Proposal for IDP

Title: developing an algorithm for automatic generation of pHRI safety curves and visualization of safety relevant data

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Introduction

In the past years numerous breakthroughs in the field of lightweight robots have been achieved. These systems become more and more capable and affordable. However, the ultimate goal to enable robots working side by side with humans is still not reality, as two major barriers have not been overcome yet. Firstly, the handling of robots is still limited to robotic-experts and secondly, the safety of physically interacting persons can hardly be guaranteed. An approach towards safe physical human-robot interaction (pHRI) can be found in [1]. This IDP is based on the above mentioned research and is aimed to realize a key component which is necessary for this safety approach. Generating safety risk curves from experimental collision data which so far was done manually shall be automated based on the methodology shown in figure 1. Additionally, the visualization and management of safety data shall be addressed.

The approach used in the research [1] is based on experimental data. This data is then used to form an injury dataset from which the following mapping is derived:

$f : (mass, velocity, curvature) \rightarrow injury$

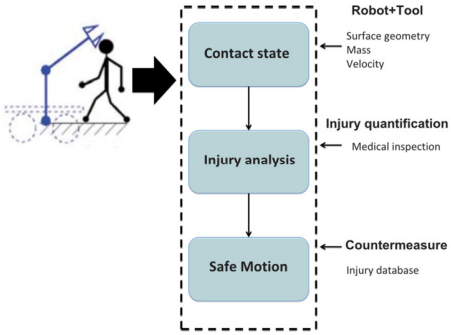

Figure 1 – Medical evaluation based on mass, velocity, and surface geometry to ensure safe motion behavior

Objective

The authors of [1] suggest that in order to guarantee safe pHRI a robot's velocity must be reduced so that a collision between robot and human will not lead to an injury which may result in permanent damage. The algorithm designed for this purpose has yet been showcased with a rather limited number of injury data. To use the developed safety algorithm in reality the comprehensive gathering of more injury data will be of paramount importance in the future. Consequently, a methodology for organizing/synchronizing this vast amount of different safety data must be developed, which is the objective of this project. Beyond the methodology a

visualization software will be developed which is able to generate risk curves from different datasets. These risk curves can then be further utilized as part of a pHRI workplace risk assessment.

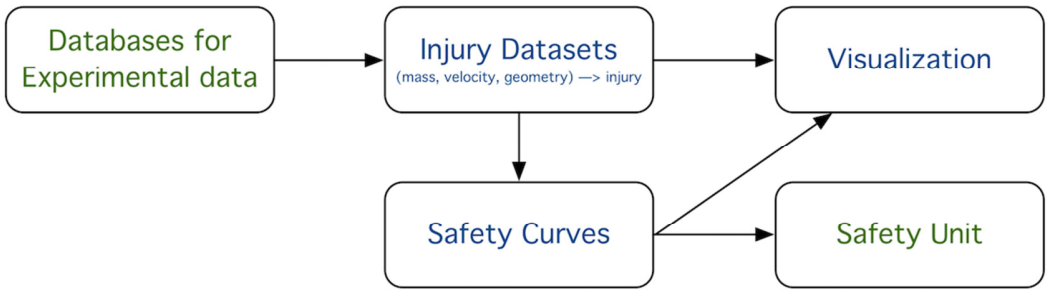

Figure 2 - Existing components in green, missing components in blue

Tasks

1. Data extraction from the raw experimental data to form the injury datasets: This data comes in form of a rational database. A tool should be created to extract the data and then process and convert it to the desired input for generation of safety curves.
2. Design/Use of algorithms for generation of safety curves from the injury data sets: This mainly involves the use of optimization methods like linear regression.
3. Visualization of the data and safety curves
4. Enabling dynamic interaction of the user with safety curves and the underlying data: The user should be able to interactively load different datasets, choose the safety curve generating algorithm and set different thresholds and parameters based on the risk level of the application.
5. Using a real robot to validate the created safety curves within the safety algorithm.

References

[1]: Sami Haddadin, Simon Haddadin, Augusto Khoury, Tim Rokahr, Sven Parusel, Rainer Burgkart, Antonio Bicchi and Alin Albu-Schäffer, On Making Robots Understand Safety: Embedding Injury Knowledge into Control (2012)