Automated Identification and Sorting of Collected Smartphones

Johanna Reimers

Refind Technologies AB

Abstract: As part of the Horizon2020 project Sustainably Smart, Refind Technologies have developed and built a phones sorting equipment using machine learning software technology. The demonstrator result and the possible integration downstream scenarios are described in this paper.

1. INTRODUCTION

This report will show the demonstration of the Sustainably Smart project outcome – the sorting equipment for phones. It involves a short description of how the equipment works, and then shows images captured from a movie recording the sorting process. Finally, it states the possible process scenarios and the next steps after the project has finished.

2. ALIGNING, SORTING AND HANDLING EQUIPMENT

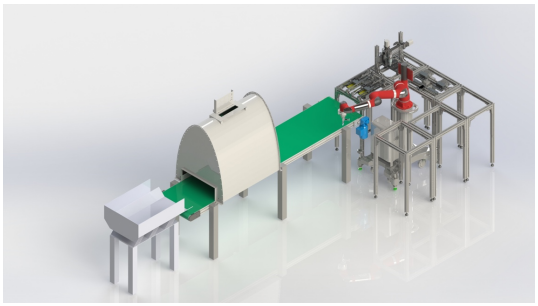

Figure 1: Side view of the complete demonstrator including identification, sorting and disassembly.

The core of the equipment is the identification tunnel, which consists of a camera, illumination and a computer with machine learning software able to recognize different objects based on their looks.
The tunnel is placed on top of a conveyor belt that transports the objects. The physical separation can be performed in several ways, either via moving guide rails that direct the objects into different sorting fractions, via pushing actuators or via a robotic picking arm.

The choice of separation method depends on the need for the customer and the required speed.

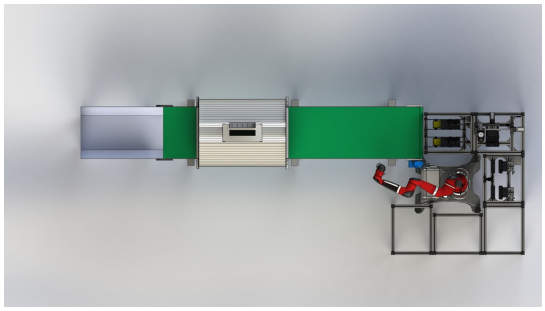

Figure 2: Top view of the complete demonstrator.

We have also investigated the possibility of queueing up material in buffers since the following step, the automatic disassembly, will be much more time-consuming than the recognition step. The automatic disassembly takes about 2 minutes per object compared to the identification and sorting that takes about 1-2 seconds per object.

The key design idea has been to keep the components modular and flexible so that they can be combined according to the potential requirements.

3. DEMONSTRATION OF THE EQUIPMENT

Here is an overview of the equipment, feeding from the left and sorting to the right.

(Link to the movie: https://youtu.be/N3Eq11RrxOM)

Figure 3: Equipment overview

The first step is feeding of the phones. The image shows an angled vibrating feeder, onto which the phones can be poured box wise. The vibration and the angle help spreading out the phones and feeding them onto the sorting conveyor belt.

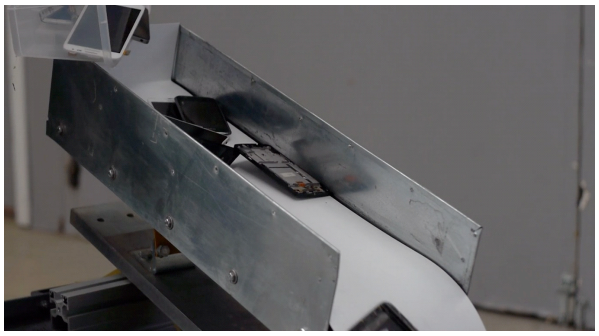
Figure 4: Vibratory hopper feeder

The phones continue on the conveyor belt to the light tunnel/identification tunnel with the camera. Photos are taken of the material passing by, classifying the objects and locating them on the belt.

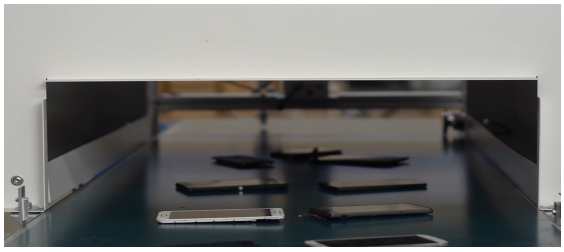
Figure 5: Phones entering the identification tunnel

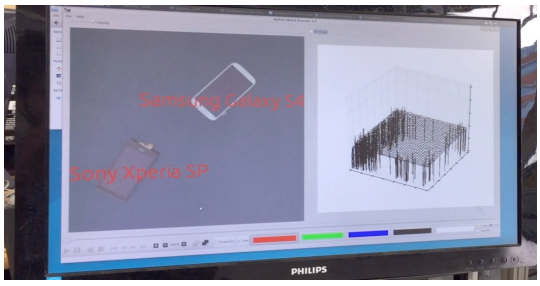

Figure 6: Classification program

Above is a screen dump of the user interface showing the classifications and the locations of the phones. The histogram on the right shows the 3D image rendering of the objects. The classifier is able to locate the object on the belt, in order to send a picking signal to the robotic arm. There is also a 3D camera added to the equipment. This is not needed for the object location, but can be used for deciding on a picking point on the object itself. A vacuum suction robotic arm will prefer a flat surface. When it comes to phones, most of the surfaces are flat, and therefore the 3D camera is superfluous in this application.

After the identification tunnel, a small picking robot is used to pick and place the classified phones in the correct sorting fraction. In this example there are three sorting fractions: left, right and straight ahead. More fractions can be added if needed.

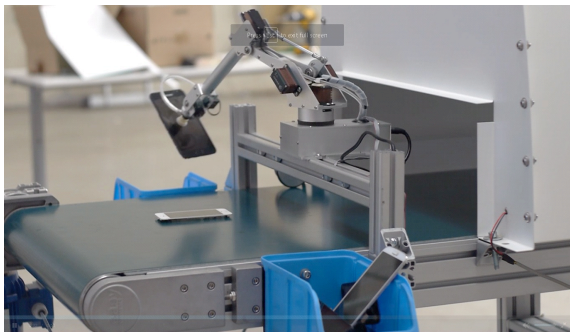
Figure 7: Robotic picking arm

All parts of the equipment are modular and can be scaled up or down if needed for the rest of the processing line.

4. POSSIBLE PROCESS SCENARIOS

The automatic recognition and sorting equipment is meant to proceed an automated disassembly equipment, developed as a separate part of the Sustainably Smart project. There are different approaches to consider when looking into integrating these two processes. Three different scenarios have been identified and analysed and described.

1) Non-integrated process
One machine that identifies and sorts the phones into different model fractions. One robot that automatically disassembles the phones fraction by fraction. The only integration would be the information about the

quantity of each model, in order to plan the disassembly process in an optimal way. The feeding between the processes would be either manual, or to pick the phones from an ordered pile of phones, something that would be easy for a picking robot.

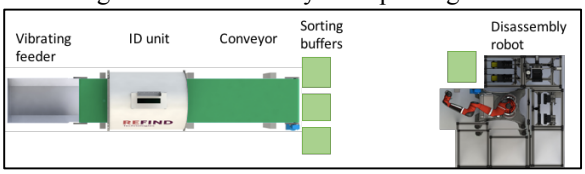

Figure 8: Non-integrated process

2) Integrated process with recirculation

The classification machine separates anything that is not a specific model to other sorting fractions. The specific model phone is further fed to the automatic disassembly robot. When the specific model phone batch is completed, another model type is started. Then the phones are re-fed into the classification system and sorted again, or at least only the new type of phones are further processed by the disassembly robot.

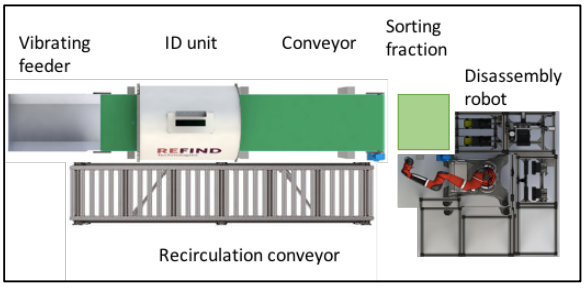

Figure 9: Integrated process with recirculation

3) Integrated process with buffers/queues per model type

The classification machine identifies and separates the phones into a certain number of sorting fractions. The sorting fractions can act as buffers using rolling belts that lines up the phones of each model after each other in parallel, so that it is easy to work on one model type at the time for the disassembly robot. This makes the process quite flexible.

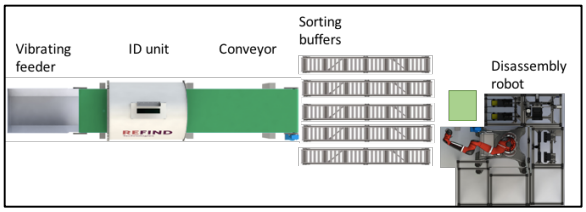

Figure 10: Integrated process with buffers/queues

5. CONCLUSIONS

The project work outcome is a modular and flexible equipment solution encompassing the stand-alone software, the identification tunnel, the integration with material handling systems and the different integration possibilities with a sequential process equipment.

The technical achievements, software and hardware wise, are meeting and surpassing the expectations. However, technical achievements will still need to be matched in business models and marketing efforts in order for the equipment to also become commercially successful.