Universidad Continental

FACULTAD DE INGENIERÍA

Escuela Académico Profesional de Ingeniería Mecatrónica

Tesis

Proof of Concept Design for Terrain Type Recognition in Urban Environments

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Proof of Concept Design for Terrain Type Recognition in Urban Environments

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***Abstract*—The autonomous navigation systems of terrestrial mobile robots have shortcomings in recognizing their environment when they move. Therefore, in this research, a conceptual design for the autonomous displacement of the Andromina robot based on Orbbec Astra S hardware was developed, which enables the recognition of the terrain in urban environments using the machine learning technique. In this article, a recognition system has been designed using the embedded system and image processing of the terrain in urban environments, in addition to the flowchart that allows us to know the sequence of actions throughout the process of recognizing the nature of the terrain. In the same way, the electromechanical design is proposed as part of the proof of concept, accompanied by the study of various sources and using a few methods to delimit the subject.**

Keywords—Navigation, Andromina V2.0., Orbbec Astra S, Triple Diamond, CNN, VDI 2225

I. INTRODUCTION

Mobile robotics is a technology that has attracted much attention in recent years. For the mobile robot to operate autonomously, it must be able to navigate by itself [1]. Autonomous navigation is increasingly in demand in various application areas. One of them is the so-called reactive navigation, where the mobile robot operates in a dynamically changing and uncertain environment [2]. To achieve autonomous navigation of the robot, integrated multisensory elements have been invented to provide further information about the environment (Kinect and Orbbec) [3].

Special terrain data collection vehicles equipped with high-speed digital cameras are typically used to capture 2D or 3D images [4] and collect information about the environment in which they are in the form of images and signals as they move across the surface of the environment [5]. However, the challenges associated with an autonomous robotic platform are not only staying at one point while exploring its environment, but in most cases, it needs to navigate and know where it is at a given time when performing an assigned task [6].

Various research projects have developed methods for real-time detection in the locomotion of mobile robots, such as the identification of certain obstacles in the navigation environment using sensors that allow better imaging, which is important to prevent the robot from being blocked in its path [7]. Similarly, they can be used in the detection of certain defects in the terrain, such as potholes or holes that can compromise the mechanical integrity of the robot [8].

However, this research differs from the others by the type of detection given to the working environment, as some previous researchers propose the detection of cracks in asphalt [9] or the real-time analysis of obstacles in its trajectory, which contributes significantly to the autonomous navigation of mobile robots [10]. However, this work focuses on the detection of the terrain type by identifying the surface texture or roughness to evaluate the safety of the robot in moving during autonomous navigation.

This research shows the proof of concept for the development of the navigation system of the Andromina robot based on the Orbbec Astra S hardware with the ability to recognize the type of terrain in urban environments using machine learning technology. First, tools are shown that allowed us to delimit the subject to later present the objectives through the IDEF (Integration Definition for Function Modeling) 0 methodology. Then, the elaboration of a morphological matrix is shown together with a technical and economic evaluation. Finally, the flowchart of the proof of concept for the detection of the terrain type is detailed together with the electromechanical design.

II. METHODOLOGY

A. Type of Research

The present study corresponds to the quantitative research type. The research level of the project is the correlational one, in which the integration of autonomous navigation of the Andromina robot using visual recognition for independent movement in urban environments is realized.

The technique used for this research in perspective. A proof of concept is developed using an embedded system that recognizes the type of terrain in an urban environment.

B. Research Desing

The design chosen for the development of this research was the triple-diamond design, a variation of the double-diamond design. This design structure is more detailed in research, ideation, and prototype realization. During the three blocks shown in Fig. 1, activities are developed that converge at the beginning of another until the main research goal is achieved, which is a proper design methodology for this research [11].