Development of a robotic sensing system to assist visually impaired people in their task of locomotion in urban environments

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Abstract—The general objective of this work is to develop a mobile robotic platform that is able to perform a predetermined trajectory and to avoid obstacles for the benefit of visually impaired people. The idea is that this platform is a robot "guide dog" for visually impaired persons, and dogs like these have very high costs (20 to 40 thousand dollars), also need a long time for training (more than 1 year), being therefore inaccessible to many visually impaired persons. Our work then turns to social robotics, where we have a big problem with disabled people and who do not get freedom to move around in urban spaces without the help of a caregiver. By collecting data from ultrasound sensors, managing a possible path to the target point in an autonomous manner, using a computer vision system to recognize and treat the obstacles encountered, representing these in the form of audio to the user. The prototype was developed to serve as a platform for research in the development of navigational algorithms and computer vision systems of the automation laboratory of the FATEC (Faculty of Technology of Catanduva). The robot presented good results in tests with navigation algorithms and computer vision that were applied to validate this platform in tests with visually impaired people in IDVC - (Catanduva Institute for the Visually Impaired).

Keywords: (Social Robotics, Computer Vision, Deep Learning, Path Planing);

I. INTRODUCTION

In Brazil there are a number of social bodies and projects for the inclusion of people with some degree of visual impairment in society, such as the Benjamin Constant Institute (IBC), which is the national reference center for the visually impaired, the Brazilian National Blind Organization (ONCB), the Dog Guide Brazil project, among others. All with the same objective of improving the quality of life, vocational training and independence of the visually impaired. This work fits into the development of a prototype to provide this public independence in their day to day. Allowing them to be guided during their locomotion, giving them greater autonomy, also allowing communication with the user through audio and informing which obstacle was detected in the route of the robot. With this type of information being “spoken”, the user can take some kind of care and attention to a certain situation.

II. RELATED WORKS

A. Robotics System

We can divide the areas of Robotics into two parts, we have robot manipulators (robotic arms) and mobile robots [1]. The manipulator robots are focused on performing repetitive tasks where it is required precision in the assembly lines [1], also, we points out that manipulator robots act within a range limit (working volume) and with stationary (fixed) base. Focused on a mass production, the manipulator robots are dedicated to a process, once programmed, it must operate for months with little maintenance, thus guaranteeing a plan for profit.

Mobile robots have a locomotion system and are strongly connected with the areas of sensing and reasoning [1]. Robot soccer, humanoids, robots used in inspection operations (dangerous zones) [1] can be cited as examples. Next, mobile robots will be better detailed.

In a paper by Cuturi et al., [2] a robot was also developed to assist visually impaired people in their task of locomotion. However, this robot has been applied to internal environments (homes, hospitals, schools) and differs from our application that is geared to urban outskirts.

In another work by Matsumura and Marranghellos [3], a platform was also developed for the study of route planning algorithms. This platform has a hardware very similar to our work, however, focused on supporting the teaching of mobile robotics and not to aid the visually impaired.

B. Route Planning

The bioinspired hybrid controller developed by Bruno et al. [1] consists of a Genetic Algorithm (GA) and an Artificial Neural Network Perceptron (ANN) [1]. The RNA assesses whether the obstacle found is recognized or not. When recognized, a knowledge bank automatically provides a deviation solution to avoid the obstacle. When not recognized, GA is applied to produce new optimal routes. Some related work using GA and ANN for mobile robot navigation are presented in the following paragraphs.