

Mathematical Model of a WheelChair

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Abstract. At this time, we have a project of basic and applied research, in the engineering and information technologies department in UPAEP, supported by the program of Basic Science of CONACYT 2007-2010. The project is the construction of a Service Robot that attends and assist people with differentiated disabilities or patient in recovery. Parallely, we are working with the paradigm SLAM (Simultaneous Localization And Map building). Also, we are integrating different models of artificial intelligence to improve the efficiency of the control algorithms [8].

Keywords: Mobile robots, modeling, nonlinear systems, position control, velocity control.

1 Introduction

The robotic prototype is a wheelchair, where the principal function is to transport a person of an origin to a predetermined destination, or simply for programmed walks, as a source of distraction or entertainment of the patient. For these two situations there is claimed that the robot always is communicating with the person to make his tour more pleasant.

To present the capacities that the prototype must have, we must depart from the mathematical model who describes its behavior (movement) in every instant of time, enclosed when it behaves as a wheeled inverted pendulum. Other elements, which motivate the creation of other capacities, will be included in the model only as adjustments of parameters of the same one, without changing its essential behavior.

The wheelchair will have the following capacities:

1. Stability in two wheels, to support its vertical position in two situations: with speed zero and constant.
2. Navigation and autonomous planning, or assist by the operator, in dynamic environments.
3. Communication with the human operator

1. The dynamic system of wheelchair is alike a wheeled inverted pendulum. The model of this underactuated system is derived with respect to the wheel motor torques as inputs while taking the nonholonomic no-slip constraints into considerations. The strong accessibility condition is checked and the maximum relative degree of the system is found. The resulting equations are then used to design two novel controllers. The first one is velocity controller for tracking vehicle orientation and heading speed set-points, while controlling the vehicle pitch (pendulum angle from the vertical) within a specified range. The second controller stabilizes the vehicle's position to the desired point, while again keeping the pitch bounded between specified limits.

2. For this purpose, we integrate a SLAM (Simultaneous Localization And Map building) method and a navigation algorithm for practical autonomous mobile robot. The SLAM method combines sonar sensors and stereo camera together using the EKF-based SLAM. Fusing sonar features and visual objects can give correct data association via object recognition and high frequency update via sonar features. The navigation algorithm consists of global and local path planner when the goal position is given. The global path planner uses modified algorithm and it gives the mobile robot enough opportunity to detect the registered landmarks during moving to the goal position.

3. In this case, the robot is equipped with auditory sensory system as well as hardware and software required to recognize speech. A person could provide verbal commands to the robot via the sensor.

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