БЪЛГАРСКА АКАДЕМИЯ НА НАУКИТЕ. BULGARIAN ACADEMY OF SCIENCES

ПРОБЛЕМИ НА ТЕХНИЧЕСКАТА КИБЕРНЕТИКА И РОБОТИКАТА, 53
PROBLEMS OF ENGINEERING CYBERNETICS AND ROBOTICS, 53

СОФИЯ . 2002 . SOFIA

A Semi-Automatised Disassembly Cell for Printed Circuit Boards

*B. Kopacek**, *P. Kopacek***

**ReUse GesmbH, Rottwiese, Oberpullendorf, Austria*
E-mail: bernd.kopacek@ihrt.tuwien.ac.at
***Institute for Handling Devices and Robotics (IHRT), Vienna University of Technology, Favoritenstr. 9-11/318, A-1040 Vienna, Austria*
E-mail: kopacek@ihrt.tuwien.ac.at

1. Introduction

In Austria the first partly implementation of the European WEEE concept was to build a prototype of an "Economical Disassembly Plant for Sustainable Reuse of Parts, Components and Materials from Electr(on)ic Products" in the last years. The main innovative features of the system will be: Ability to disassemble different boards with only few software modifications of the system, low investment costs, step-by-step investments because of the modularity, the predominant working conditions (toxic vapours, hard work) could be changed efficiently by the system, the work security and job quality will be increased, because of the modularity it is easily possible to build up disassembly cells for different product groups, the possibility of extracting some components without damage in an economical way for reusing and it fulfils all criteria proposed by the draft directive for waste from electrical and electronic equipment.

2. The PCB disassembly cell

The disassembly process can be divided in several steps which are performed successively. At the beginning PCB's are dismantled from collected electrical and electronic equipment manually – today automation is not very efficient because in the next years these costs are covered by social projects, but for the future we are going to set up standardised criteria for the product design for manual disassembly, so that manual disassembly costs will already be minimised during the design-phase.

The PCB disassembly cell consists of a transportation system, a vision system, a desoldering station and a station for removing socketed parts.

In disassembly the parts to be disassembled are usually always in the same position attached to the print circuit board. Therefore feeding of the cell can be done manually for disassembly purposes. After the manual disassembling procedure components of the gained PCB's are going to be identified by a vision system (Fig. 1) and additionally they are going to be automatically classified into valuable, environmental relevant and remaining components.

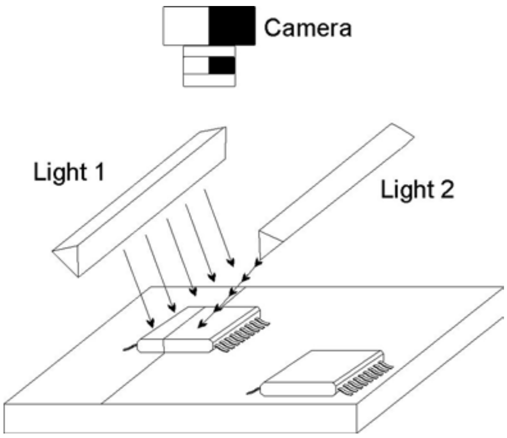

Fig. 1. Vision system

Especially to acquire positional data and other data of the components, required for the selective disassembly, a high quality image detecting system is necessary it is the module called "Vision System". The re-useable components must be localized and identified on the printed circuit board to send the information for disassembling over the control computer (CC) to the de-soldering and the robot system. The vision system must be able to reach a position in accuracy of ± 0.1 mm (coordinates, etc.), and determine the characters on the parts (OCR – Optical Character Recognition) with an average probability of 95%, as shown in Fig. 2. This information about the parts will be stored in the CC (Control Computer) – database. The de-soldering system is able to detach the electronic components (position, geometry, dimensions of the part from the CC) which are directly fixed on the printed circuit board. The robot-system has several tasks: to remove socketed components, to pick up desoldered parts and put these in appropriate storage devices (magazines).

We choose a robot with a reasonable accuracy of ± 0.2 mm and a reasonable payload (15 kg) and a relatively innovative controller based on the operating system Windows NT. This robot offers also the possibility to work with signals from simple low-cost sensors (e.g. micro switches, etc.). For signals from force torque sensors there is additional research necessary for adaptation of this type of robot. A multi-purpose gripper equipped with simple sensors as an weighted compromise between flexibility, costs and time was developed.

The heart of the vision system is a CCD-camera with a resolution of 4096 pixels in an area of 220 x 300 mm.

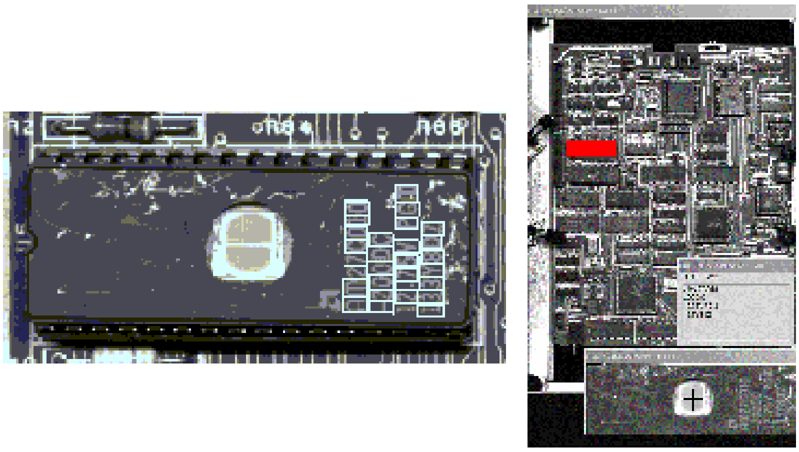

Fig. 2. Position and characters of one part as detected by the vision system

The hierarchical cell control system of the disassembly cell has to coordinate subsystems. Each of these subsystems (robot, laser, vision system, transport system) has an own controller. Therefore the cell control system has to manage the interaction between all subsystems (Fig. 3).

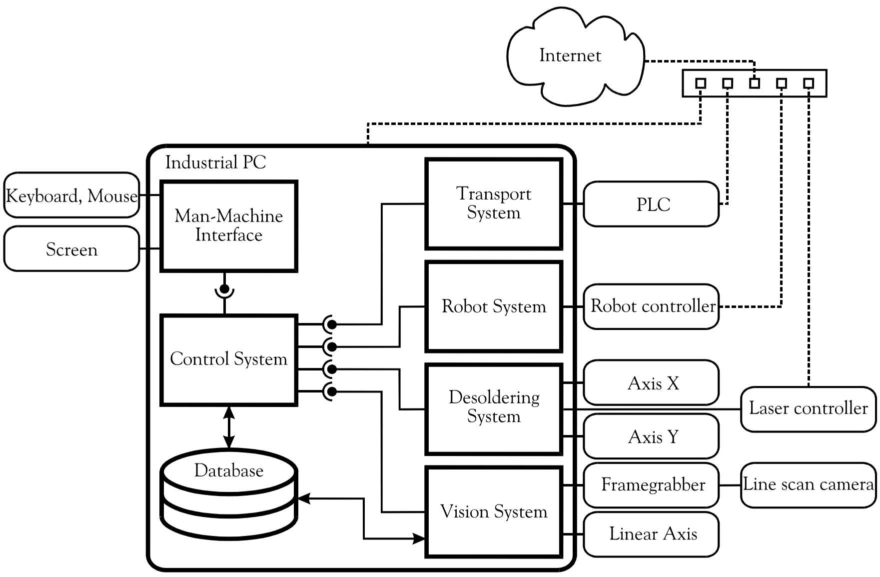

Fig. 3. Control system of the disassembly cell

The transport system handles the workpiece holder and is controlled by a PLC. The PCBs have to be transported to the vision system, which has to declare the working order for each single pallet. The information about all relevant chips on the PCB's is stored in a database from where the control system generates the command sequences for the subsystems. In a disassembly cell with two disassembly subsystems – a desoldering system for desoldering and a robot system for picking chips from sockets – there are four possibilities for the further process.

According to the kind of the PCB the transport system gets the instruction which subsystems are necessary for disassembly of this PCB. If a workpiece holder is in a station or an error occurs the PCL sends information to the CC. Is a workpiece holder in a station the subcontroller sent all necessary commands step by step. The subcontrollers are able to handle the execution of its tasks. The CC checks the state of each command avoiding the start of a module before the previous step has been completed successfully. Of course, in different subsystems the work may be done simultaneously.

In the desoldering station two linear axis and the desoldering laser have to be controlled. The robot system controller is responsible for the grippers and for the magazines.

The CC has its own database, where all information about the disassembly cell are stored: parameters for the modules, program numbers for the subsystems, data of the chips, layout, and content of the magazine, as well as error codes, and the runtime errors of the cell.

As the demand for real time could be branched out to lower level controllers, it was possible to implement the Control System using Microsoft Visual C^{++} under Microsoft Windows. Hence the user interface is intuitive and easy to use. The CC displays the actual state of all modules within the cell and has all components for network connection. So a remote access maintenance system using internet connection can be used.

3. Conclusions

Disassembly automation especially for electr(on)ic devices is absolutely necessary worldwide in the nearest future because of the dramatically increasing amount of electr(on)ic scrap. Today only some pilot projects in form of fully automated single purpose solutions – and only for one distinct type of one product – are realized. Main problems are the collection and transportation of a sufficient amount of these products to one place in one area. Therefore it is necessary to disassemble more than one product in an automated or semi automated cell. For this purpose products with similar disassembly operations are collected in "disassembly familiesfamilies which are disassembled in modular cells, developed by means of computer" – aided planning systems. Such modular, intelligent, flexible disassembly cells ensure high flexibility necessary for the factory of the future.

R e f e r e n c e s

1. K o p a c e k, B., P. K o p a c e k. Semi-Automatised Disassembly. – In: Proceedings of the 10th International Workshop "Robotics in Alpe Adria Danube Region – RAAD`01", Vienna, May 16–18, 2001, 363-370.
2. D r i n e k, M., K. D a i c h e n d t, H. Z e b e d i n. A new concept for a fully automatized disassembly cell. – In: Proceedings of the 10th International Workshop "Robotics in Alpe Adria Danube Region – RAAD`01", Vienna, May 16-18, 2001, 383-388.
3. K o p a c e k, B., P. K o p a c e k. The role of semi-automized disassembly in recycling. – In: Preprints of the 14th IFAC World Congress, Beijing, P. R. China, July 5-9, 1999, 67-72.
4. K o p a c e k, B., P. K o p a c e k, H. Z e b e d i n. Hierarchical control of disassembly cells. – In: Preprints of 4th IFAC Symposium on "Intelligent Components and Instruments for Control Applications – SICICA`00", Buenos Aires, September 2000, 265-272.

Полуавтоматизированное демонтирование печатных карт

Б. Копачек, П. Копачек***

**ReUse GesmbH, Rottwiese, Oberpullendorf, Austria*
E-mail: bernd.kopacek@ihrt.tuwien.ac.at
***Institute for Handling Devices and Robotics (IHRT), Vienna University of Technology, Favoritenstr. 9-11/318, A-1040 Vienna, Austria*
E-mail: kopacek@ihrt.tuwien.ac.at

(Р е з ю м е)

Тема полу- или вполне автоматизированного демонтажа электронных устройств актуальна не только после введения стандартизации Европейской совети. Одно из обстоятельств является неэфикасности ручного демонтажа в последных годах. Только токсические компоненты отстраняются не ручным способом.

Рассматривается оборудование для полуавтоматизированного демонтирования печатных карт. Связание распределенных приборов в сети требует иерархической структуры и применение персональных компьютеров.