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Intelligent disassembly in the demanufacturing process

The industrial revolution did not take the environment into consideration when designing products. However, today the eco-friendly design of products is a task that gets more visibility due to the great quantity of industrial waste generated to finalize the useful life of items such as household appliances, electronic and mechanical products, etc. In order to accomplish this objective of waste reduction generated by the products, governments are introducing laws that promote and compel the product recycle; this recycling includes a profit, however small, by the reuse of components or raw materials when the product's useful life has ended.

The industrial recycling process becomes more important due to the increasing necessity of optimizing resources. The key to recycling is the non-destructive disassembly, which allows separation of the materials, components and toxic materials. The raw materials can be used as new clean materials, and the components with the aim of re-use in new products.

Automatic disassembly is a technology that tries to perform this task of great interest and it is supported by international institutions with research programs and funds in this field.

The automatic disassembly techniques allow separation of the different elements that compose a product. That separation is performed for two different reasons: as a maintenance task (to exchange a component for another one) or as a recycling operation. This second approach can focus on the product components or on the raw materials that compose it. According to the target desired, two types of recycling approaches can be considered: the non-destructive disassembly and the destructive one.

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Non-destructive disassembly allows the separation of components, which can then be re-used in new products, optimizing the resources. Moreover, non-destructive disassembly can also be used in maintenance tasks.

On the other hand, destructive disassembly is used if the component separation requires the destruction of some part, which does not allow direct re-use in new products. Taking these characteristics into consideration, destructive disassembly is performed using a geometric model of the components that compose the products, and computing the optimal cutting points to perform the optimal disassembly of the product.

Destructive disassembly is used when the target objective is recycling the raw materials that compose a product, i.e. separation of plastics from metals, separation of different types of materials, etc. In this approach, the target objective is acquiring the materials for recycling and re-use in other new products. On the other hand, in a great majority of instances it is more interesting to use the destructive disassembly approach to perform a recycling process because this approach allows the removal of unions among components which allow a more complicated non-destructive approach, like in weeding, stamping, clinching, etc.

Product disassembly can be performed on a product designed to be recycled in the future or, conversely, from any product whose disassembly was not considered in the design. Contrary to the assembly systems, automatic disassembly requires more on-line control strategies and more flexibility and adaptability to differences in the products that appear in the disassembly process. This is due to the uncertainty existing in the product to be disassembled, the preservation status, the great amount of manufacturers, and the product range, etc. Working with all this information leads to a higher difficulty level, requiring the combination of several research fields and powerful methodologies which allow the generation of automatic disassembly strategies. In this special issue, some examples of these techniques and specific disciplines necessary to accomplish a disassembly process are shown.

In a disassembly process, it is necessary to set up, in an automatic way, the sequence of tasks and operations that are necessary to perform the total or partial disassembly of a product. Examples of such are presented in this special issue which include “Ant colony optimization for disassembly sequencing with multiple objectives” by Seamus M. McGovern and Surendra M. Gupta, “Disassembly sequencing using genetic algorithm” by Elif Kongar and Surendra M. Gupta, “A hierarchical approach to disassembly sequence planning for mechanical product” by Tianyang Dong, Ling Zhang, Ruofeng Tong and Jinxiang Dong, and “A hybrid approach to selective-disassembly sequence planning for de-manufacturing and its implementation on the Internet” by Chulho Chung and Qingjin Peng.

Additionally, a disassembly system requires a powerful sensorial system, that allows the recognition and location of the objects based on models, recognition of partially occluded components, etc. In the work presented by P. Gil, F. Torres, F.G. Ortiz and O. Reinoso (“Detection of partial occlusions of assembled components to simplify the disassembly tasks”) an example of a vision system used in an automatic disassembly process is shown.

Another important aspect of automatic disassembly systems is the performing of an exhaustive analysis of the grasping problem. A solution to this problem is described in the work presented by Cesar Fernández, Oscar Reinoso, M. Asunción Vicente and Rafael Aracil (“Part grasping for automated disassembly”).

There are others aspects of interest that have not been presented in this special issue, but without doubt they will get particular attention in the near future in the development of automatic disassembly systems in de-manufacturing systems, e.g. multi-sensorial systems, cooperative manipulators robots, human-robot interaction, supervision of the process, simulation, virtual reality, etc.

In the works presented by P. Kopacek and B. Kopacek (“Intelligent, flexible disassembly”), A. Weigl-Seitz, K. Hohm, M. Seitz and H. Tolle (“On strategies and solutions for automated disassembly of electronic devices”), and Hu Cai-qi, Lin Zhong-qin and Lai Xin-min (“Concept design of checking fixture for auto-body parts based on neural networks”), examples of industrial applications of special interest disassembly systems are shown.