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DESIGN AND DEVELOPMENT OF A PROTOTYPE FOR NONDESTRUCTIVE INSPECTION, SORTING AND GRADING POTATO USING LASER TECHNIQUE AND AUTOMATIC CONTROL

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ABSTRACT: A prototype for nondestructive inspection, sorting and grading potato using LASER technique and automatic control was designed and developed specifically for the present work.

The developed prototype was experimentally investigated as a function of change in motor rotational speed, inspection time period and number of LASER diodes.

The performance of the developed prototype was evaluated in terms of productivity, inspection efficiency, prototype accuracy, grading efficiency, energy requirements and operational cost.

The experimental results reveal that the use of the developed prototype for inspection, sorting and grading potato increased inspection and grading efficiencies and reduced operational cost under the following conditions:

- Motor rotational speed of 6 rpm.
- Inspection time period of between 6 to 8 seconds.
- The use of two LASER diodes.

Key words: Nondestructive, inspection, sorting, grading, automatic, LASER, control, productivity, developed prototype.

INTRODUCTION

Potatoes (*Solanum tuberosum*) are one of the most important foods in Egypt. Egyptian farmers cultivate more than 200,000 feddan yearly which produce about two tons at the whole season of potatoes yield. They also export about 250,000 Mg yearly to Arab countries and some Europe countries (Agricultural Research Center 2004).

Potatoes are economically important produce that need to be inspected, sorted and grading. Inspection of potatoes is an important procedure for marketing, storing and processing. Sorting and grading potatoes for size and quality is an essential preliminary to marketing.

Usually, quality inspection and grading is performed manually by trained human inspectors who assess the potato by seeing the potato for a particular quality attribute. However, there are some disadvantages to apply human inspectors such as inconsistency, extensive time to inspect huge volumes and expensive labor cost.

A number of research works have been reported in literature an inspection and grading systems used for vegetables and fruits.

Edan *et al.* (1997) developed a weighted color parameter based on human perception that provided a stable model invariant to changes in lighting conditions with excellent classification into 12 maturity classes of tomatoes.

Abd-Alla *et al.* (2000) reported that the grading efficiency was decreased with increasing both fruit feeding speed and tilt angle of grading unit. The grading efficiency was increased with the increase of critical distance to open the pivoted beam from 0.04-0.1 m and starts to decrease at critical distance of 0.13 m.

Genidy (2003) concluded that the machine grading capacity increased by 22.2% when the cylinder speed of feeding was increased from 10 - 40 rpm (0.11 - 0.42 m/s) at different levels of tilt angles during grading muskmelon.

Abd El-Rahman (2004) tested and evaluated a portable shaker type-grading machine with garlic and onion bulbs. The results indicated that grading efficiency decreased as feeding rates and frequency levels increased. The best result was obtained at bulbs feeding rate of 800 kg/h and frequency levels 30 freq/s for grading unit.

El-batawi (2004) studied the possibility to determine fruit ripeness related properties in a non-destructive way. He found the fruit firmness measured by non-destructive acoustic response showed a strong negative colleration with the LASER image.

El-Sayed (2004) developed a two grading machines for olive grading. He concluded that the maximum grading efficiency were 93, 92, and 91% for Agiza, manzanillo and picual at 8 rpm speed of rotating, and 3 degree of slope of roller sizer.

Singh *et al.* (2004) developed a spectroscop technique to determine water content in potato. The study demonstrated high accuracy in water content prediction. Partial least squares regression was used to establish calibration models for predicting the water content in potato samples. Significant wavelength ranges of 700-900, 1000-1100, and 1250-1600 nm and 850-900, 1100-1200, 1400-1500 nm were selected to establish prediction models for estimating the water content in potato samples without skin and with skin respectively.

Zakaria (2004) showed that the grading efficiency increased by 28.6% as a result of the automatic control of feeding system instead of the traditional feeding system.

El-Raie *et al.* (2005) measured the electrical and optical properties of strawberry maturity stages [sweet charl variety (montakhab)] using He-Ne LASER with wavelengths 632.8 (Red) and 543.5 (Green) nm with low power. Obtained results were summarized as follows: (a) Reflection intensity using LASER beam 632.5 nm was higher than using LASER beam 543.5 nm in the stages 3, 4, 5 and 6. (b) There is reverse relation between reflection and absorption percentages, where the reflection increased from stage 1 to stage 6, while the absorption percentage decreased.

Using small inspecting and grading machinery is one of the most important parts of handling technology. The cheapness and simplicity of these machines would encourage its use. So, the objectives of this study are to:

1. Design and development of a prototype for inspection, sorting and grading potato using LASER technique and automatic control.
2. Determine the optimum conditions affecting the performance of the developed prototype.
3. Evaluate the developed prototype from the economic point of view.

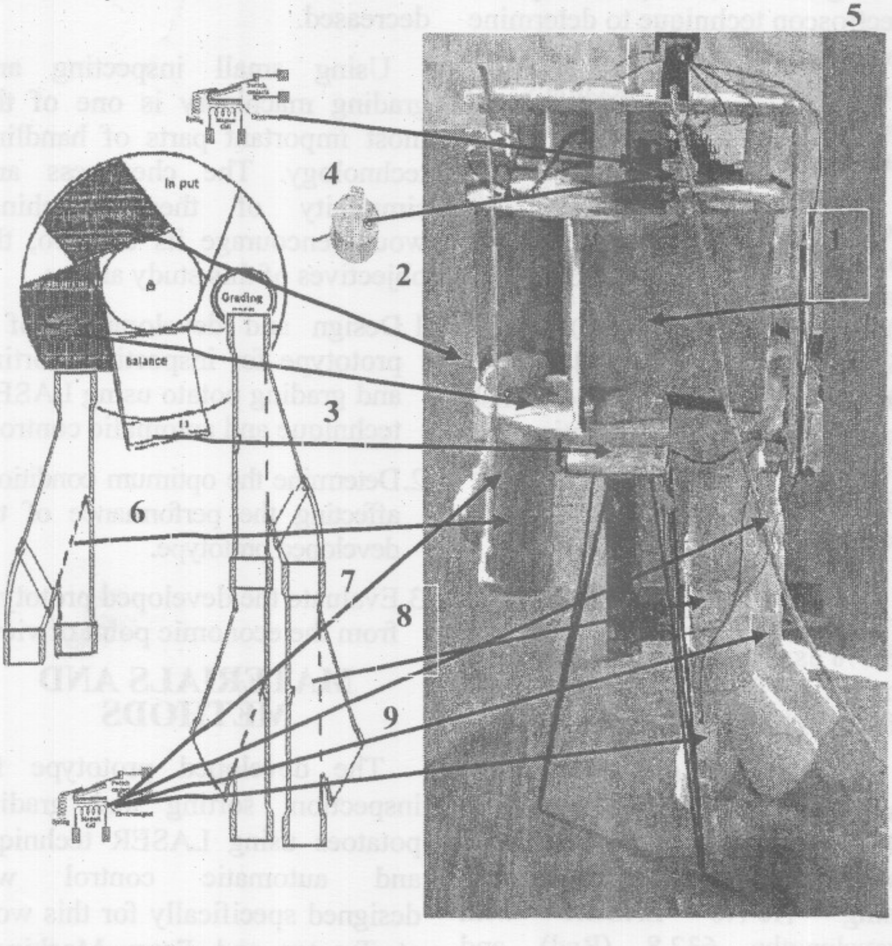
MATERIALS AND METHODS

The developed prototype for inspection, sorting and grading potatoes using LASER technique and automatic control was designed specifically for this work at Tractor and Farm Machinery Test and Research Station in Alexandria Governorate.

Materials

The Developed Prototype

The developed prototype Fig. 1 consists mainly of two main units, inspection unit and grading unit.



1	The testing chamber,	6	Inspection gate,
2	Photocell,	7	Inspection relay,
3	Digital balance,	8	Grading gate,
4	D.C. motor,	9	Grading relay.
5	Relay switch,		

Fig. 1.The inspection, sorting and grading potato prototype

Inspection Unit

The inspection unit consists of the following parts:

Reflector halogen lamp

Preliminary experiments were carried out to select one of the following halogen lamps as shown in Fig. 2.

Description

1) JCDR 220V/20 - 30W

2) JCDR 220V/20 - 40W

3) JCDR 220V/20 - 50W

4) JCDR 220V/20 - 60W

Fig. 2. Reflector Lamp

Experiments results reveal that JCDR 220V / 20-50W is the preferred to be used.

Red LASER diode

Red LASER diode is shown in Fig.3 and has the following characteristics.

Short wavelength: 658 nm.

Output power : 60 mW

Low operating voltage: 2.2V.

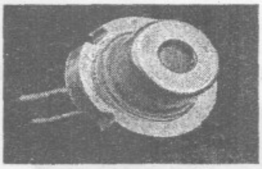


Fig.3. Red LASER diode

Photocell panel

High-speed, large areas, silicon photocell detector mounted in 16 X 16 cm. as shown in Fig.4 features high sensitivity, low noise, fast response and low capacitance. Applications include optical instrumentation, light and LASER detection, and optical communication; output from the device is related to the incident light.

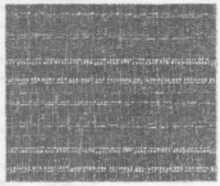


Fig.4. Photocell panel

Grading Unit

The grading unit consists of the following parts:

Digital balance

The digital balance used in the experiments is shown in Fig.5 and has the following specifications:

Capacity : 2000 g

Readability : 1 g

Weighing units: kg, g

Calibration: 3 seconds or more.

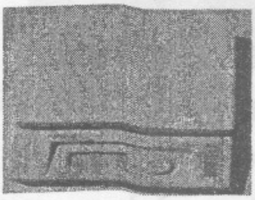


Fig. 5. Digital balance

Synchronous motor

The synchronous motor used with the setup is shown in Fig.6. It has the following specification:

Model	Rated voltage (V)	Rated speed (rpm)	Rated current (mA)	Input power (W)
50SM21	220	1/2	≤20	≤30
50SM21	220	5/6	≤20	≤30
50SM21	220	10/12	≤20	≤30
50SM21	220	15/18	≤20	≤30

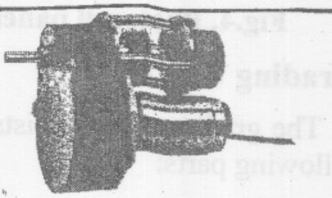


Fig.6. Synchronous motor

Digital power meter

The NU digital watt power meter is shown in Fig.7 is designed to measure the required power with a high performance. It is designed to measure A.C. current without the need to break the circuit under test by the clamp meter.

- A.C. current measurement from 3 A to 300 A
- A.C. voltage up to 600 V

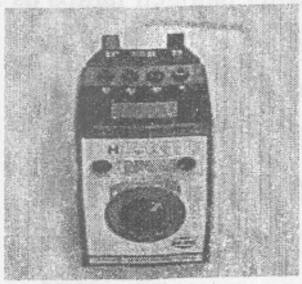


Fig. 7. Digital Power meter

The Separation Unit

The separation unit consists of the following:

Synchronization unit

The Synchronization unit shown in Fig. 8 used to determine the period time of inspection and grading units.

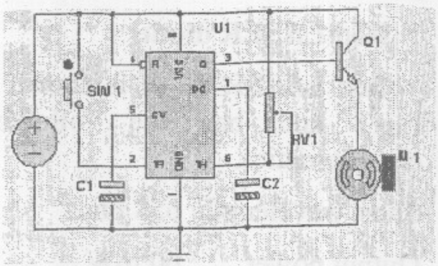


Fig. 8. The synchronization unit

Separation gate circuit diagram

The separation gate circuit diagram shown in Fig. 9 used in separation gate.

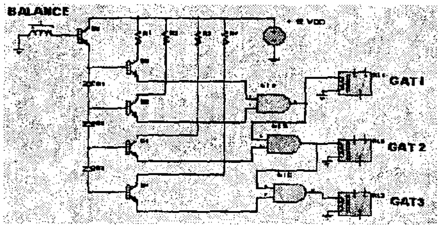


Fig. 9. The gate circuit diagram

Separation gate

The separation gate shown in Fig. 10 consists of a movable plate (3) inside a plastic tube as a Y shape (1) and an electric coil (2).

Theory of Prototype Work

To inspect, sort and grade potato in the developed prototype, potato passes through two main units (inspection and grading units).

The inspection unit

The inspection unit contains three chambers:

1. The first chamber is called the feeding chamber through which the potato is fed to begin the inspection operation.
2. The second chamber is called the photo chamber in which a potato white picture is taken using Reflector Halogen Lamp (50W).
3. The third chamber is called the LASER chamber in which a potato LASER picture is taken using a LASER diode with photocell panel.

The inspection unit rotates by dc motor- the dc motor takes its power from a power source 220 V through relay timing switch. Every one period (1/5 revolution) the switch turns off and the motor stopped at this time the timer turns on. There are three options made throw this time the first takes a white photo and delaying the time, and then takes a LASER picture and comparing between the two pictures. The second if there is a different voltage between the two pictures the inspection gate (6) opened by the inspection relay (7), while if there isn't a different voltage between two pictures the inspection gate stay closed and the tuber go to the grading unit.

The grading unit

The grading unit contains two chambers:

1. The first chamber is called weighting chamber in which potato mass is determined using a digital balance.

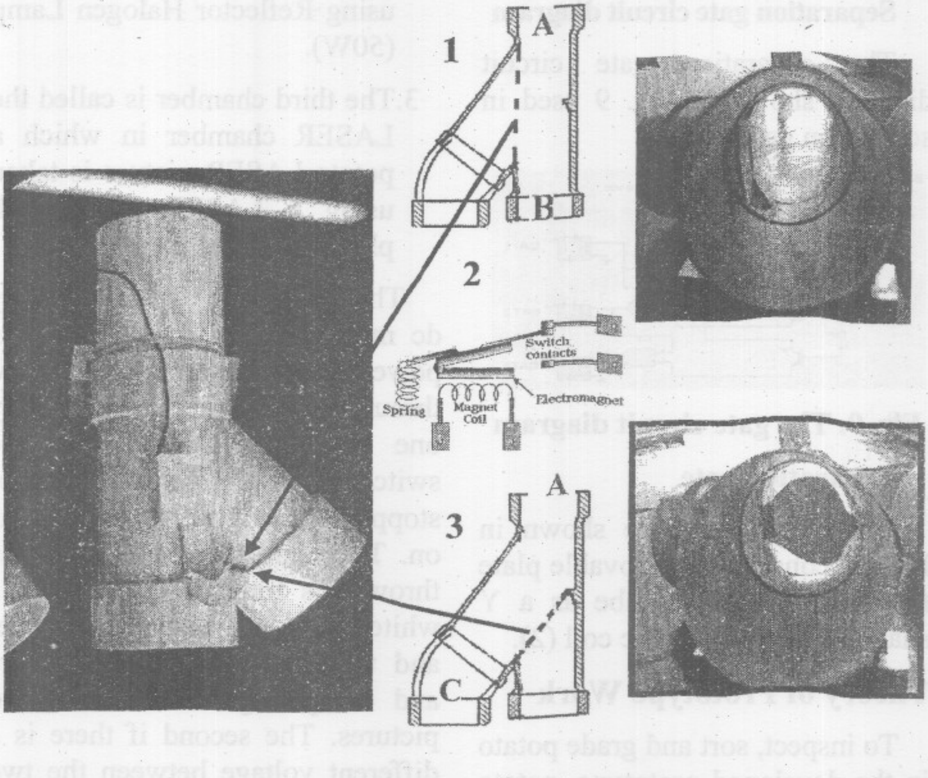


Fig. 10. The separation gate

2. The second chamber is called separating chamber through which bad potato is separated from good ones.

The potatoes from grading chamber pass through grading gate (8) opened by grading relay (9). Normally the gate (1) opened a way (A.B) to move the potato from A to B way. But when electric pulls go to the relay (2) the gate was opened a way (A–C) to move the potato from A to C way (3).

Potatoes from grading unit are classified by mass into four categories as follows:

- Small (mass < 40 g)
- Medium (mass 40-85 g)
- Large (mass 85-130 g)
- Very large (mass > 130 g)

Methods

Experiments were carried out at Tractor and Farm Machinery Test Station at Alexandria Governorate to evaluate the performance of the developed prototype for non-destructive inspection, sorting and grading potatoes.

Experimental Conditions

The developed prototype was examined as a function of change in the following parameters:

- Number of LASER diodes (2 and 3 diodes).
- Motor rotational speed (2, 6, 10 and 15 rpm).
- Inspection time period (4, 6, 8 and 10 seconds).

Measurements

Evaluation of the developed prototype was carried out taking into consideration the following indicators: Prototype productivity, kg/h, prototype accuracy, %., inspection efficiency, %., grading efficiency, % energy requirements, kW, h/kg. operational cost, LE/kg.

Productivity

Productivity for the developed prototype was calculated using the following formula:

$$\text{Productivity, (kg/h)} = \frac{Q}{t} \quad \text{..........1}$$

Where:

Q = Total potatoes mass, kg;

t = Operational time, h.

Prototype accuracy

Prototype accuracy was calculated using the following formula:

$$\text{Prototype accuracy, \%} = \frac{q_1 - q_2}{q_1} \times 100 \quad \text{.......2}$$

Where:

q_1 = Mass of the infected potato and inspected by inspection unit, kg;

q_2 = Mass of the infected but not inspected by inspection unit potato, kg.

Inspection efficiency

Inspection efficiency was calculated using the following formula:

$$\text{Inspection efficiency, \%} = \frac{Q - q_1}{Q} \times 100 \quad \text{......3}$$

Where:

Q = Total potatoes mass, kg;

q_1 = Mass of the inspected infected potato, kg;

Grading efficiency

Inspection efficiency was calculated using the following formula:

$$\text{Grading efficiency, \%} = \frac{q_4 + q_5 + q_6 + q_7}{q_3} \times 100 \quad \text{...........4}$$

Where:

q_3 = Mass of the inspected good potatoes, kg;

q_4, q_5, q_6, q_7= Masses of the proposed classified potatoes for the different outlets, kg.

Energy requirements

The energy requirements can be calculated using the following formula:

$$\text{Energy requirements, kW.h/Mg} = \frac{\text{Required power, (kW)}}{\text{Machine productivity, (Mg/h)}} \quad \ldots\ldots\ldots 5$$

The require power was measured using the digital power meter

Operational cost

The hourly cost of performing nondestructive inspection, sorting and grading potatoes was estimated according to the conventional way of estimating both fixed and variable cost.

Operational cost was calculated using the following formula:

$$\text{Operational cost (L.E. /Mg)} = \frac{\text{Hourly cost (L.E./h)}}{\text{Machine productivity(Mg/h)}} \quad \ldots\ldots 6$$

RESULTS AND DISCUSSION

The obtained results will be discussed under the following headings:

Productivity

The developed prototype productivity is greatly affected by many operational parameters such as motor rotational speed and inspection time period (Fig.11).

Concerning the effect of inspection time period on prototype productivity, results show that productivity varies inversely with time period under any motor rotational speed. Obtained data show that increasing inspection time period from 4 to 10 seconds decreased productivity from 39.0 to 24.0 kg/h, from 63.4 to 31.5 kg/h, from 72.5 to 33.6 kg/h and from78.1 to 34.7 kg/h to kg/h under motor rotational speeds of2, 6, 10 and 15 rpm respectively.

The decrease in prototype productivity by increasing the time period can be explained as follows: The arithmetic means for number of 10kg potatoes are 86 tubers and the inspection times for one tuber are 4, 6, 8 and 10 seconds. From the previous analysis, the total time for each 10 kg of potatoes, at a time period of 4 sec. is 5.7 minutes, while the total time at a time period of 6 sec. is 8.6 minutes, while the total time at time period of 8 sec is 11.5 minutes, while the total time at a time period of 10 sec is13.4 minutes. This means that the total time for inspection increased by increasing time period. As a result productivity decreased with increasing time period.

As to effect of motor rotational speed on prototype productivity, result shown that productivity values were more pronounced (Fig.12) as the motor rotational speed increased for any inspection time period. Obtained data show that increasing motor rotational speed from 2 to 15 rpm, increased productivity from 39 to 78.1 kg/h, from 32.3 to 55.1 kg/h, from 27.5 to 42.6 kg/h and from 24 to 34.7kg/h under inspection time periods of 4, 6, 8 and10 seconds respectively.

The increase in prototype productivity by increasing motor rotational speed can be explained as follows: One prototype revolution covers 5 tubers; therefore the 86 potatoes tubers required 18 revolutions. The rotational time is considered a loss time per revolution. From the previous analysis, the total time losses at the different motor rotational speeds of 2, 6, 10 and 15 rpm are 9, 3, 1.8 and 1.2 minutes respectively.

Therefore the time losses values per one kg are 0.9, 0.3, 0.18 and 0.15 minutes respectively. This means that, the more motor rotational speed, the less time losses is expected. As result, productivity increased by increasing motor rotational speed.

Prototype Accuracy

Prototype accuracy is more sensitive to different factors such as: inspection time period, motor rotational speed and number LASER diodes.

Regarding the effect of inspection time period on prototype accuracy, results show that prototype accuracy increased by increasing inspection time period Fig.13. Obtained data show that increasing inspection time period from 4 to 10 seconds, increased prototype accuracy from 79.35 to 85%, from79.15 to 84.55%, from 78.9 to 82.3% and from 74.85 to 79.35 under motor rotational speeds of 2, 6, 10 and 15 rpm respectively with the use of two LASER diodes, While accuracy increased from 79.5to 89.95%, from79.3 to 88%, from 78.75 to 84.25% and from 76.5 to 80.6 under the same previous motor rotational speeds with the use of three LASER diodes. The increase in prototype accuracy by increasing

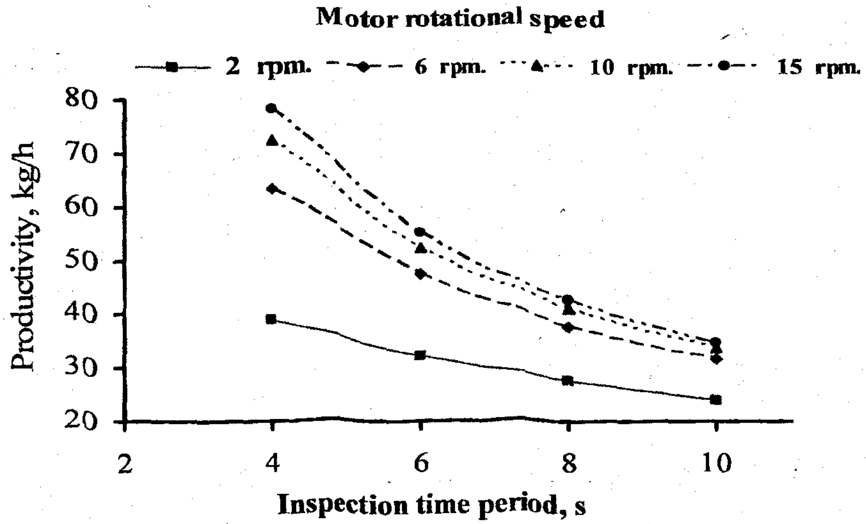


Fig.11. Effect of inspection time period (s), on prototype productivity at different motor rotational speeds

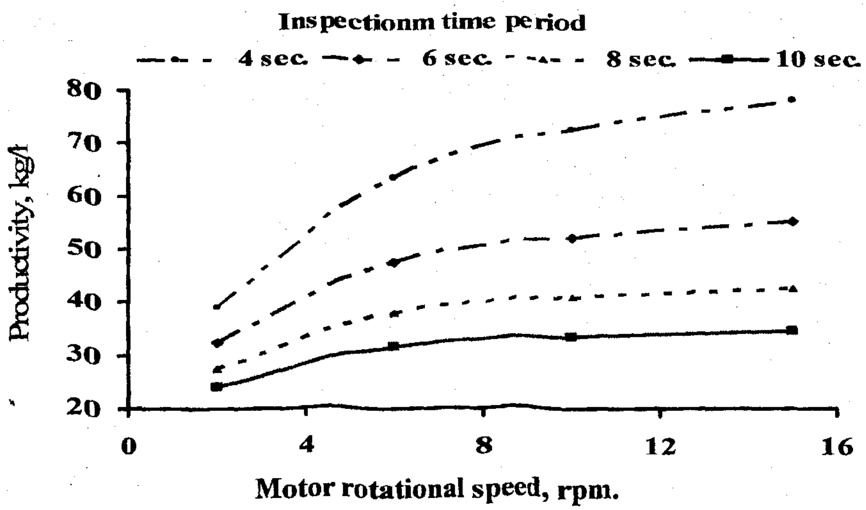


Fig.12. Effect of motor rotational speed (rpm), on prototype productivity at different inspection time period

inspection time period is attributed to the more available time for inspecting potato tubers resulting in high accuracy. Rotating to the effect of motor rotational speed on prototype accuracy, results in fig. 11 also show that increasing motor rotational speed from 2 to 15 rpm,

Rotating to the effect of motor rotational speed on prototype accuracy, results in fig.11 also show that increasing motor rotational speed from 2 to 15 rpm, decreased prototype accuracy from79.35 to74.85%, from79.35 to 75%, from 80.75 to77% and from85 to79.35% under inspection time periods of 4,6,8 and 10 rpm respectively with the use of two LASER diodes, While accuracy decreased from79.5 to76.5%, from80.4to 78.4%, from 83.2 to79.6% and from89.95 to81% under the same previous conditions with the use of three LASER diodes.

As to the effect of LASER diode number on prototype accuracy, results show that the use of three LASER diodes increased accuracy under any inspection time period and any motor rotational speed. This attributed to the clear LASER picture that was taken for the potato tubers with the use of three LASER diodes comparing with the picture that was taken with two LASER diodes.

Prototype Inspection Efficiency

Considering the effect of inspection time period on inspection efficiency, obtained data in Fig.14 show that increasing time period from 4 to 10 seconds, increased inspection efficiency from 95.87 to 97%, from 95.83 to 96.91%, from 95.78 to 96.46% and from 94.97 to 95.87% under motor rotational speeds of 2,6,10 and 15 rpm respectively with the use of two LASER diodes. While efficiency increased from 95.9 to 97.99%, from 95.86 to 97.6%, from 95.75 to 96.85% and from 95.3 to 96.2% under the same conditions with the use of three LASER diodes.

With regard to the effect of motor rotational speed on inspection efficiency, the same data show that increasing motor rotational speed from 2 to 15 rpm, decreased inspection efficiency from 95.87 to 94.97%, from 95.95 to 95.1%, from 96.15 to 95.4% and from 97 to 95.87% under inspection time periods of 4, 6, 8 and 10 seconds respectively with the use of two LASER diodes. While efficiency decreased from 95.9 to 95.3%, from 96.08 to 95.68%, from 96.64 to 95.92% and from 97.993 to 96.2% under the same previous conditions with the use of three LASER diodes.

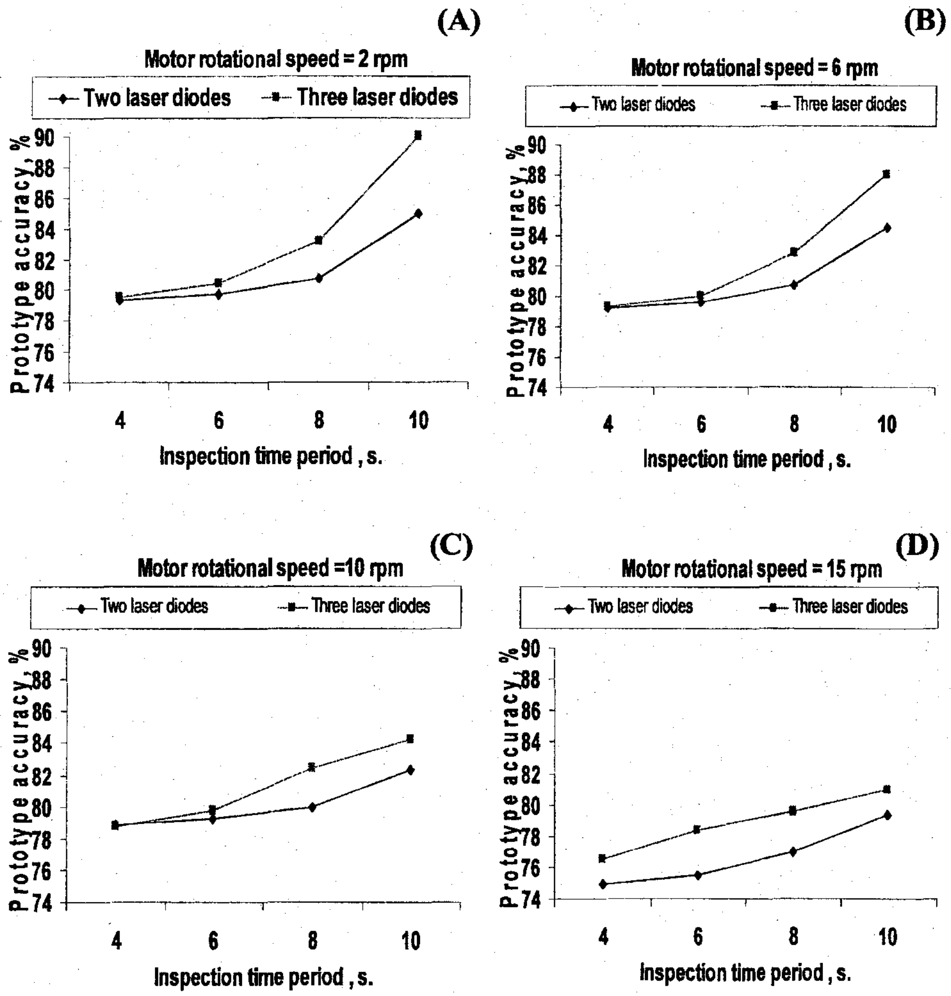


Fig.13. Effect of inspection time period (s), on prototype accuracy at different motor rotational speeds using two and three LASER diodes

As to the effect of LASER diode number on inspection efficiency, results show that the use of three LASER diodes increased inspection efficiency comparing with the use of two LASER diodes.

Prototype Grading Efficiency

The grading machine efficiency is greatly affected by the inspection time period as a function of the balance stabilization time, motor rotational speed and the gates response time.

Considering the effect of inspection time period on grading efficiency, obtained data in Fig.15 show that increasing time period from 4 to 10 seconds, increased grading efficiency from 96.00 to 96.75%, from 96.04 to 96.99%, from 96.05 to 97.09% and from 96.17 to 97.48% under motor rotational speeds of 2, 6, 10 and 15 rpm respectively.

Increasing grading efficiency by increasing time period is attributed to the accurate reading of potato mass due to the stabilization of tubers on digital balance.

Relating to the effect of motor rotational speed on grading efficiency, obtained data Fig.16 show that increasing motor rotational speed from 2 to 15 rpm increased grading efficiency from 96.00 to 96.17%, from 96.04 to 96.43%, from 96.35 to 96.73% and from 96.75 to 97.48% under motor rotational speeds of 2, 6, 10 and 15 rpm respectively.

Energy Requirements

The energy required for operating the prototype had been consumed for driving motor, LASER diodes, halogen lamp, the separated gates and synchronization unit. Energy requirements versus inspection time periods are given for two and three LASER diodes at different motor rotational speeds in Fig.17.

Considering the effect of inspection time period on energy requirements, results show that increasing time period from 4 to 10seconds increased energy values from 5.79 to 9.42 kW.h/Mg, from 3.56 to 7.17 kW.h/Mg, from 3.12 to 6.73 kW.h/Mg and from 2.9 to 6.51 kW.h/Mg under motor rotational speeds of 2, 6, 10 and 15 rpm respectively with the use of two LASER diodes. While energy values increased from 6.92 to11.2 kW.h/Mg, from 4.26 to 8.57 kW.h/ Mg, from 3.72 to 8.04 kW.h/Mg and from 3.46 to 7.78 kW.h / Mg under motor rotational speeds of 2,6,10 and 15 rpm respectively with the use of three LASER diodes.

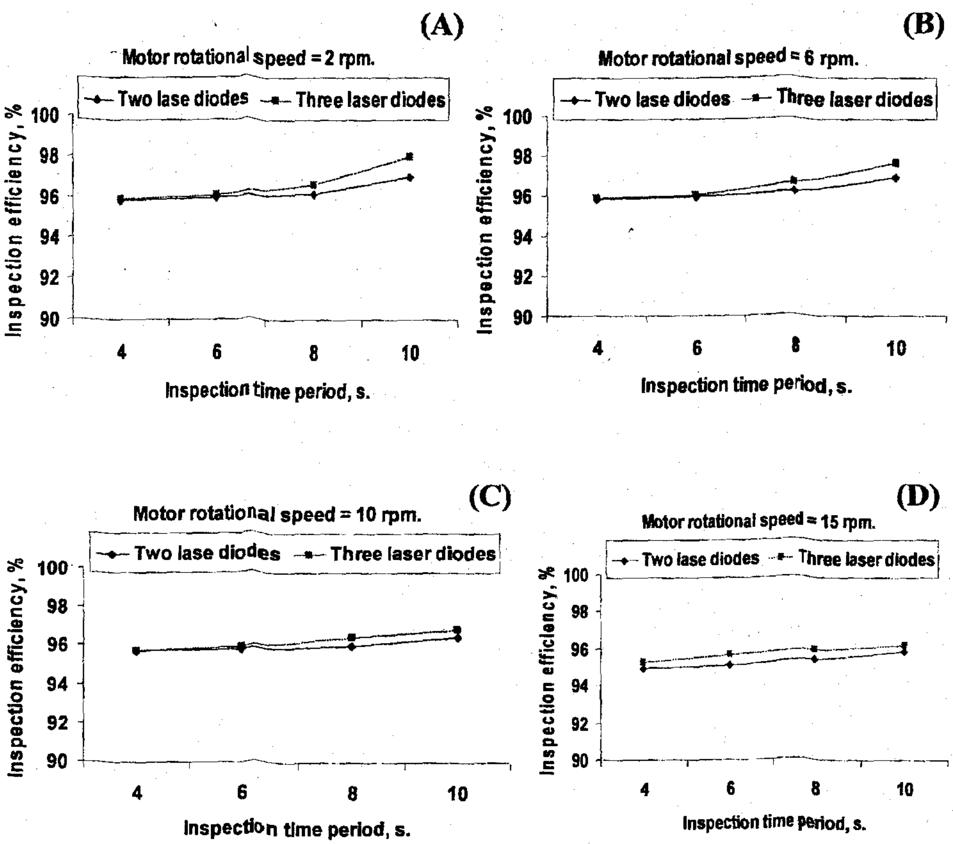


Fig.14. Effect of inspection time period (s), on inspection efficiency at different motor rotational speed using two and three LASER diodes

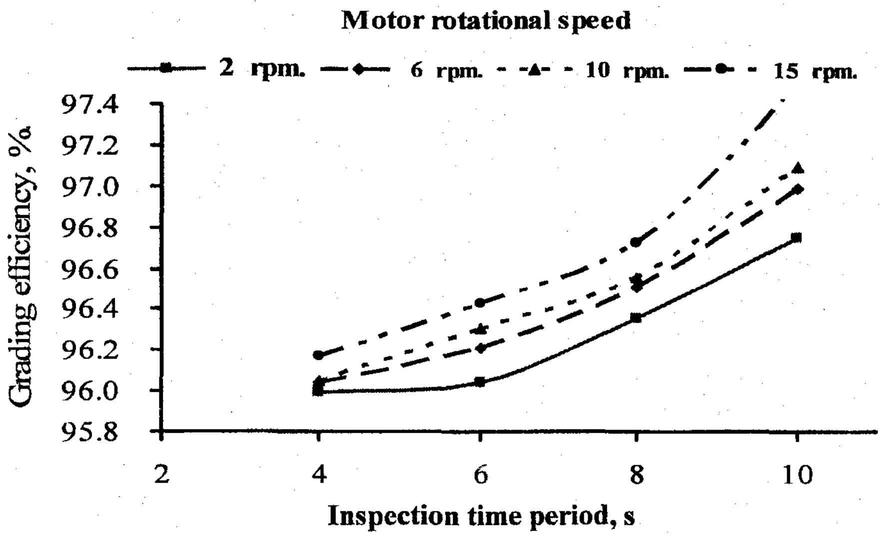


Fig.15. Effect of inspection time period (s), on prototype grading efficiency at different motor rotational speed

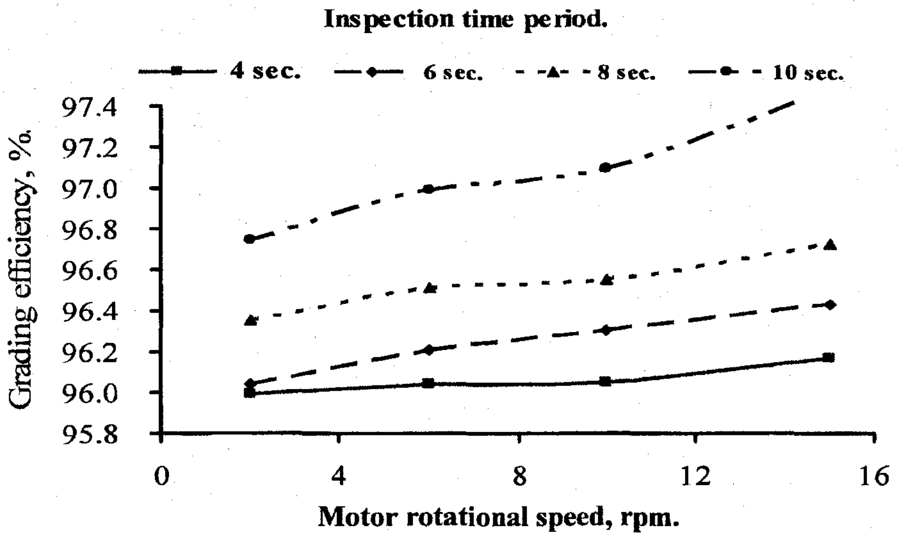


Fig.16. Effect of motor rotational speed (rpm), on prototype grading efficiency at different inspection time period

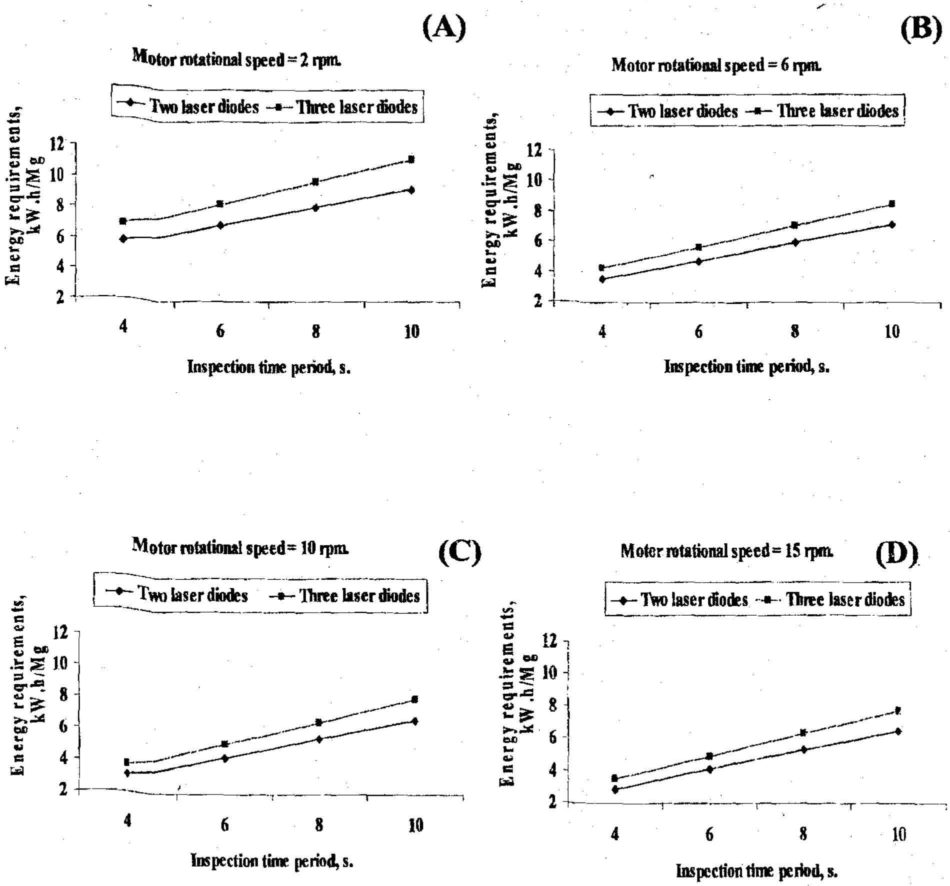


Fig.17. Effect of inspection time period (s), on energy requirements at different motor rotational speed using two and three LASER diodes

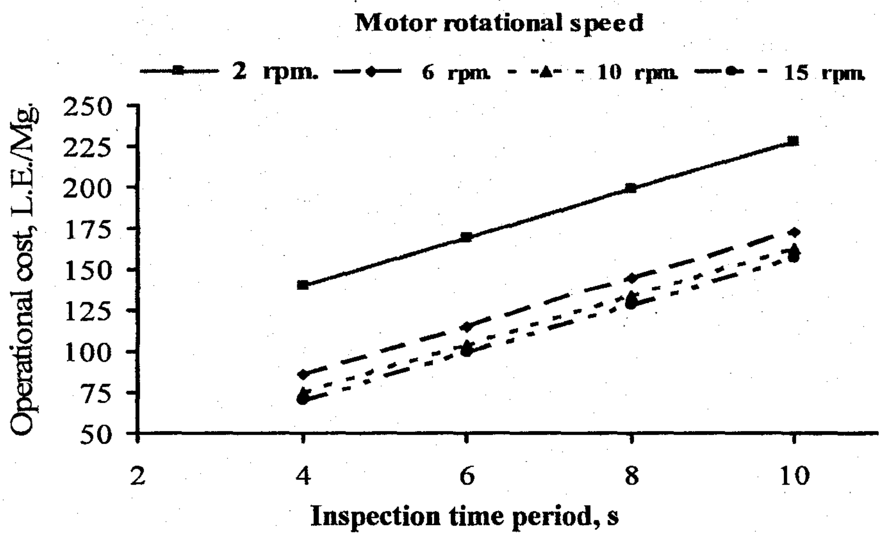


Fig.18. Effect of inspection time period (s), on the operational cost at different motor rotational speed

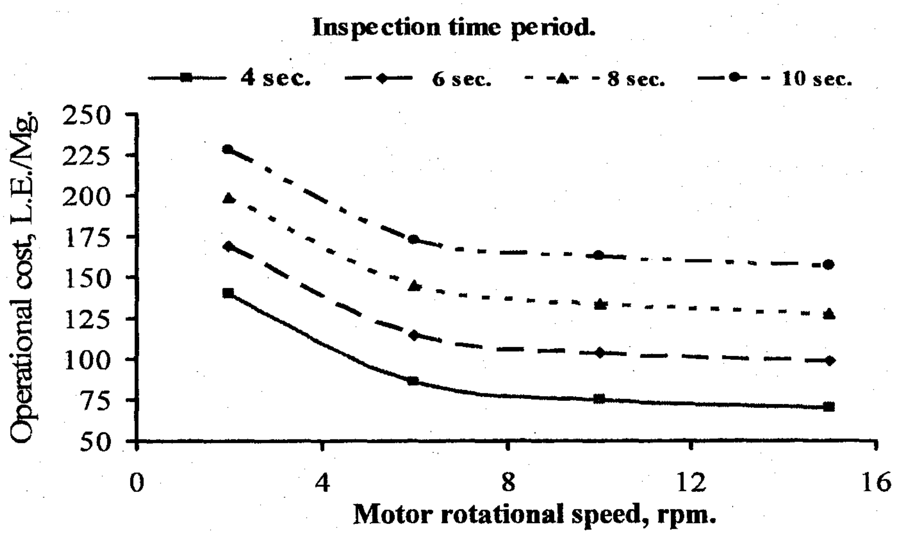


Fig.19. Effect of motor rotational speed (rpm), on the operational cost at different inspection time period

Reading the effect of motor rotational speed on energy requirements, obtained data show that increasing motor speed from2to15 rpm, decreased energy requirements from 5.79 to 2.9 kW.h/Mg, from 7 to 4.1 kW.h/Mg, from 8.22 to 5.31 kW.h/Mg and from 9.42 to 6.51 kW.h/Mg under inspection time periods of 4, 6, 8 and 10 seconds respectively with the use of two LASER diodes. While these values decreased from 6.92 to 3.46 kW.h/Mg from 8.36 to 4.9 kW.h/Mg from 9.82 to 6.34 kW.h/Mg and from 11.25 to 7.78 kW.h/Mg under the same conditions with the use of three LASER diodes.

As to the effect of LASER diode number on energy values, results show that the use of three LASER diodes increased inspection efficiency comparing with the use of two LASER diodes. While efficiency increased from 95.9 to 97.99%, from 95.86 to 97.6%, from 95.75 to 96.85% and from 95.3 to 96.2% under the same conditions with the use of three LASER diodes.

Regarding the effect of motor rotational speed on energy requirements, obtained data show that increasing motor rotational speed from 2 to 15 rpm, decrease energy requirements from 95.87 to 94.97%, from 95.95 to 95.1%, from 96.15 to 95.4% and from 97 to 95.87% under inspection time periods of 4, 6, 8 and 10 seconds respectively with the use of two LASER diodes. While these values decreased from 95.9 to 95.3%, from 96.08 to 95.68%, from 96.64 to 95.92% and from 97.993 to 96.2% under the same conditions with the use of three LASER diodes.

As to the effect of LASER diode number on energy values, results show that energy requirements values are higher with the use of three LASER diodes comparing with the use of two LASER diodes.

Operational cost

The operational cost depended mainly on the machine productivity and the required power added to that inspection time period as well as motor rotational speed are also affected the operational cost.

Referring to the effect of inspection time period on operational cost, results in Fig.18 show that increasing time period from 4 to 10 seconds, increased operation cost from 140 to 230 L.E. /Mg, from 90 to 170 L.E. /Mg, from 80 to 160 L.E. /Mg and from 70 to 160 L.E. /Mg at motor rotational speeds of 2, 6, 10 and 15 rpm respectively.

Relating to the effect of motor rotation speed on operational cost, obtained data in Fig.19 show that increasing motor rotational speed from 2 to 15 rpm, decreased operational cost from 140 to 70 L.E. /Mg, from 170 to 100 L.E. /Mg, from 200 to 130 L.E. /Mg and from 230 to 160 L.E. /Mg at inspection time periods of 4, 6, 8 and 10 seconds respectively

The mentioned data show that inspection time period of between 6 to 8 second and motor rotational speed of 6 rpm are recommend to obtain reasonable values of productivity, efficiency and cost.

Conclusions

Based on the results obtained in this study, the following conclusions can be drawn:

- Inspection time period, motor rotational speed and number of LASER diodes are considered very important variables affecting the performance of the developed for nondestructive inspection, sorting and grading potato.

Inspection time period of between 6 to 8 seconds, motor rotational speed of about 6 rpm and use of two LASER diodes are recommended to control the performance of the developed prototype.

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تصميم وتطوير نموذج آلة لفحص وتصنيف وتدريج غير هدام للبطاطس باستخدام تقنية الليزر والتحكم الآلى

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يعتبر محصول البطاطس من أهم المحاصيل الزراعية فى مصر لما له من أهمية تصديرية واستخدامات عديدة فى كثير من الصناعات الغذائية. حيث تبلغ المساحة المنزرعة من المحصول حوالى٢٠٠٠٠٠ فدان سنويا بإنتاجية حوالى ٢ مليون طن سنويا.

ويهدف هذا البحث لدراسة أداء نموذج آلة لفحص و تصنيف وتدريج غير هدام للبطاطس باستخدام تقنية الليزر والتحكم الآلى. هذا النموذج تم تصميمه وتصنيعه وتطويره محليا، حيث أن من المشاكل التى تواجه المزارع هى مشكلة تلف الدرنات الداخلى والتى تؤثرعلى جودة المحصول ومدة تخزينه وسعره وعملية التصدير وبالتالى الدخل الناتج عنه.

ونفذت هذه التجارب فى محطة أبحاث وإختبار الجرارات والآلات الزراعية بمحافظة الإسكندرية لتقييم أداء الآلة آخذا فى الإعتبار كل من انتاجية الآلة ودقتها وكفاءة كل من الفحص والتدريج للآلة والطاقة المستهلكة وكذلك التكاليف المطلوبة تحت ظروف تشغيل مختلفة هى:استخدام اثنين أوثلاث دايود ليزر (أحمر) مع أربع فترات مختلفة للفرز (٤، ٦، ٨، ١٠ ثوان) بأربع سرعات مختلفة (٢، ٦، ١٠، ١٥ لفة/دقيقة).

وقد أظهرت النتائج أن كل من فترة الفرز وسرعة الدوران وعدد دايود الليزر من أهم العوامل المؤثرة على أداء استخدام آلة الفحص والتصنيف والتدريج المصنعة محليا.

ويمكن التوصية باستخدام عدد اثنين من دايود الليزر مع سرعة دوران ٦ لفة/دقيقة وعند فترة فرز من ٦–٨ ثانية عند استخدام الآلة المذكورة والمصنعة محليا لفحص وتصنيف وتدريج البطاطس.