Chapter 44

Study and Design of an Autonomous Mobile Robot Applied to Underwater Cleaning

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ABSTRACT

The chapter describes the stages of an autonomous mobile robot project, in this case, an underwater cleaning robot. First, the authors analyze the products already available for costumers, mainly focusing on the tasks they can perform (instead of the systems they use), in order to define the requirements of their project. Then, they build some models, based in the literature available. Based on them, the authors dimension the parts and systems by evaluating the results of these models. Finally, the authors use all information gathered to create a prototype, modeled with a CAE system.

INTRODUCTION

The main objective of this chapter is to design a robot, which "does a task," specifically, cleans a pool. Therefore, we will design an autonomous robot that cleans a pool. This is the concept of domotics: the use of available technology to make some house chore or just to provide a friendly interface to control the home systems.

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Thinking about autonomous mobile robots, we usually cite the vacuum cleaner, although there are many others.

Also concerning operations on the floor, besides the vacuum cleaner, some manufacturers have released floor-washing robots. Both are very similar, but the vacuum cleaner does not use water. Other autonomous mobile robots are window cleaners, which climb glass as they remove dirt. Since our work will be based on pool cleaning machines, we will briefly review their characteristics.

Thus, we will be able to start the modeling process and later design the prototype.

BACKGROUND

Nowadays, there are many options available to the costumer, and the prices are intimately related with their complexity.

The simplest model available is human controlled and it can just clean the pool floor. This means that the owner must not only spend his money, but he has to spend his time controlling the machine. Obviously, this does not fulfill the autonomy requirements of our project. However, this is an exception because the majority of the available models are autonomous. Nevertheless, they are differentiated by their features.

The simpler of them just cleans the pool floor randomly. It just has to determine the time needed to go through the pool ensuring that almost the whole pool is cleaned. Following this philosophy, a new feature was added: cleaning the pool walls.

Lastly, there are the robots which are able to map the pool and ensure that the whole pool is cleaned after a certain time. They usually clean the floor and walls, but some of them can just clean the floor.

Based on these points, we will design our own equipment, focusing on simplicity in order to reduce costs.

MAIN FOCUS OF THE CHAPTER

Pre-Project

The first step is to determine what features the robot will offer based on others available and on the market and consumer needs.

As an essential feature, our equipment has to clean the pool floor because this characteristic is available in all pool-cleaning robots.

However, on second thought, if the owner has to clean the walls by himself, he will not be inclined to buy this equipment, so the pool wall cleaning is an important feature too. Besides, since the customer looks for convenience, the equipment must also be autonomous.

Thus, only these few requirements guide our project.

Pool floor cleaning will demand brushes and pool wall cleaning will need a floater. The robot will also need a pump and a filter. For autonomy, the robot will require some sensors and some control devices.

Floating

We can think of two ways of performing the pool wall-cleaning task, one is by using a sucker or a floating system. The use of a sucker, or an array of them, depends on the wall material, and we do not want to restrain this. Therefore, the floating feature is the more reliable way to allow pool wall cleaning, because it depends only of specific mass of water instead of the pool physical characteristics.

The floating system consists, basically, of an empty tube, which can be filled with water and submerged. A piston controls the input and the output of water. To get water inside the system, a steel cable pulls the sealing disc, reducing the chamber pressure. Since the opening is in contact with the pool water, the chamber is filled. When the cable is released, a spring pulls the seal, increasing the pressure and discharging the water into the swimming pool.

Actually, the input of water increases the equipment's specific mass, making it greater than the specific mass of the water, making the equipment submerge. When the floater expels the water, the specific mass of the equipment is less than the water's specific mass and it floats. Our calculation will assume a Newtonian fluid and the load loss is negligible. Let ρ_w be the water specific mass, ρ_e the specific mass of the equipment when the floater is empty, and ρ_f when it is full of water. V