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DEVELOPMENT OF A ROBOTIC GLUE APPLICATOR
SYSTEM FOR VARIABLE DOOR PROFILES

ROBOT-LIIMISEADME ARENDUS ERISUGUSTE UKSEPROFIILIDE
LIIMIMISEKS

MASTER THESIS

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SUMMARY

The main objective of this thesis is to develop a robotic glue application system for variable door profiles. The door profiles are manufactured by a leading Estonian door manufacturer, T-Tammer OÜ and the are solutions developed for the automated gluing process by ABB AS in Estonia and feature ABB's vision guided robot offering which combines robotics and vision to achieve the desired results. For this thesis task, certain constraints were applied to the design and a broader solution containing more use cases can be worked upon in the future. For example, the system can be further developed to service doors with circular profiles and a vision based system to detect the application of glue can also be developed. These are currently not included in the solutions.

The thesis consists of four sections. The first section discusses the production process of doors with the use of manual work and human labour for all tasks, particularly focussing on the glue application process and its characteristics. The latter part of this chapter discusses the need for an automated system. The need for an automated solution is defined by the manufacturer due to them wanting to improve the efficiency of their production process, with emphasis laid on the cycle time of the gluing process. As such, these expectations form the basis of targets to be achieved by the automated system which is developed.

In the second part of the thesis, Vision guided robotic systems are discussed in general. Starting from a brief history of computer vision, the chapter deals further on with the different components critical to vision systems. In particular, emphasis is laid on lighting systems; sources of light and techniques of lighting, lenses which can be selected and parameters which lenses control in obtaining a good image, image sensors and the basics of working of these , integrated vision kits from ABB and communication between the camera system and process or robot controllers. From Lighting to lenses and from Cameras to communication, the various important parameters and criteria in the selection and design of the system for the solutions are discussed. The chapter also provides a primer on the vision algorithms and tools which can be selected in the RobotStudio package, particularly highlighting proprietary algorithms which make using vision tools easy, such as PatMax.

The third part of the thesis deals with explaining the two solutions proposed and installed in phases. This section deals with the selection of vision components, the robot and its controller, a brief working of the nozzle system and the nozzle holder bracket developed for these solutions, the configuration of the vision algorithms for each of the solutions and finally an explanation of the robot program in each case. In addition to this, the systems developed for safety are also explained.

The chapter concludes with a comparison between the performance of the two solution's components and design ideologies; the principle difference being that one solution featured two cameras, one of which was mobile. The other solution, on the other hand, made use of input from one stationary camera, and it turned out to produce better results and faster cycle time.

The final part of the thesis allows the reader to understand the end impact realised by implementing the solution and also provides insights into future developments of the system. Overall, through a combination of using RobotStudio for simulation and through trial and error of auxiliary components, automation of the gluing process was successful with the help of a vision guided robotic system, while meeting and exceeding the customer's expectation of achieving a significant drop in the gluing process' cycle time.

KOKKUVÕTE

Lõputöö peaesmärgiks on väljatöötada robotiseeritud liimimissüsteem, erinevate usteprofiilide rakedamiseks. Uste profiilid on valmistatud juhtiva uksetootja T-Tammer OÜ poolt ning ABB AS'i poolt väljatöötatud lahenduste nägemisjuhitava robotisüsteemist, mis pakub kombineeritud robotika ning kaamerapõhiseid lahendusi tulemuse saavutamiseks. Antud lõputöö ülesandes on kasutatud kindlaid piiranguid disaini osas, mis tulevikus võib edasi arendada. Näiteks süsteem võib olla edasi arendatud ümarate profiilide liimimiseks nägemisjuhitava robotisüsteemi poolt.

Lõputöö koosneb neljast osast. Esimene osa käsitleb uste terviklikku tootmisprotsessi, kus on kasutatud ainult inimtööjõudu. Lõigu põhifookus on liimi pealekandmise protsess ja selle eripärad. Peatüki lõpp keskendub automaatsüsteemi vajadusele, mille on määratlenud uste tootmisettevõtte. Eesmärgiks on võetud tootmisprotsessi efektiivsuse parandamine. Eelkõige on magistritöö rõhk seatud liimimisprotsessi kestvusel ning viisil, kuidas kasutatav automaatsüsteem aitab eesmärke täita.

Teises osas on vaatluse all tehisnägemisega robotid. Antakse lühiülevaade tehisnägemise ajaloost, keskendudes valgustussüsteemidele, valgusallikatele, läätsede valiku-ja toimimispõhimõtetele. Näitena on toodud ABB integreeritud tehisnägemissüsteem. Lisaks tutvustatakse ABB RobotStudio programmeerimistarkvara algoritme ja tööriistu, keskendudes algoritmidele, mis lihtsustavad tehisnägemise funktsioonide kasutamist nt PatMax

Magistritöö kolmas osa selgitab kahte tootmisesse paigaldatud süsteemi. Tutvustatakse roboti ja kontrolleri valiku-ja tööprintsipe, düüssüsteemi ja düüsi kinnitusklambri lahendusi, mõlema paigaldatud nägemissüsteemi konfigureerimise algoritme ning selgitatakse robotprogrammi toimimist. Peatüki lõpus kirjeldatakse arendatud ohutussüsteeme. Kokkuvõttes on võrreldud kahe süsteemi komponente, tehnilist lahendust, tööprintsipe ning analüüsitud mõju liimimistsükli ajale.

Viimases osas selgitatakse lugejale, missugust efekti avaldas paigaldatud tehisnägemissüsteemiga robotsüsteem tootmisele ning arutletakse võimalike edasiarenduste osas. Kasutades nii RobotStudio simulatsioone kui katse-eksitus meetodi korral väliseid komponente