

CLAIMS

1. Sorting system for sorting objects (100) belonging to at least two classes of objects having different acoustic signatures when impacting an impact body (50, 104), the
5 system comprising:
 - at least one acoustic detector (60) configured to capture acoustic data corresponding to the impact of a candidate object (100) to sort on the impact body (50, 104),
 - a processor (66) for processing acoustic data to identify the class of the
10 candidate object (100) executing a machine learning algorithm trained to identify the class to which a candidate object (100) belongs based on acoustic data of objects previously captured by the acoustic detector (60) and additional information describing said objects, and to generate a sorting information based on the identified class for the candidate object,
 - 15 - feedback means (80, 120) for providing to the processor (66) an additional information on the candidate object depending on the sorting information generated by the processor (66).
2. System according to claim 1, wherein the system is for sorting objects (100) belonging to at least three classes of object having different acoustic signatures
20 when impacting the impact body (50, 104).
3. system according to claim 1 or 2, comprising the impact body (50, 104) that is impacted by the candidate object (100).
4. System according to any one of preceding claims, wherein the machine learning
25 algorithm is based on any appropriate model, such as one or several neural networks, and/or one or several decision trees, and/or one or different classifiers, as for example artificial neural networks, decision trees, support vector machines, regression analysis, bayesian networks, genetic algorithms, preferably on one or several neural networks.
5. System according to any one of preceding claims, comprising a pre-training
30 phase in which the machine learning algorithm is trained on acoustic data captured for objects for which classes are known.

6. System according to any one of preceding claims, the processor (66) being configured to determine the probabilities that the candidate object (100) belongs to each of the at least two classes using the machine learning algorithm and to identify the class with the higher probability for the candidate object (100).
- 5 7. System according to any one of preceding claims, wherein the processor (66) generates a confidence index of the identified class whose value is a percentage characterizing the confidence in the identified class identified by the processor (66), the confidence index depending preferably at least on the probability that the candidate object (100) belongs to the identified class determined by the
10 processor (66).
8. System according to claim 7, wherein the sorting information comprise information to sort the candidate object (100) in the identified class when the confidence index is above a predetermined threshold and in a default class when the confidence index is below the predetermined threshold, the predetermined
15 threshold being preferably between 50% and 95%, better between 60% and 90%, better still between 70% and 90%.
9. System according to any one of preceding claims, wherein the feedback means (80, 120) is at least one among an optical camera, a Xray transmission technology, in particular a single, dual or multi-energy Xray transmission
20 technology, an infrared, ultraviolet or laser induced breakdown spectrometers (LIBS), or a Human-Machine Interface.
10. System according to any one of preceding claims, wherein the feedback means (80, 120) is configured to provide additional information whether the class of the candidate object (100) has been correctly identified by the processor (66) or not
25 and/or corresponding to the class of the candidate object (100).
11. System according to any one of preceding claims, wherein the feedback means is a Human-machine Interface (80) configured to display the class identified by the processor (66) for a candidate object (100) and/or the confidence index and configured such that the user can select whether the identification is correct or
30 not and/or provide the correct class of the candidate object (100).

12. System according to any one of claims 1 to 10, wherein the feedback means (120) is a detector, in particular an optical camera, a Xray transmission technology, in particular a single, dual or multi-energy Xray transmission technology, that is configured to identify the class of the candidate object when the confidence index is below the predetermined threshold.
13. System according to any one of claims 1 to 10, wherein the feedback means is a detector, for example an optical camera, a Xray transmission technology, in particular a single, dual or multi-energy Xray transmission technology, an infrared, ultraviolet or laser induced breakdown spectrometers (LIBS), for sorting the candidate object (100) of at least one of the classes into sub-classes and that is configured to identify whether the class of the candidate object (100) has been correctly identified based in particular on criteria different from acoustic signature.
14. System according to any one of preceding claims, comprising a diverting unit (70, 72, 110) that takes different configurations depending on the sorting information each corresponding to one of the classes, each configuration directing the candidate object (100) to a different routes corresponding each to at least one of the class.
15. System according to any one of preceding claims, the objects to sort are electronic components, in particular electronic wastes, and the classes comprise one or more predetermined types of the electronic components, for example selected among active components, passive components and electromechanical components, and/or more precisely transistors, diodes, integrated circuits, optoelectronic devices, display technologies, vacuum tubes, discharge devices, power sources batteries, resistors, capacitors, magnetic devices, memristor, networks, transducers, sensors, detectors, antennas, assemblies, modules, prototyping aids, piezoelectric devices, crystals, resonators, terminals and connectors, cable assemblies, switches, protection devices, mechanical accessories (electrical enclosure, heat sink, fan), bare printed circuit boards, lamp, waveguide, memristor, CPU holder, CPU, coil, flat capacitor, MLCC

capacitor, Ceramic Dual In-line Package (CERDIP), coin cell, cylindrical capacitor and heat sink.

16. Method for training the machine learning algorithm of the sorting system described above, the method comprising:

- 5 – capturing, with an acoustic detector (66), acoustic data corresponding to the impact of a candidate object to sort on the impact body (50, 104),
- identifying the class to which the candidate object (100) belongs using the machine learning algorithm trained to identify the class based on acoustic data of the impact of objects previously captured and additional
10 information describing said objects,
- generating a sorting information based on the identified class for the candidate object,
- generating an additional information on the candidate object depending on the sorting information with feedback means (80, 120),
15 – training the machine learning algorithm with the acoustic data captured for the candidate object (100) and the additional information on the candidate object received from the feedback means (80, 120).

17. Method for sorting objects belonging to at least two classes of objects having different acoustic signatures when impacting an impact body, the method
20 comprising:

- capturing, with an acoustic detector (66), acoustic data corresponding to the impact of a candidate object to sort on the impact body (80, 104),
- identifying the class to which the candidate object belongs using a machine learning algorithm trained to identify the class based on acoustic data of
25 the impact of objects previously captured and additional information describing said objects,
- determining a confidence index of the identified class,
- generating a sorting information based on the identified class for the candidate object and on the confidence index of the identified class,
30 – diverting the candidate object to a corresponding route based on the sorting information.