Real-time Assistive, Adaptive and Intelligent Mobile Robotic Control for the Powered Wheelchair

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ABSTRACT The SYSIASS project is an Interreg IV A 2 Mers Seas Zeeën Cross-border Cooperation which aims to address the uptake of new technological advances within the healthcare professions. One aim is to develop an intelligent system for assisted navigation and control of powered wheelchairs. Autonomous indoor robotics requires accurate knowledge, tracking of objects, and self-localisation within that operating environment. While these autonomous robotic systems are suitable for workshop or factory, when human interaction becomes part of that system, it is necessary to adapt that system to allow for the additional requirements of the human passenger, both in terms of comfort of motion and additional user interaction governing the behaviour of the system.

The aim of our proposal is to allow the system to be assistive not autonomous and directive, allowing user independence and encouraging self-empowerment giving suggestive feedback to the user. A smart and adaptive system is proposed which emulates biological behaviour; obstacles are detected by smart sensors which differentiate between dynamic and static, and utilising highly localised non-linear potential fields allow the user negotiating these obstacles far greater flexibility with manoeuvring around them. The user is given feedback from the smart sensors and the trajectory generating input device, responses are then used to tune the localisation of the potential fields and the input device. Thus the adaptive system allows the user a more natural and consistent yet flexible trajectory which is independent of the user's fluctuating physical abilities. Rather than removing control from the user, it assists them with generating their own obstacle avoiding trajectories addressing the issue of autonomous robotic wheelchairs setting back wheelchair user's autonomy and habilitation.

KEYWORDS assistive, control, adaptive, wheelchair, localised potential fields, obstacle avoidance, robotic

REFERENCES

[1] Bourhis G, Moumen K, Pino P, Rohmer S, Pruski A. Assisted navigation for a powered wheelchair, Systems, Man and Cybernetics, 1993. Systems Engineering in the Service of Humans. International Conference on 1993; 3:553-558.

[2] Randall Flanagan JR, Vetter P, Johansson RS, Wolpert DM. Prediction Precedes Control in Motor Learning. Current Biology, 2003; 13: 146-150.

[3] Koren Y, Borenstein J, Potential field methods and their inherent limitations for mobile robot navigation. Proceedings of the IEEE Conference on Robotics and Automation, Sacramento, California, 1991; 1398-1404

[4] Carlson T, Demiris Y. Human-wheelchair collaboration through prediction of intention and adaptive assistance, Robotics and Automation, ICRA 2008. IEEE International Conference on 2008; 3926-3931.

[5] Demeester E, Hüntemann A, Vanhooydonck D, Vanacker G, Van Brussel H, Nuttin M. User-adapted plan recognition and user-adapted shared control: A Bayesian approach to semi-autonomous wheelchair driving. Autonomous Robot; 24:193-211.

[6] Demiris Y. Prediction of intent in robotics and multi-agent systems. Cognitive Process 2007; 8:151-158.

[7] Nisbet P. Who's intelligent? Wheelchair, driver or both? Proceedings of the 2002 IEEE International Conference on Control Applications. Glasgow. UK.

[8] Perrin X, Colas F, Pradalier C, Siegwart R. Learning to identify users and predict their destination in a robotic guidance application. In: Howard A, editor. Field and service robotics. Berlin Heidelberg: Springer; 2010. p 377-387.

[9] Taha T, Miro JV, Dissanayake G. POMDP-based long-term user intention prediction for wheelchair navigation, Robotics and Automation. ICRA IEEE International Conference on; 2008. 3920-3925.

[10] Urdiales C, Fernandez-Carmona M, Peula JM, Annicchiaricco R, Sandoval F, Caltagirone C. Efficiency based modulation for wheelchair driving collaborative control, Robotics and Automation ICRA IEEE International Conference on; 2010, 199-204.