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Webbook with major sections

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Dissemination Level: PU

WEBook

Deliverable: DR 5.1

The most ambitious initiative within the Education and Training Key area is the Webook, a compendium of robotics material, as an electronic book, and for the same reason, the one with more difficulties to fully accomplish.

The Robotic WEBook is an electronic incremental book made available to the robotics' community by Internet. The main goal is to start a structure to compile contributions from the robotics research community to do a web compendium with a collection of tutorials on essential topics on robotics. The RoboticWEBook will provide also, a complete description of methods and applications of robotics methodologies covering the main topics on practice and research, including results in real experiments.

The compendium will compile a set of links to related material (papers, thesis, reports, virtual labs, emblematic research projects) and it will be a repository of public domain and shareware software for robotic applications.

The longer term of the project is to make a comprehensive Encyclopedia of Robotics shared by our community, and the RoboticWEBook will be converted into this more ambitious resource at some future point.

In this period, a new interface to facilitate the potential contributors to provide material has been developed, some contents added and the topics reviewed.

The WEBook separates basic science and technology topics from robotics-specific topics, because efforts to develop the former can be shared with related fields such as computer vision, control, virtual reality and computer animation, mechatronics, or machine design. It contains also a glossary of terms.

The current contents is mainly on the robotics part, because it is believed that when a significant amount of contents is there it will be much easier to complete the fundamentals. The topics are:

Kinematics & Dynamics

Serial robots
Parallel robots
Mobile robots & manipulators
Humanoids & walking robots

World & interaction models

2D/3D world maps
Interaction dynamics

Planning

Motion interpolation
Motion planning & navigation
Task planning
Mission planning

Sensing & estimation

Motion estimation
Localization & recognition
Model & map building

Control

Motion control
Interaction control

The current contents corresponds to the first level, presenting the different topics and orientation for contributions.

Fig 1 shows the global presentation, and fig. 2 and 3 are examples of two of the main topics, showing the links to each of the related subtopics.

THE ROBOTICS WEBOOK
The online textbook project

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Welcome to The Robotics WEBook, the online repository of **peer reviewed, PhD-level textbook material** on robotics.

The WEBook separates **basic science and technology** topics from **robotics-specific** topics, because efforts to develop the former can be shared with related fields such as computer vision, control, virtual reality and computer animation, mechatronics, or machine design.

The material is available as **HTML** webpages (for browsing), as **PDF** files (for the highest typographic quality), and in the **LaTeX** source code form (for local adaptation, e.g., in the course notes for your own robotics class).

The WEBook is **community-driven**, with an **open source** approach and an open **peer review**.

- The contents of the WEBook is available under a **free content license**, so you can use it without costs, and adapt it to your particular teaching and studying needs.
- Everybody can **contribute** to making the WEBook more complete. Contributions can be as simple as **feedback** on typographic errors, as constructive as critical (re-)reviews of available material, or as extensive as writing a whole new chapter on a not yet covered topic.

You keep the full copyright of the material you contribute, your name appears on your contributions, but you allow the WEBook to distribute them under its **free content license**.

- Contributions are only accepted after an **open peer review**: everybody can provide comments on a contribution, and all these remarks are publicly available. The only constraint on becoming a reviewer are: (i) you are expected to provide **constructive comments for improvement**, and (ii) you have to register yourself on the **mailing list**, so that we are able to keep a public archive of all discussions (*and* can provide spam protection!).

BASIC SCIENCE & TECHNOLOGY
Mathematics & physics
Mechanical design
Sensors & actuators
Systems & Control
Statistics & Bayesian probability

ROBOTICS
Kinematic & dynamic models
World & interaction models
Planning
Sensing & estimation
Control
Systems
History of robotics

GLOSSARY

Fig. 1 Presentation of the Webook project

THE ROBOTICS WEBOOK
The online textbook project

HOME | ROBOTICS | BASIC SCIENCE & TECHNOLOGY | GLOSSARY LAST UPDATE: 10 FEBRUARY, 2005

Planning

As soon as the robot controller can rely on **models** of itself, and of the environment it must act in, it can use the information in these models to predict the outcome of possible actions, in order to select the "best" one. This **planning** must take into account the **goals** to be reached in the current task, as well as the **constraints** on, both, the resources that the robot has available, and those the environment imposes on the motion degrees of freedom of the robot. In addition, the robot usually has only incomplete information about the world, so the planning must be robust against the influence of this uncertainty on the accuracy of the available models.

Planning algorithms come in a large variety, the division followed in the WEBook runs roughly along the lines of the **common hierarchy** of robot architectures:

- Interpolation**. This is the planning activity with the shortest time horizon, and the highest hard realtime constraints. It determines how the robot should move in each sample time of its fastest control loop, in order to reach the next target position. In other words, the path from "A" to "B" is subdivided in a large number of very small position increments. The calculation of these **interpolation points** only takes into account the constraints of the robot itself (workspace boundaries, kinematic singularities, actuator saturation, etc.), and not any possible external constraints (e.g., collisions with objects in the environment).

In general, interpolation is not limited to positions only, but can also be done on the time derivatives of position (velocity, acceleration, etc.). Also non-geometric "motions" can be interpolated, such as trajectories in joint torques, laser cutter power, or milling speeds.

Interpolation is most important in "hard realtime" robotic and automation: assembly, metal cutting, process

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PLANNING
Motion interpolation
Motion planning & navigation
Task planning
Mission planning

SENSING & ESTIMATION
Motion estimation
Localization & recognition
Model & map building

CONTROL
Motion control
Interaction control
Multi-agent control
Hybrid event control

SYSTEMS
Software architectures
Hardware architectures
Applications
Human-machine interfaces

<h1 style="margin: 0;">THE ROBOTICS <i>WEBOOK</i></h1> <p style="margin: 0;">The online textbook project</p>	
HOME ROBOTICS BASIC SCIENCE & TECHNOLOGY GLOSSARY	LAST UPDATE: 13 FEBRUARY, 2005
<h2 style="margin: 0;">Robotics systems</h2> <p>The ultimate goal of studying robotics is to be able to make working robots. That requires making choices about which robotics components (planning, sensing, control, hardware, etc.) to integrate into the robot system, and how to configure all these components.</p> <p>Fifty years of robotics research have produced some architectures (i.e., specific combinations of robotics components, both in software and in hardware) that have proven to work in practice, i.e., to solve particular goals. This Chapter of the WEBook describes these architectures. In addition, it presents discussions about what kind of applications can be solved, and about how people can interact with such autonomous systems.</p> <p>(TODO: to define in what form, and to what level of detail, systems should be described in the WEBook.)</p> <p>In many robotic systems, the components of modelling, planning, sensing and regulation/control are closely interacting, at various levels. The following three levels are often identified (implicitly) in the literature (with a sample of the terminology that occurs in the literature):</p> <ol style="list-style-type: none"> 1. Reactive/Operational/Motion/Hard realtime: the sensor signals and the planned motion are immediately transformed into actuation setpoints, and (almost) no model information is used. 2. Deliberative/Tactical/Task/Soft realtime: the sensor signals are interpreted within one or more possible models, and the current controller can be changed according to the outcome of this model interpretation. A replanning action can be needed when such a deviation from the current plan is recognized. 3. Reflective/Strategical/Mission/Non-realtime: the robot system is able to "reflect" about its interaction with its environment, and to generate its own models and plans, based on what it is learning from the sensor information acquired during the execution of lower-level programs. 	<div style="border: 1px solid black; padding: 2px; margin-bottom: 2px;"> KINEMATIC & DYNAMIC MODELS Serial robots Parallel robots Mobile robots & manipulators Humanoids & walking robots </div> <div style="border: 1px solid black; padding: 2px; margin-bottom: 2px;"> WORLD & INTERACTION MODELS 2D/3D world models Interaction dynamics </div> <div style="border: 1px solid black; padding: 2px; margin-bottom: 2px;"> PLANNING Motion interpolation Motion planning & navigation Task planning Mission planning </div> <div style="border: 1px solid black; padding: 2px; margin-bottom: 2px;"> SENSING & ESTIMATION Motion estimation Localization & recognition Model & map building </div> <div style="border: 1px solid black; padding: 2px; margin-bottom: 2px;"> CONTROL Motion control Interaction control Multi-agent control Hybrid event control </div> <div style="border: 1px solid black; padding: 2px; margin-bottom: 2px;"> SYSTEMS Software architectures Hardware architectures Applications Human-machine interfaces </div> <div style="border: 1px solid black; padding: 2px;"> HISTORY OF ROBOTICS </div>

Fig. 2 and 3 Examples of two pages of the webook, with the links to the different additional pages to which the reader can access. It is progressing as an encyclopedia that brings information from many different sources.