

Technical vision system designed to analyze seeds quality

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Abstract— The possibilities of the use of technical vision systems (TVS) in agriculture for seeds quality analysis are presented. The paper contains the analysis of the requirements for the system and its design. The idea of static TVS is given.

Keywords— **technical vision system, seeds quality analysis, optical sorters, static technical vision system.**

I. INTRODUCTION

Technical vision systems (TVS) play a significant role among modern technologies. TVS overcome the limitations of human vision, expand the range of possibilities for the analysis of different images. TVS can be used in conditions unsuitable for humans, especially when the worker's life or health can be damaged.

II. THE PROBLEMS SOLVED BY TVS FOR SEEDS QUALITY ANALYSIS

A. *Seeds infection and illnesses detection*

Nowadays, specialists identify an illness visually. Small spots on the seeds may be unrecognized or unnoticed. In the brewing industry seeds are germinated (soaked in a warm humid environment) for malting for several days. If some seeds are infected the infection will spread rapidly. As a result, the whole portion becomes unusable.

B. *Seeds mixture analysis*

Sometimes seeds in a mixture can be rather small with length up to 5-7 mm). It'll take a specialist about the whole day to analyze 12g of a mixture that consists of fescue, ryegrass, bentgrass and Kentucky bluegrass. At the end probability of a human error rises, incomplete seed can be skipped a culture can be detected incorrectly and so on.

In the baking industry TVS helps to determine impurities, such as seeds of another kind of culture. In canning, green vegetable pea shouldn't be mixed with brown fodder pea.

C. *Seeds viability determining*

Seeds curvature, hollowness shall, fullness and color can be determined visually. The luminescent method helps to determine seeds infections, to recognize viable and unviable seeds. Removing the unviable seeds from a mixture makes the using of the crop areas more effective and help to avoid empty spaces where weeds can appear.

For the purposes of sorting and cleaning of seeds from impurities optical sorters are used. Each seed or a piece of seed is checked. If it doesn't meet appropriate standards it'll be sent to special tray for waste, as a rule, by a sharp concentrated exhaust of compressed air.

There is Voronezhselmash that is the manufacturer of the optical sorters in the CIS. Its equipment sorts the seeds by color, shape and size [1]. The cost of such equipment is about rather high.

Bühler (Switzerland) is another manufacturer of the optical sorters, that analyze such seeds properties as color, shape and size. It has a number of modern technologies (special cameras

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with high resolution, additional cameras InGaAs for invisible properties analysis, PROfile technology for defects detection, extractors) [2].

III. DETERMINATION OF REQUIEREMENTS

TVS should classify seeds, determine the impurities, determine seeds quality (find collapsed, shriveled, incomplete), identify seeds infections. So the system should meet the next requirements.

Mandatory requirements for the system are the next.

- A presence of high-resolution color camera (for getting images of seeds and subsequent analysis of their color, shape and other characteristics).
- Providing high speed analysis.
- Use materials that meet industry standards (e.g. for the food industry).
- Availability of preprocessing module (for brightness characteristics improving, filtering).
- Image processing module (objects detection, properties calculation).
- Classifier module.

If there is a problem of physical separating of seeds, the system as a rule should have high speed of seeds transporting, wear resistant coating along the transporting path that doesn't injure seeds, mechanism for impurities extracting.

Additional requirements for the system are vibrator for better seeds distribution on a surface, special (infrared, ultraviolet, visible range, X-rays, or a combination of them) and reporting module.

IV. TVS STRUCTURAL SCHEME

The most interesting TVS is the one that can classify and then separate seeds. Existing equipment uses small channels for separating seeds. Seeds follow along the channel one by one, video camera gets image, the system classify every seed and then a seed should get either to the main tray or to the waste tray. Better performance is achieved by increasing the number of channels. It causes size and cost increasing.

On the other hand, the analysis can be done without channels. An example of the system is in fig. 1.

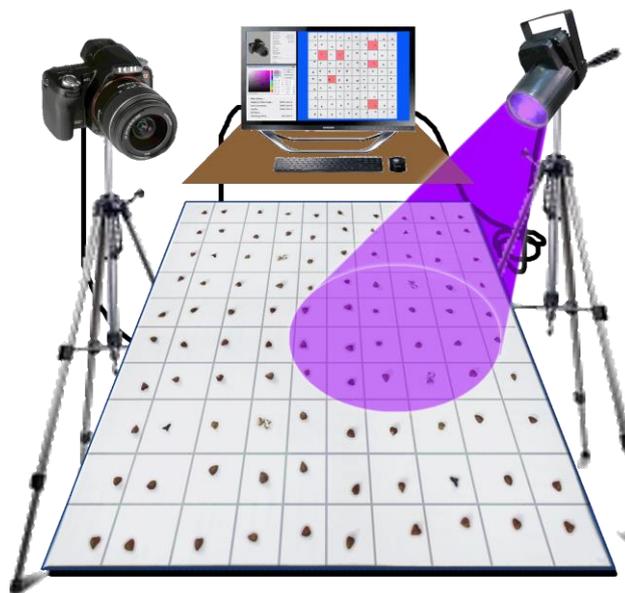


Fig. 1. Example of TVS for seeds analysis.

The seeds are distributed at the surface. The data from camera get to the processing module. The objects (seeds and waste) are identified in the image and classified. We need a database with the information about cultures and seeds properties that will be used by the system to classify objects. After the analysis the system should calculate a sequence to extract some kinds of objects. Then the objects can be extracted in different ways. For example, the surface consists of special cells. After the analysis cells with the same kind of objects are opened, so the objects get to a container. Then the other cells are opened and so on until all the seeds are classified.

The next step is a report creation. A specialist can add some data to the report, and the system should make a conclusion about seeds quality. Also we need a database with standards. A structural scheme is shown in fig. 2. Let's discuss each module with more details.

Images preprocessing module increases the analysis quality. At this module brightness, contrast and sharpness can be corrected, some noise can be removed. We can use filters for better visual difference between objects and the background surface.

Properties calculation module calculates objects properties for the classifying. The seeds can be classified by its color, size, shape and weight. Sometimes its light can be analyzed. For each case some of the parameters are more informative than others.

Color is an important property when we need to classify plant species of the same culture and when we need to detect infections. In some cases the most noticeable difference between the seeds is their form.

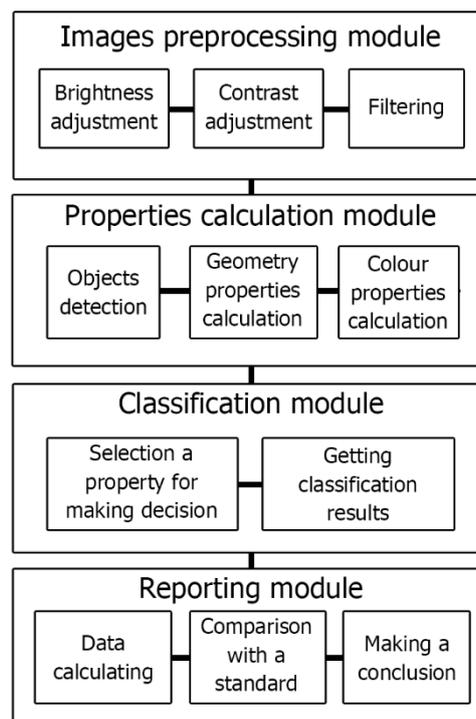


Figure 2. A structural scheme.

The size of seeds can be important too. Fig. 3 shows a mixture of lawn grasses. There are relatively big seeds of ryegrass and fescue and small seeds of Kentucky bluegrass. It's rather difficult to compare its shape. But we can detect a culture by its size. The size of ryegrass and fescue is about 5-7 mm and the size of Kentucky bluegrass seeds doesn't exceed 3.5 mm.

We can get additional information when use luminescence analysis. The method helps to detect seeds infections, determine viability of a seed. The main idea of the method is that after processing with special liquids or in some lighting spectrum the seed begin to glow in a specific way or don't change the color.

Full and empty seeds have different weight. But it's difficult to use the property. Existing sorters don't use it. E.g. if the weight of 1000 seeds is less than 2g, we should use super accurate scales and we need to analyze each seed separately. It causes speed reduction and the system will be more expensive.



Fig. 3. An example of lawn grasses mixture with waste.

In a classification module a decision about object is made. Depending on its size, shape and color it can be a seed of some culture or waste. The main property should be selected, because properties importance varies in different cases. Then each object is classified.

When the analysis is finished, a report should be composed. The system has all the information about mixture and seeds.

V. CONCLUSION

TVS is rather useful in seeds analysis. It can solve a number of problems: counting the number of each component in a mixture, determine its quality, identify seeds defects and impurities, the detect infections. TVS advantages are high processing speed, accuracy, efficiency. The most important advantage is that system can't be tired, the analysis is always impersonal and specialists can save their health (vision).

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