Towards Acceptable Close-Proximity Behavior of Mobile Robots

As modern society is preparing to face new and complex challenges, such as overpopulation, hunger, demographic changes, aging of population, etc., Robotics appears to be an inspirational science field, towards which society is looking with the hope of finding answers for some of these issues. Creating truly autonomous machines that could be used in day-to-day life, for all sorts of tasks, has been a dream and fascination of humanity for centuries. While current day robots are still far away from the sentient beings envisioned by Science-Fiction, the technological advancements from the recent decades have certainly brought the idea closer to fruition.

Although they have been around for decades, the vast majority of robots have been used in industrial production related applications, where they could perform tasks that used to be done by manual labor, such as welding, spray painting or moving objects between various machines. However, due to both scientific advancements and changes in the societal context, there has been an increase in the desire of using robots in other areas, such as agriculture, welfare or healthcare.

In general, when discussing about applications in which robots are involved, a very important factor that has to be considered is safety – both for the benefit of the human user and of the robot itself. In industrial applications, safety can often be ensured by using protective equipment (e.g. hard hats, safety goggles), protective fences or visual and sound alarms, or by avoiding direct human-robot contact altogether. Nevertheless, these methods can not be applied in domains as welfare or healthcare, where robots have to work very closely with humans and the use of safety equipment is unrealistic. Additionally, because these robots have to also be used by non-expert users (such as patients or elderly people), their displayed behavior has to be predictable and understandable. To achieve this, the robot has to first be capable of distinguishing its environment and then to understand and properly respond to humans.

A robot can interpret and understand its surroundings through its sensors (e.g. cameras or microphones). However, because each sensor has its own limitations, it is desirable to use more sensors in parallel. This can be done by using sensor fusion techniques, where the information of multiple sensors can be combined in order to generate a better result. Furthermore, a robot can use the sensors to detect the human users activity and generate proper responses. To do this, the robot has to detect and generate social feedback cues, which can be verbal or non-verbal actions (e.g. facial expression, body movements, sounds) meant to guide the interaction.

In this thesis different aspects of human-robot collaboration are explored, with the goal of designing methods for creating non-harmful, intuitive and proper robot behavior. This includes the investigation of different sensor fusion techniques and the effect that social cues have on human-robot interactions.