An Autonomous system for the locomotion of a Hexapod Exploration Robot

Pablo Muñoz[1], María D. R-Moreno[1], Javier Gómez-de-Elvira[2], Sara Navarro[2] and Julio Romeral[2]
[1]Departamento de Automática. Universidad de Alcalá.
28805 Alcalá de Henares (Madrid), Spain.
mdolores@aut.uah.es
[2]Centro de Astrobiologia (CAB)
28850 Torrejón de Ardoz (Madrid), Spain.
gomezej@inta.es

***Abstract*—P-Tinto is a hexapod robot designed to keep the equilibrium when moving around rocky and cumbersome areas during the exploration of the Tinto river in Huelva (Spain).**

We have developed an integrated planning and scheduling system called PIPSS to control the locomotion of the P-Tinto robot. PIPSS tries to make the better moves for the legs in order to keep the right balance and calculate the trajectory between two points. PIPSS exchange information with an executor system that execute the plan, and in case there are some obstacles that PTinto cannot avoid, a new trajectory will be re-calculated.

***Index Terms*— Legged locomotion, planning and scheduling, terrestrial robot, executor.**

I. Introduction

THE Tinto river crosses the South-West part of Spain. In its way to the Atlantic Ocean it crosses a miner area rich in heavy metals. The water, by the metal effects, presents some special features that make it very similar to the Mars planet: is red, dense and with limited oxygen, what has made scientist think that there is no life. Recent studies have demonstrated that there exist microscopic organisms that can life in that environment. In order to study them, the Astrobiology Center (CAB) in Spain is developing a terrestrial robot called PTinto to analyze shallow and difficult access areas in the Tinto river.

II. PTinto exploration robot

The legged robots represent an alternative to the traditional wheels robots. It is proven that they were quite inefficient in rocky and cumbersome environments. Legged robots offer better mobility in difficult terrains and they are more capable to overcome obstacles.

The PTinto exploration robot is composed of six legs (hexapod). This robot has one mini PC for the main program control connected with all the pods with a CAN bus. Also, each pod has a microprocessor with its necessary electronic components and low level programming to provide an interface with simple control commands. Currently the only sensors that the robot has are contact detecting obstacles for each pod.

III. The Architecture

The PTinto autonomous control architecture is a traditional 3 tiers or 3T architecture. The lowest tier constitutes the functional layer. The middle tier is an executive that executes commands to achieve the goals. The top tier is the planning tier that uses the AI Planning and Scheduling system called PIPSS (Parallel Integrated Planning and Scheduling System).

The novelty of PIPSS is that it defines an interface for each of the most important components of the planning and scheduling integrated search, which are: planning algorithm, scheduling algorithm and planning and scheduling integrated search scheme. This allows the cooperation of different components of these kinds, which can work together regardless of their particularities. Various standard patterns have been defined for each of these components that all algorithms must compulsory comply with. This way, it is possible to connect any planning and scheduling algorithms with any kind of integration scheme without the need to modify or enlarge other parts of the system. The PIPSS language is based on PDDL but extended to reason about resources, temporal windows and deadlines.

Due to the complexity of calculating the path and the legs that have to be moved, we have chosen to break down the planning problem into multiple layers, each operating at a different level of granularity and over a different horizon. One layer will calculate an optimal trajectory (to avoid detected obstacles) and other will optimize legs movement (based on time and costs).

IV. Future Work

PTinto is still in an early stage and the autonomous control system just controls its motion. There are still missing important control systems such as cameras or optical obstacles sensors before it can completely be deployed into the abrupt environment of the Tinto river.