Robots Assisting in the Packaging Industry

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Abstract

How can robots effectively assist humans in the packaging industry, when it comes to handling large components, such as a LCD television? This is the question that scientists and industry partners of the research project “CustomPacker” [1] are seeking to answer. The aims of the project are to free the human worker of tedious, unchallenging work, whilst simultaneously reducing packaging costs.

Area of Conference Topic: Robotics in Production / Industrial Robots

Keywords: Safe human-robot cooperation / cooperating robots

1 Motivation

The packaging of electronic appliances currently presents a big obstacle in industry of installing robotic systems. Furthermore the development of robotic systems and their integration is time-consuming and the industrial state of the art often resembles a patchwork of ad-hoc solutions [2]. Added to the fact, the efforts and costs required for the integration and reconfiguration of the systems are enormous and by far exceed the costs of the robot components themselves [3].

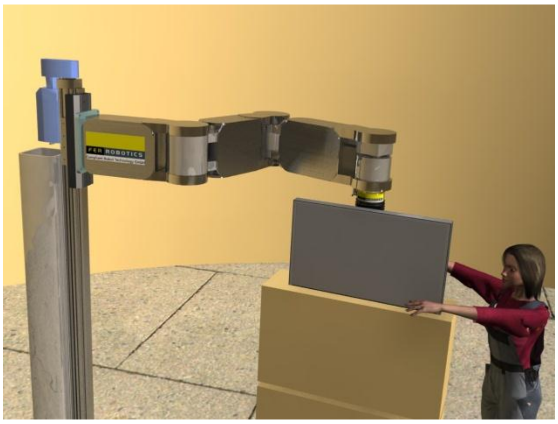

Figure 1: Scenario

One of the reasons for this is the time cost of slow, old fashioned programming methods as well as the cost of the necessary preparation of the robot’s work space and work-piece processing. These barriers have resulted in only around 25% of all potential applications currently being controlled by robots.

2 Project Overview

Consumer behavior indicates that one’s viewing experience is generally enhanced when the television is as large and flat as possible. However, television manufactures have encountered a problem whilst trying to keep up with this trend: Naturally increasing the size of televisions has increased their weight. So much so, that they are starting to exceed 50kg; the maximum load that is permitted to be carried by a human. This leads us to the question as to whether a robot would be able to work interactively, efficiently and safely alongside a human worker, in a constantly changing working environment [4]. The EU- Project “CustomPacker” (Highly Customizable and Flexible Packaging Station for mid- to upper sized Electronic Consumer Goods using

Industrial Robots) is hoping to find the answer by developing new hard- and software solutions for a packaging cell.

3 Safety aspects within the packaging cell

Safety is a fundamental cornerstone in the implementation of the CustomPacker project. In the past there has always been a distinct separation between the human worker and the robot. In order for there to be human worker-robot cooperation, human workers within the working area of the robot must be able to be detected. There are different methods to achieve this: One is to detect the location of humans by using laser scanners. A second method is to use deep imaging cameras, which are attached to the robot cell. A third is to use safety mats that can monitor the entire working area of the robotic cell, both in terms of the position and presence of people.

In this EU Project an industrial robot will be used together with a human worker in the packaging process. Therefore the robot must be able to work together with the human work in the same work place efficiently, safely and interactively.
This is where FerRobotics specializes. The FerRobotics Compliant Robot Technology GmbH is the world's only provider of resilient and flexible robotic systems, which are gentle, yet strong at the same time, as can be seen in Figure 2.

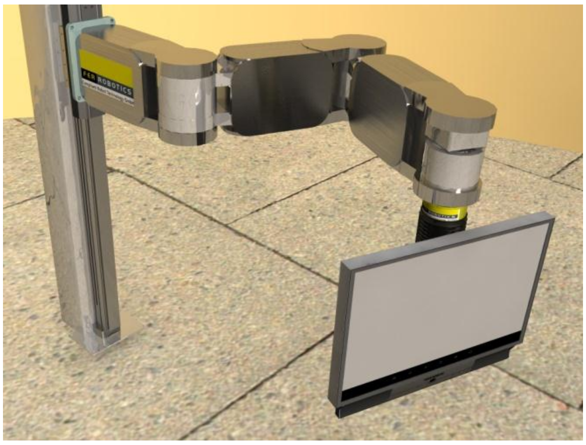

Figure 2: CustomPacker robot arm (FerRobotics)

Humans and robots work shoulder to shoulder in a small environment under the CustomPacker project. The robot frees the human worker of strenuous manual work, however the worker is still required to help guide the television into its packaging by hand and placing further accessories into the carton. Existing industrial robots designed for lifting heavy loads are very dangerous and are a strict no-go area for humans [5].
FerRobotics has implemented its intuitive, flexible "Compliant Robotic Technology" into CustomPacker, which has been especially developed for flexible work in small series production in a human-oriented environment [6].

4 Software components (examples from project)

Figure 3 depicts the draft for the overall software architecture within the CustomPacker packaging cell.

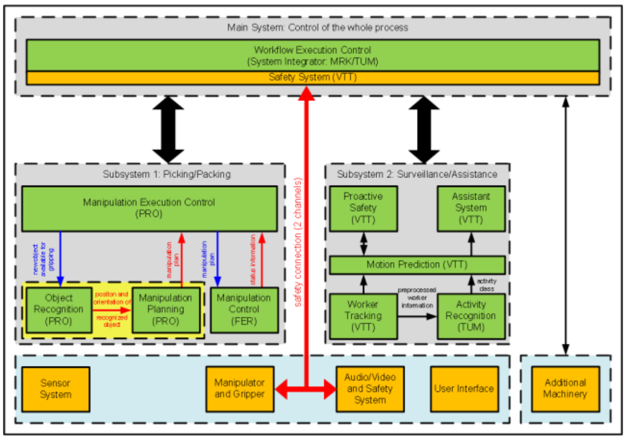

Figure 3: CustomPacker software architecture

It consists of two major subsystems. One is responsible for picking and placing and the second is responsible for observing the work space during the packaging task. The whole system is controlled by a workflow execution module while monitored by a safety system.
In the following chapters, only two aspects of the whole system are introduced.

4.1 Object localization and manipulation planning

In order to track the position and orientation of the packed television sets, a CAD based image processing solution is needed. 3D scanners will be used to record and divide the 3D point cloud images into objects and obstacles. Figure 4 depicts the localization of sample parts in a storage box.

The 3D object recognition will be based on the knowledge of previously known objects and their position can be determined to within six degrees of freedom. The monitored data from a scene can be put together with the help of this previously known information collected by the CAD, thus the avoidance of collisions can be calculated more efficiently.

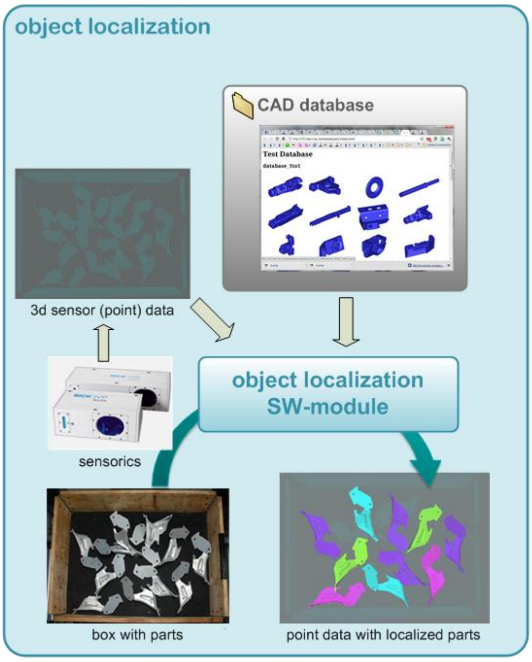

Figure 4: Object localization

By using the CAD-based approach, more information regarding the object can also be detected (e.g. the TV set gripping points), which is important for subsequent processes.

4.2 Activity Recognition

In order for the human worker to be optimally supported whilst working with the system, it is envisioned that the activities of the worker will be monitored. Such information is necessary in order to prepare the correct configurations for the next production step. If this information was not recorded, there would continue to be a limited ability to detect errors in production. In such cases a simple signal could alert the worker to show that a step in production has been missed.

For this, the work area is monitored using a camera system, which extracts the relevant information from the image data. Current sensor technology such as a Microsoft Kinect sensor can be used to achieve this. The Kinect sensor delivers up to thirty synchronized, color and deep image pictures per second, allowing for accurate human detection and pose recognition.

5 Summary and Conclusion

We presented some of the relevant components and aspects, which are considered within the CustomPacker project to help the packing industry for heavy consumer goods in further automating their work-flow and relieving laborers from unpleasant work.

As a test bed for the components introduced above, two demonstrators were set up within the project. For testing and evaluating research aspects, a research demonstrator was created at the Technische Universität München at the Institute for Machine Tools and Industrial Management. The resulting hard- and software components will afterwards be transferred to the industrial demonstrator within the factory environment of the partner and sample end-user LOEWE.

These demonstrators incorporate developed and integrated concepts required for future human robot interaction within an industrial packing application. These topics range from inherent safe robot stations over certified safety devices, to methods for designing packaging workflows.

Furthermore, the recognized worker activity can help to make the robot a better assistant, because he “knows” what his human counter-part is doing. On the other hand the motion planning of the robot within the modeled working cell can also take the activity into consideration to adapt the planned robot motion, avoiding a safety related stop or shutdown.

The consortium, which consists of several international partners, wishes to develop new methods and systems to help form a scientific basis for a new generation of robots in the industrial sector. This means that production should be flexible and adaptive to changes that may arise in the robot industry and to various processes. Furthermore the programming and reconfiguration of the system should be intuitive, allowing those who don’t possess a robotics background to be able to operate it; this should lead to an improvement of the ergonomics in the work place. Last but not least, it is envisaged that the processes of labor intensive production will be able to be effectively carried out using human-robot cooperation for the first time.

6 The Project Consortium

The project consortium consists of seven European partners:

- Technische Universität München, Munich, Germany (project coordinator)
- FerRobotics Compliant Robot Technology GmbH, Linz, Austria
- LOEWE AG, Kronach Germany
- MRK-Systeme GmbH, Augsburg, Germany
- PROFACTOR GmbH, Steyr-Gleink, Austria
- Tekniker, Eibar, Gipuzkoa, Spain
- VTT, Finland

Please visit also our project homepage for more information: http://www.custompacker.eu/

7 Acknowledgement

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8 Literature

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