Humanoid Robots

Academic Year: (2023 / 2024) **Review date: 30-01-2024**

Department assigned to the subject: Systems Engineering and Automation Department

Coordinating teacher: GONZALEZ VICTORES, JUAN CARLOS

Type: Electives ECTS Credits : 3.0

Year : 1 Semester : 2

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

Basic subjects on programming, control and industrial robotics.

OBJECTIVES

The objective is to introduce humanoid robotics. A historical review of this area of robotics is carried out, analyzing human evolution and focusing on the design of bio (human) inspired robots. The kinematic models of humans and our gait are analyzed, both from the energy point of view as well as temporal efficiency and ergonomics in service applications in common environments. All this leads to demonstrate the need for life-size humanoid robots.

We must highlight the complexity of robots with >20 DOF that require design and control both in space and in time. The most advanced robots (such as Atlas © from Boston Dynamics) use well-known strategies such as those studied in this course.

The course focuses on the study of humanoid models and their control, which is based both on more classical methods and on Lie logic models and the product of exponentials (POE). Likewise, the main concepts of humanoid control such as the Zero Moment Point (ZMP) of global postural stability and the Whole Body Motion (WBM) are introduced. In the dynamic part, models of distributed masses and concentrated masses are studied. Among the latter are the models of simple and double inverted pendulum (LIPM) and the model called "car-table".

Another part of the course is dedicated to the generation of robot steps (gait) both quasi-static and dynamic. In addition, both hardware and software control architectures, man-machine interfaces, OS and humanoid programming languages, and machine learning mechanisms that little by little will replace the more pre-programmed conventional mechanisms are described.

DESCRIPTION OF CONTENTS: PROGRAMME

1. Introduction
2. State of the art of humanoids
3. Definitions and classification of stability criteria.
4. Kinematics
4.1 Kinematics of bipedism
4.2 Models D-H
4.3 Model based on Lie Logic and POE
5. Dynamics
5.1 Classical models
5.2 Models of inverted pendulums
5.3 Model of "car-table"
6. Generation of gaits of humanoids
7. Grasping abilities
8. Control Architecture: hadware and software
9. Tasks generation: skills, learning, etc.
9. HMI and collaboration

LEARNING ACTIVITIES AND METHODOLOGY

Tutorials will be after the classes

% end-of-term-examination:	40
% of continuous assessment (assigments, laboratory, practicals…):	60