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Enabling Collision Avoidance in Human Robot Collaborative Industrial Environment: Prototype of Safe UWB-Based Hybrid System.

ABSTRACT - Masterthesis

Manufacturing industries are in a race nowadays to introduce Human Robot Collaboration (HRC) to their industrial production lines. Evolutions in interaction and collaboration between a human and a robot arise from the necessity for more efficiency, powerful, flexibility and productivity task accomplishment. However, the most important requirements for HRC is to maintain human safety by avoid collision between the robot and the human. In this work a proposed prototype collision avoidance system for HRC system is introduced. The prototype system has the features of being more design flexible suitable for different workspace scenarios, real-time operation, plausible decision making, collaborative production task enhancement, and fast collision avoidance response. The system operation is based on hybrid multi human position estimation sub-systems with smart plausibility algorithm capable of avoiding collisions with working industrial robots. The prototype system will execute only plausible emergency stops that form risk to the human performing a collaborative task together with the robots, which will efficiently increase production rate under human safety standards.

As the first main trend, the aspects of using indoor positioning system IPS was explained by introducing the concepts of various possible configurations of IPSs applications. Advantages and limitations of these scenarios of obtaining a human position estimation were introduced and the selection of the best solution in providing plausible estimations was also discussed. Such solution was the core of developing a smart collision avoidance algorithm which can detect un trustable human position estimations using three proposed layers of plausibility checks. Smartness presented in distinguishing between instantaneous estimation errors and system failures that form no risk to the human from critical ones. The second main trend was the obtaining a full robot body sensing by modeling robot joint angles and arms interpolation by forward kinetics. Full structure coordinates of a robot are instantaneously provided through real-time data fetching from robot controller and processing. This step enabled the system to sense fixed and movable parts of the robot in coordinate with the human motion.

System integration of these two main trends resulted in the implementation of a collision avoidance system prototype capable of providing two major attainments in HRC industrial workspace environment: human safety and increased task productivity. Furthermore, Power transformer assembly tasks were assumed as an application, where specific human interaction is required. Results were satisfying from human safety, task productivity, real-time response, and cost-effective prototype implementation point of views.