

DESIGN OF A PERSON-CARRYING ROBOT FOR CONTACT COMPLIANT NAVIGATION

Carlos Gonzalez^{1,*}, Samantha Lee², Francisco Montano¹, Steven Ortega¹, Dong Ho Kang¹, Mehar Jaiswal¹, Junfeng Jiao², Luis Sentis^{1,*}

¹Department of Aerospace Engineering, The University of Texas at Austin, Austin, TX, USA

²School of Architecture, The University of Texas at Austin, Austin, TX, USA

ABSTRACT

Navigating human-centered environments is a complex task for robots. It requires having hardware capable of sensing the environment as humans do and requires software that efficiently reasons about this information in real time. Current robotic platforms tend to avoid contacts, while human robot interaction highly depends on this. We believe having platforms and algorithms that combine visual and tactile information is crucial in developing navigation algorithms for human-centered environments. In this work, we present the mechatronic design of our new mobile robot which is capable of carrying a person and that can sense its environment through contact and vision. We detail our design procedure, parting from design specifications to material selection and show its preliminary appearance along with some experimental navigation while carrying a person. We provide detailed analyses on our mechanical design through Finite Element Analysis simulations, present our material selection for all of the hardware components, and give details on our low-level code controlling our robot. We have set up our robot to work with the ROS framework and have shared our code, which includes the low-level code to communicate with the EtherCAT servo drives. We believe this information will ease development of new robots by the robotics research community.

Keywords: Mechatronic design, mobile robot, contact compliant navigation, ROS control robots

1. INTRODUCTION

The presence of autonomous mobile robots in human-centered environments has become more prolific over the last few years. Some popular applications include as personal delivery robots [1], personal mobility devices [2], service robots [3], home assistance [4], and even chatbots at airports [5], to name a few. Being able to efficiently navigate autonomously in these environments depends both on the algorithms developed for these

tasks but also in the sensing modalities of the robot itself. The robot must be able to collect observations of human motions (including social cues) as well as information from the scene to make predictions and act accordingly [6]. At the same time, it must be able to compliantly act upon both intentional and non-intentional physical contact [5, 7].

Deployment and proper testing of controllers that achieve the aforementioned tasks is often limited by the capabilities of the robotic platform being used. Most of the common commercial platforms used for autonomous navigation are often well equipped with cameras and depth sensing modalities [6], but often lack force sensing capabilities. On the other hand, mobile platforms that include force sensing often use this information to turn a safety controller on, e.g., to freeze the robot [7, 8]. In these cases, it is commonly the case that getting access to the low-level code to change these settings is not easy to attain.

The technological advancements in maker boards, the availability of fast prototyping, and the increased community support within the robotics community have eased the way for the development of new robotic platforms to overcome any sensing limitations. Several mobile robots are continually developed for different purposes, including autonomous navigation in GNSS-denied environments [9], to teach robotics using low-cost educational platforms [10], and to use as robotic assistants in hospital settings [11]. By equipping these approaches with more powerful hardware and slightly more sophisticated communication protocols, it is possible to build scalable systems capable of navigating human-centered environments in a more holistic manner. In this work, we present our new platform, dubbed *Bumpybot*, equipped with vision and force sensing modalities to explore a wider range of navigation algorithms, and which is also designed to carry heavy payloads. We have made this platform user-friendly by making it compatible with ROS (Robot Operating System), which will also allow us to benchmark our algorithms.

Despite concerns from part of the community to seek navigation solutions that avoid contact at all costs [12], there is also

*Corresponding author: carlos.gonzalez@utexas.edu, lsentis@utexas.edu