AN AUTOMATED SYSTEM FOR POTATO QUALITY CONTROL

A.G. Divin, S.V. Ponomarev, G.V. Shishkina, D.A. Lyubimova

Abstract: The model of a robotic facility for potato sorting is considered. The method of sorting is based on the method of thermal quality control, which makes it possible to detect abnormalities in the structure of the surface and subsurface layers of plant tissue. As a source of information, a thermal imaging camera was used, as well as cameras of the visible range. Images from cameras were processed using NI VISION technologies.

Keywords: potato, quality, sorting, vision system, thermophysical properties

Introduction

The quality of potatoes, the absence of phytotoxicides in tubers in many respects determine the safety of this agricultural produce for a long time. This article proposes a method and a model of a facility with a technical vision system (TVS) which is used to sort potatos by the size of tubers, the presence of phyto-diseases, and mechanical damages.

1. Methods and tools used to control the quality of potatoes

For continuous transportation of inspection objects through a vision system, a roller conveyor 1 has been selected, the design of which is shown in Fig. 1.

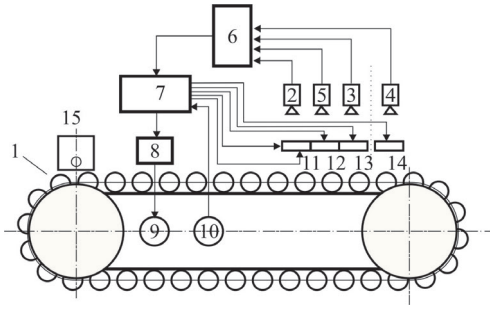

Fig. 1. Simplified functional layout of the robotic facility

The outer surface of the rollers is made of an elastic damping material with a high coefficient of friction, so as to roll without slipping on the horizontal plane, while moving the potato tubers, which are individually distributed among the rollers, rolling freely and thus ensuring the identification of the defects, 300x300 mm in size, on the whole surface in the areas of technical vision. The linear velocity of the rollers is set by the controller 7 via the frequency converter 8, which determines the rotation speed of the conveyor drive 9.

The technical vision system includes color cameras 2 and 4 of the Basler acA1920-155uc type, which have sensitivity in the visible range of electromagnetic radiation wavelengths, a high-speed thermal imaging camera 5 of the type FLIR A 35 operating in the 8-14 μm range of the infrared wavelength range, and a monochrome camera 3 type Basler acA1920-155um.

Camera 4 of the visible range of the emission spectrum is designed to record emission radiation from potato tubers exposed to ultraviolet lamps 14. Chamber 3 serves to determine the average size of potato tubers illuminated by the source 13. Thermal imaging camera 5 perceives radiation from tubers exposed to the infrared heater 12. Color camera 2 is designed to register tubers with greenish skin.

The software of the vision system implemented in the LabView environment with the NI VISION library is used for processing images from cameras, searching for defects and registering the coordinates of inappropriate objects. The use of the encoder signal 10 of the conveyor is used to calculate programmatically the time point at which the control system generates a signal to the actuator 15, so that it is possible to remove the defective object from the conveyor. A collaborative robot with a grip is proposed to use an actuating mechanism.

2. Results of the method study

Studies have shown that control based on thermal imaging cameras can be successfully used to detect such potato diseases as dry rot, late blight and others that cause a change in the structure of plant tissues, their thermophysical properties [1] and, consequently, the temperature field of plant tissue after heat exposure of the given power. Fig. 2

shows a thermal imaging of a potato tuber affected by dry rot after exposure to a heat flux from a 100 W incandescent lamp for 1 second. As can be seen in Fig.2, the surface areas of the tuber, which have foci of dry rot, have a different (higher) temperature, and correspondingly, a different brightness of the pixels.

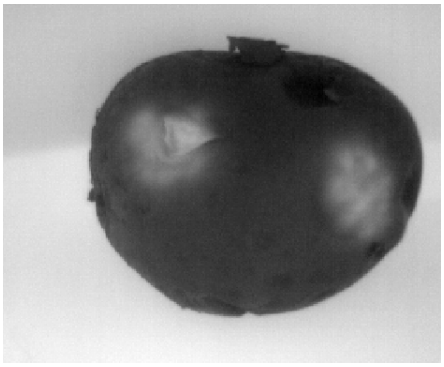

Fig. 2. A thermal image of a defective potato tuber

Thermal imaging processing involves standard filtering, binarization and contour analysis operations, and its duration does not exceed 100 ms. The result of processing is shown in Fig. 3. The thermal imaging control modes were predetermined in the course of numerical simulation using the Solid Works package, and the results of experimental determination of the thermophysical properties of potato tissue of various qualities [2]. To reduce glare due to the reflection of thermal radiation from the design elements of the layout, all its internal surfaces were painted in black matte color.

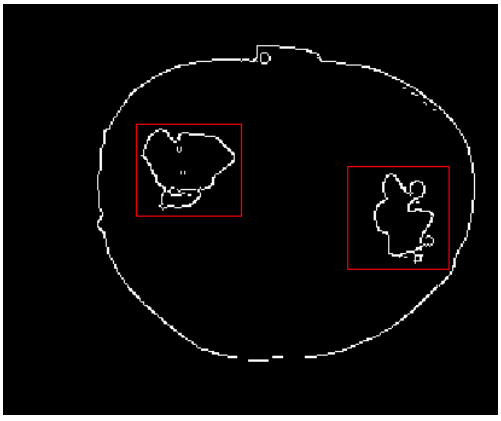

Fig. 3. Detection of a defect by a vision system

3. Conclusion

The method proposed for potatoes and other plants differs from the known methods by the presence of new measuring and auxiliary operations related to the organization of a given thermal impact on an object whose power depends on the experimentally measured thermophysical properties of plant tissues. It ensures reliable registration of temperature contrasts on the surface of the object caused by violation of structure and the presence of surface and subsurface defects of tissues.

The proposed system can be used to sort not only potatoes, but also other agricultural products.

References

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