# Activities of the Robotics group at CIMAT

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The recently created Robotics research group at CIMAT gathers researchers working on the study and development of algorithms and applications of Computer Vision and Motion Planning for robots. Work is performed along the following directions:

- Sensing and Motion Planning Algorithms.
- Multi-camera and Multi-target Tracking.
- Landmark-based Navigation.
- Motion Planning with Dynamics.

Our talk is intended to review the activities on each of this areas:

## 1 Sensing and Motion Planning Algorithms

This research line studies sensing and motion planning algorithms for mobile robotics. The design of such algorithms raises new issues in motion planning, where sensing constraints and motion obstructions must be simultaneously taken into account.

The goal of this work is to develop techniques that allow one or multiple robotic observers to operate with autonomy while accomplishing the tasks of exploration for map building, sensor based navigation and target finding and tracking.

Some of the questions that this work answers are:

– What is the minimal information required to navigate in an environment with obstacles?

– Which locations must be visited by a robot to efficiently map an indoor environment?

– How should a robot move to find a target?

– What motions will keep the target in view?

One characteristic feature of this study is the need to satisfy sensing constraints while planning motions. Thus, this work focuses on the fundamental motion planning problem considering the information provided by the sensors. Our planning algorithms operate using simple but flexible models of the robot sensors and actuators capabilities. Computational and control techniques are used to approximate these idealized sensors and actuators to the actual ones. The possible applications of this work include: surveillance, search and rescue, manufacturing automation, etc.

## 2 Multi-camera and Multi-target tracking

This multi-form problem requires two kinds of algorithms:

1. Algorithms for tracking and detecting motion in video streams. These algorithms should be robust enough to handle difficult scenes with crowds, where occlusions do not allow the use of classical techniques, such as those based on histograms. We intend to base our algorithms on the tracking of local characteristics such as *interest points*.
2. Algorithms for geometric calibration of the system, specially with mobile cameras (PTZ). When using these cameras the geometry between the static scene and the camera has to be constantly estimated.

## 3 Landmark-based Navigation

This problem can be considered as a dual problem to the precedent: from a mobile sensor we need to extract stable and natural environment characteristics that are then going to be used to localize the robot. They must be specified in a way that authorize large viewpoint changes, variations in image acquisition and partial occlusion. We are also interested in the problem of incorporating these landmarks in a map built on-the-fly, with temporal filtering techniques at the core of Simultaneous Localization and Mapping.

## 4 Motion planning with Dynamics

This research deals with the consideration of dynamics directly into motion planning algorithms. We have used iterative algorithms in order to plan the motions of complex dynamical systems such as a humanoid robot. This has been done by performing a functional decomposition of the robots degrees of freedom in order to obtain simplified models . We have described a three stage algorithm that:

1. Produce a rough collision-free path that takes a simplified model of the mechanism to the desired location.
2. Use available controllers to generate a trajectory that assigns values to each of the mechanisms articulations to follow the path.
3. Modify iteratively these trajectories until all the geometric, kinematic and dynamic constraints of the problem are satisfied.

We have applied this approach to generate the motions of redundant human-like systems. We are interested in extending the use of the motion controllers, that take the dynamics of the system into account, into the motion planning process itself.