Modern approaches to identification of collected WEEE

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Abstract: Producers and importers of EEE (electrical and electronic equipment) have a legal obligation to collect and recycling WEEE (waste electrical and electronic equipment). The most frequently this happens by nations-wide take-back systems. ASEKOL is a non-profit company that organizes, on behalf of the producers and importers of EEE, a nation-wide take-back system for WEEE, i.e. collection, transport and recycling of WEEE, including financing of the entire system.
Since ASEKOL wanted to trace and identify the WEEE flow and to make the system even more effective, it decided to design a device that could be able to identify taken back equipment (TVs and PC monitors which create almost 80 weight % in the stream primarily) in order to get to know as much information about the waste stream as possible.
These requirements have resulted in the design of the prototype - WEEE Identification Tunnel. The proposed system introduces a completely new approach to identify both the producer and the model of taken back equipment. The only current way how to identify models is to read the information from the labels placed on the device.
Current system efficiency of the prototype unit is higher than 90 % in case of model recognition and in case of producer recognition and the average processing time takes less than 5 seconds.
The main benefits that ASEKOL sees in the development of this device are environmental, economic and administrative, consisting in a significant improvement in data acquisition and subsequent recording.

Key-Words: WEEE, Identification, LCD, Database

Introduction

The production of electric and electronic equipment (EEE) is increasing worldwide. One of these EEE products is the liquid crystal displays (LCD). Both technological innovation and market expansion continue to accelerate the replacement of equipment leading to a significant increase of waste electric and electronic equipment (WEEE) [1, 3, 6].

EU strategies for waste management have long recognized the key role of recycling to move towards sustainable consumption and production. This resulted in a range regulatory measures, among which the WEEE directive, which sets weight-based targets for recovery, preparation for re-use and recycling [4]. In Europe, a number of different recycling systems for WEEE have been put in place, motivated by the EU directive on WEEE [5]. In Czech Republic is the most frequently WEEE is collected by nations-wide take-back systems.

ASEKOL is a non-profit company that organizes, on behalf of the producers and importers of EEE, a nation-wide take-back system for WEEE, i.e. collection, transport and recycling of WEEE, including financing of the entire system. Its services may be utilized by producers and importers of EEE on the basis of an agreement. Within the operation of the take-back system, ASEKOL co-operates closely with cities and municipalities, the final dealers and service shops, collection companies and processors of WEEE.

One of the main missions of ASEKOL is to provide for the collection and environmentally sound treatment of discarded electrical appliances on behalf of the producers and importers, to be a credible partner for governmental authorities and local

governments, to strictly comply with the quality of environmentally sound management of waste electrical and electronic equipment (WEEE) and as well as to ensure effective expending of costs.

Since ASEKOL wanted to trace and identify the WEEE flow and to make the system even more effective, it decided to design a device that could be able to identify taken back equipment (TVs and PC monitors which create almost 80 weight % in the stream primarily) in order to get to know as much information about the waste stream as possible.

Material and Methods

WEEE Identifications Tunnel

The proposed system introduces a completely new approach to identify both the producer and the model of taken back equipment. There is not implemented any uniform mandatory labelling of produced and marketed equipment. Automated recognition therefore couldn't be possible so far. The only current way how to identify models is to read the information from the labels placed on the device. Since this information is not standardized, it is a nontrivial task in the field of computer vision and artificial intelligence. Any standard commercially available technology does not have such a possibility.

The uniqueness of the solution was also demonstrated in a feasibility study on the device (carried out in 2011) which in practice could not find a similar project solution. In this study was described that there exist various partial solutions which are completely unsuitable for the technological purposes of the project plan.

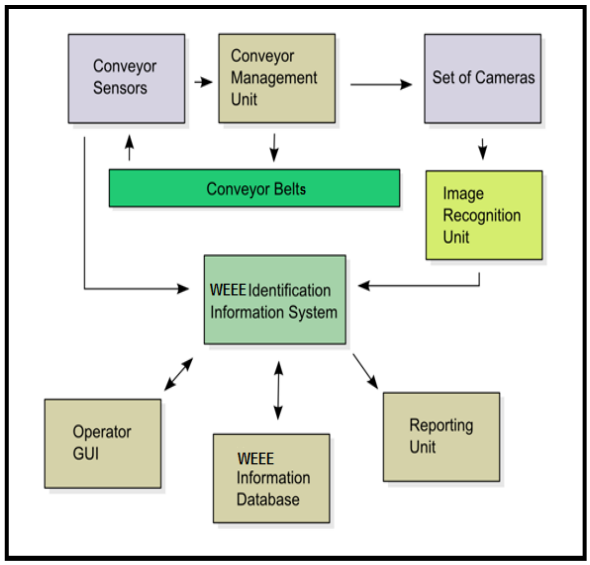
However this task is solved completely newly, its successful resolution was enabled due to the discovery of new algorithms for computer vision within last few years. Thanks to them it is possible to identify the position of general labels and manufacturers' logos at first and subsequently to determine the producer and to relate unstructured information from labels with a specific model of electrical equipment.

The suitability of using labels to obtain information about the appliances mentioned for example Dos Santos *et al*. [2],

Test procedure

Testing was carried out during the September 2014 in the premises of the company Enviropol in the village Lety. It was tested the success identifications of WEEE (especially identifications of LCD and CRT TVs).

Fig. 1 Scheme of the technical solution



Test methodology

It is necessary to establish rules for verifying the success of identifications:

- Appliances - experimental solution done so far has focused mainly on the screen devices (CRT televisions and monitors, LCDs, plasma). However proposed technology of this device enables to identify automatically a wide range of products bearing adequate readable information (logos, labels).
- Databases - the current database structure consisting of information about brand, model, dimensions, weight, completeness and technology used can be moreover extended for other relevant information related to the appliances involved in the database.
- Measurement - measurement consists in inserting the appliance to the conveyor belt is aligned to the upper side of the board of conveyor. Orientation of appliances can affect the result measurement.
- Successful identifications - State of the system report with the relevant identification model number is considered as a successful identification. Wrong model number or model change are considered to be mistake.

There were tested 1001 appliances (LCD TV or monitors). Before the measurements were excluded 101 appliances because they did not have identification label.

Results and Discussion

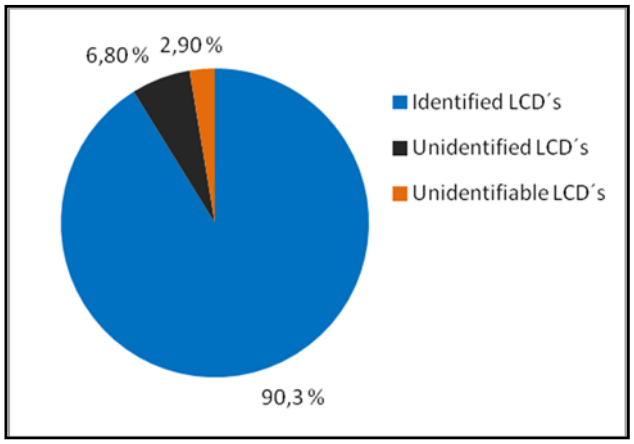
Total number of measurements was 1001 pieces of LCD displays (TV and monitors). Identification test results are displayed clearly in the Table 1.

Tab. 1 Results of the identification

Total LCD´s	1001
NEW in database	183
Identified LCD´s	721
Unidentified LCD´s	68
Unidentifiable LCD´s	29
Total success rate of identification	90,31%
Success identification on identifiable LCD´s	93,21%

The ratio between identified and unidentified is higher than 9:1. Unidentified can be divided into 2 groups (Unidentified and Unidentifiable). Unidentifiable LCD´s are appliances with missing or damaged labels, labels placed in the unreadable site for camera vision (see Figure 2).

Fig. 2 The percentage of identified and unidentified LCD´s



Reasons for failure identification:

1) Wrongly chosen height of the camera. Systems focusing on the wrong competitive surface on the LCD´s displays.
2) Lighting of the labels. For camera vision is problematic to identify too dark or bright labels with featureless descriptions or labels with reflections.
3) Errors of reading algorithm. Incorrectly identified clearly identifiable scanned text (substitution of LCD´s models)
4) Other causes, for example timeout for the identification.

In the pilot testing process is scheduled additional testing of the success identification by the end of 2014.

Conclusion

Operational testing of prototype „WEEE identification Tunnel" confirmed success from the pilot test results in identifications of WEEE (LCD TVs and monitors).

Total success of identifications LCD´s is more than 90 % of the prototype.

On the other hand, analyses of the unidentified appliances shows that is necessary to focus on ways to improve methods of determining the appliances position (3D model, point cloud) or any adaptation in algorithms reading.

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