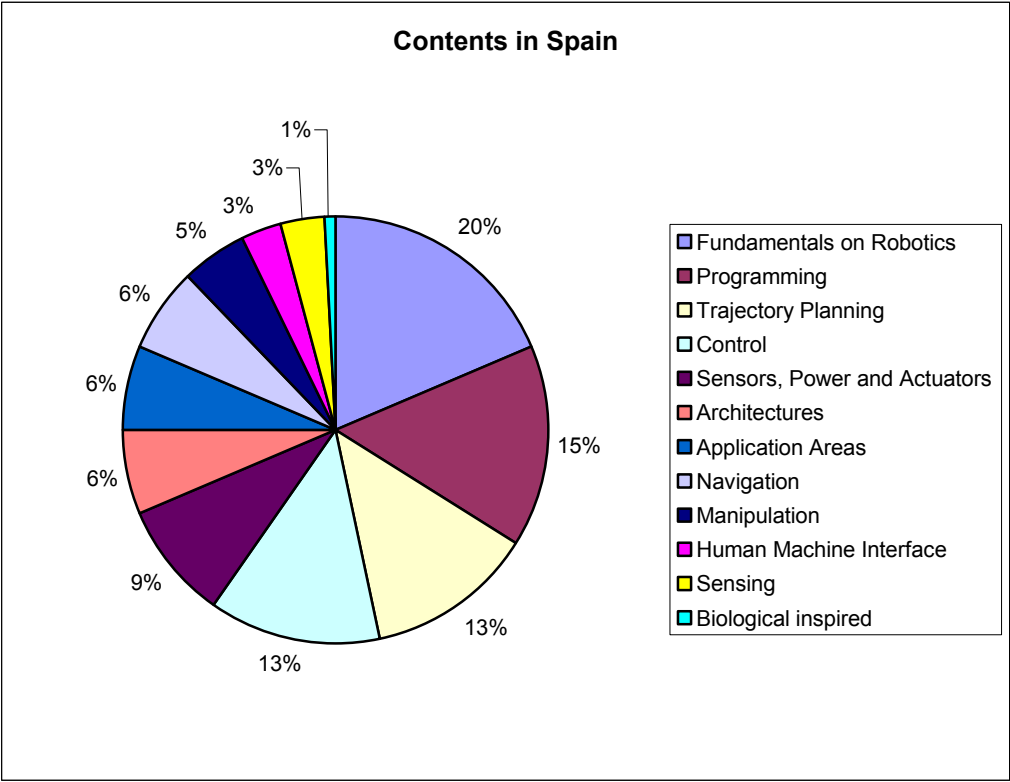


Fig. 3.a) Percentage of relevant topics in the Spanish robotic courses

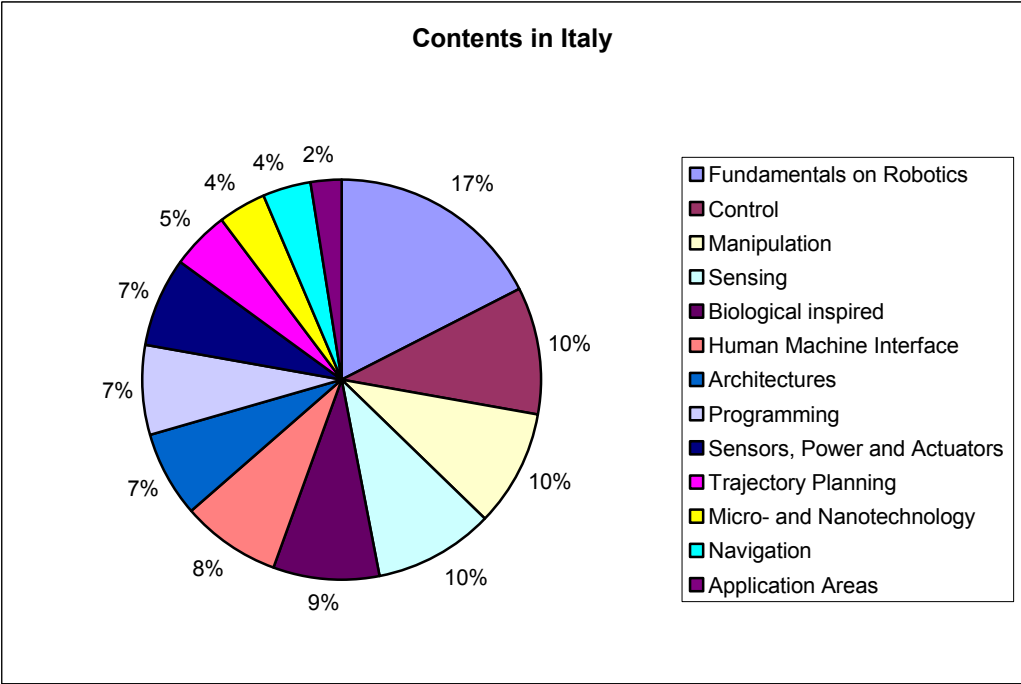


Fig. 3.b) Percentage of relevant topics in the Italian robotic courses

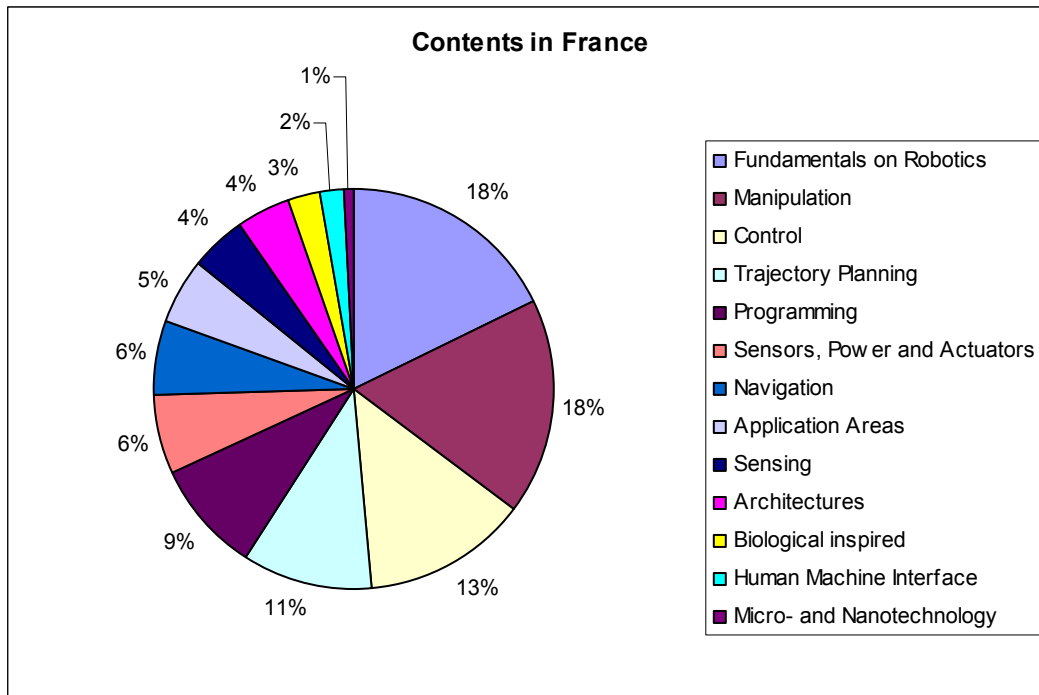


Fig. 3.c) Percentage of relevant topics in the French robotic courses

## Recommendations on Subjects' Contents

By analyzing the contents of registered courses in the RCDB it can be established a high diversity of Robotics subjects is present. About 50 courses has been selected as example of "Introductory Undergraduate Course on Robotics", all they with some differences. As an anecdote we have realized that courses from Spain present a high homogeneous format with respect to each other.

It seems then impossible to fix a proper recommendation with respect to the contents which could serve as a model to all others. If we tried to put together all the topics tackled on these 50 courses, probably we'd get a common Syllabus with more than 12 or 15 ECTS!

However we have tried to identify two different areas in these undergraduate subjects that seem to appear frequently separated in all the universities curricula around Europe. We have called these two repeated subjects as: "*Introduction to Industrial Robotics*" and "*Introduction to Mobile Robotics*":

### *Introduction to Industrial Robotics (5 or 6 ECTS)*

It would be focus on mechatronics fundamentals, manipulators and their use in Manufacturing Systems.

#### Goals

- to provide an understanding of robot analysis and technology, including the study of robot manipulators currently used in manufacturing industry, and an introduction to other applications for robotics (space, medicine, etc.).
- to communicate basic knowledge about design/construction and use of industrial robots.
- to form students' basic knowledge for specifying, purchasing and implementing use of robots in industrial applications.

Students will be able to:

- to describe the different mechanical configurations for robot manipulators.
- to choose the appropriate robot actuator and sensor technology for a given application
- to undertake kinematics analysis of robot manipulators
- to design, in concept, robot control systems
- to understand robot programming concepts
- to describe the social and economic impact of industrial robotics
- to appreciate in outline the current state and potential for robotics in new application areas (e.g. medical)
- to describe in outline current developments in robot technology research.

### *Introduction to Mobile Robotics (5 or 6 ECTS)*

#### Goals

- The aim of the course should be to provide the basics required to develop autonomous mobile robots.
- Application of Mobile Robots in Industry must be analyzed and discussed.
- Also behavior based systems could be presented in this introductory course.

Focus on:

- Architectures, Sensors, Power and Actuators.
- Mobile robot locomotion
- Perception
- Environment modelling
- Navigation, including motion planning and location.
- Real applications

But even in these two similar subjects that can be grouped under the same name, it remains differences in the way in which the different topics are treated, and also in how many hours each school dedicates to each topic.

This is why in order to fix a specific Syllabus for each of these subjects that serves as a model we must take into account in what kind of curricula context the subject is, that is, in which “Degree” the student is being formed.

We propose to make use of the statistical distribution of the declared topics tackled by the different courses within the RCDB, but related to the Degree (or Curricula) to which this subject belongs. We had already defined the next groups of different Curricula:

- Computer Engineering
- Electrical and Electronics Engineering
- Industrial Engineering / Automatic Control
- Mechanical Engineering

This statistic gives us a table like this:

	Computer	Electrical and Electronics	Automatic Control	Mechanical
Fundamentals on Robotics	10	9	8	2
Programming	6	7	9	1
Control	6	7	4	1
Trajectory Planning	6	7	6	1
Sensors, Power and Actuators	3	4	7	2
Navigation	7	3	3	1
Architectures	2	4	3	3
Sensing	4	3	1	2
Application Areas	4	3	4	2
Manipulation	6	1	2	2
Biological inspired	2	0	0	1
Human Machine Interface	1	0	0	1
Micro- and Nanotechnology	0	0	0	0

*Fig. 4 Distribution of topics within the courses considered in relation to the curricula*

We think this statistical data can be a good start point to propose a specific syllabus for each subject related to these degrees.

We must decide now whether to propose four different syllabus (one for each degree), or just make a big syllabus with some recommendations on duration of the different themes in the syllabus in relation to the degree. This last option seems to be more generic and easy to be considered by the community.

## Conclusions

After the study of the undergraduate courses registered in the RCDB we have committed ourselves to generate the Syllabus for two introductory courses on Robotics. One focused on Industrial Robotics and other focused on Mobile Robotics. For other courses there is impossible to try to make any recommendation due to the high diversity on the offer and the little number of courses registered.

On the other hand, the RCDB has been demonstrated to be useful providing information about courses contents, but it needs for more courses to be registered. Only when all countries have dozens of courses registered, we'll be able to establish conclusions from the statistics.