INTEGRATING ROBOTICS ELEMENTS INTO A SYSTEM FOR HARVESTING OLIVES

Doctoral Thesis-Summary

For obtaining the scientific title of Doctor at

The Politehnica University Timisoara

In the doctoral study field of Industrial Engineering

Author: Eng. Theoharis BABANATSAS

Doctoral supervisor Prof.univ.dr. ing. ec. Dumitru ȚUCU

Month 07 Year 2019

Chapter 1
IMPORTANCE AND NECESSITY OF THE THEME

1.1 Importance and necessity of the theme

Currently, the olive, both in Greece and in the other Mediterranean areas that are producing olive trees (Spain, Italy, Turkey, etc.), is cultivated in specific individual plantations. Such a plantation must be carried out taking into account all the physical qualities of the soil, the people who will execute the cultivation and harvesting of olives, but also the technology available.

Starting from the economic and social importance of the olive tree and the current competitiveness needs, it is necessary to conceive, implement and integrate the robotics elements at harvest to achieve the harvesting of the olives by eliminating, as much as possible, the human operator engaged in large numbers over a duration limited. The measure would lower harvesting costs, which is reflected in the value of the final product, simultaneously increasing productivity by improving the harvesting process.

For the time being, hand-held and mechanized harvesting are predominant in Greece.

Due to the prevalence of manual harvesting, there is a social problem with jobs.

Fewer people become "specialists" in olive harvesting, making it difficult to find qualified individuals who are getting fewer each year. For example, qualified people work in such a way that they do not hurt the tree or the fruit, thus avoiding lower productivity.

Harvesting begins at the end of September if green olives are desired or in mid-October to produce black olives and lasts for 15 to 20 days. It is necessary to harvest a group of 3-4 people to an olive tree, which can be harvested by hand 6-7 fruit per day in the case of trees which give a yield of about 70-80 kg of olive oil per tree. The harvest begins in the morning (06.00-07.00) and lasts until the afternoon (17.00-18.00). Thus, a thousand-olive plantation requires a large number of people to work, leading to high costs for the harvesting process, correlated with the final destination for the finished product (olives or olive oil).

In recent years, the trend towards BIO products (where no pesticides, fertilizers, and additives have been used in cultivation) and more natural is more and more intense, so researchers propose optimized harvesting systems as efficient as products to be of the best quality.

Based on these needs, the thesis investigates the methods of harvesting and the implementation of robotic systems in these methods, with possible use for other fruits that can be harvested by vibrating the tree such as cherries, plums,, nuts, almonds, etc.

By developing such technologies, the process and the olive harvest can be streamlined, with the possibility of extension for other fruit, increasing the efficiency in this field, consequently expanding the market.

Chapter 2
ASPECTS ON THE HISTORY, IMPORTANCE AND MAIN CHARACTERISTICS OF OLIVE OIL

2.1 Short history

Olive is a tree of wealth, longevity, prosperity, and life. Olive is one of the oldest trees that gave food to humans and one of the essential fruit trees for the Mediterranean diet. Olive is a long-lived tree that can reach thousands of years of survival (Figure 2.1). The olive tree loves Mediterranean warmth, grows even on arid and stony soil, and is also very resistant to drought and strong wind. Olives, olive oil, and olive groves have been an essential element for the economic and cultural development of the Mediterranean regions.

Fig. 2.1. The olive tree in Salamina, Crete, about 3000 years old

The olive has been known since antiquity. According to mythology, the homeland of the olive is Athens, and the first olive was given by the goddess Athena of the Athenians (figure 2.2), which appeared in the place where the spear fell during the fight between the gods to choose the city's protector. The Mycenaeans offered olive oil to the gods, while Homer called the "golden liquid gold" from the diet. Aristotle regarded olive cultivation as science, while Hippocrates used olive oil as a medicine.

Fig. **Error! No text of specified style in document.**.1. The goddess Athena and the olive tree

2.2 The economic and social importance of the olive tree

Olive has always been significant to the peoples of the Mediterranean because it has provided food to people through its fruit (olives) and olive oil. Apart from food, the olive tree has contributed to daily living by offering wood as a building material and for various uses. Olive has played an essential role in the economy, as olive oil has been marketed among different peoples. Olives have also been a source of inspiration for artists of all time, whether it is painting or poetry. Since antiquity, it has been known that olive has medicinal properties, both through oil and its leaves.
Cultivation of the olive continues to be linked to man's life in modern times as olive oil continues to be an essential food. Interestingly, some olive cultivation processes have not changed significantly over time as the requirements are the same. The way olive oil is produced has also remained the same.
The olive groves cover an area of 400,000 million square meters in the world, and the number of olive trees amounts to 3 billion. Of this cultivation area, 98% is in the Mediterranean.

2.3 The main characteristics of the olive tree

From the previous descriptions, it can be concluded that all of these characteristics directly or indirectly influence the quality of the olives and are related to the method and the harvest period, so that their knowledge is necessary for the realization of the optimal harvesting device.
Olive belongs to the Oleaceae family, represented by more than 25 species. Of these, the most important are Olea, Syringa, Forsythia, Ligustrum, Fraxinus, and Phillyrea.
The olives, known as Olea europaea, which means "European olives", are a small tree species of the Oleaceae family found in the Mediterranean basin. The olive, Olea europaea, is a

permanent green tree of the Mediterranean, Asia, and Africa, with a height of 8-15 m. Flowers are small, white, and the fruit is small, 1-2.5 cm. Olea europea euromediterranea var. oleaster or Olea europea var. oleaster Hoffm and Olea europea var. sylvestris Mill, is found in southern Africa, Spain, Portugal, Sicily, Caucasus, Armenia, and Syria. It is a shrub with spines, which usually gives small fruit.

Chapter 3
RESEARCHES ON THE STRUCTURAL MODELING OF THE TECHNOLOGICAL FOR OLIVE HARVESTING SYSTEMS (OHS)

3.1 Research objectives

The objectives of this research are focused on the study of the harvesting of olives in different types of orchards in Greece.

The proposed experimental plan studies the different current ways of harvesting, improving, and implementing robotics in olives harvesting where possible.

This study will identify the main advantages and disadvantages that define each harvesting process.

At the same time, the entire process could lead to the qualitative and quantitative improvement of olive production.

3.2 Functional principle of olive harvesting systems (OHS)

Fruit harvesting is an essential step in agriculture that contributes to cost savings by making it more efficient. The fruit harvesting principle includes the recognition, harvesting, and storage stage of the fruit. When harvesting olives based on these steps, we analyzed the functional harvesting principle.

Olive harvesting systems (OHS) are based on the analysis of the stages of identification, detachment, and temporary storage of olives during harvesting (Figure 3.1).

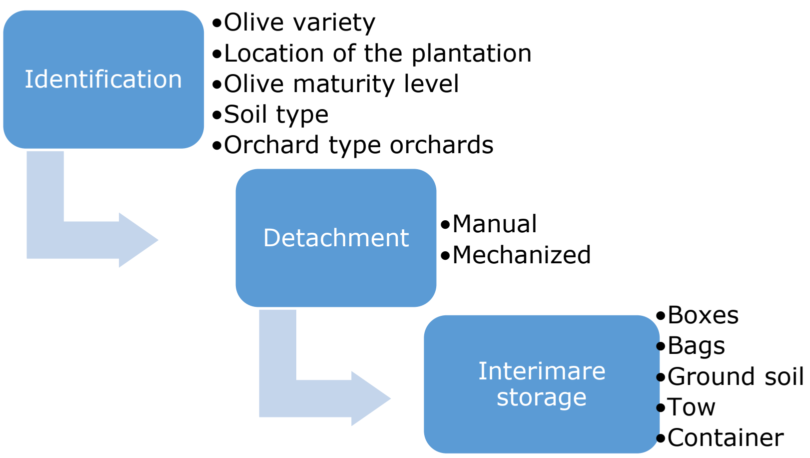

Fig. **Error! No text of specified style in document.**.1. Principle OHS

Identification stage contains all those elements that are needed to identify the olives to be harvested.
Each element in this stage has particular requirements, namely:

- *The olive variety* defines, in large part, the way of harvesting. Consumption olives must not be damaged;
- If the *plantation* is in a mountainous area, access to the equipment is limited;
- At a sure maturity level olives lose their nutritional properties and specific characteristics;
- If the soil is impoverished in nutrients then the productivity will be low as well as the quality of the olives will be more inferior;
- A *hyperintensive orchard* requires an irrigation system and a mechanized harvesting system.

Stage of detachment includes an analysis of possible posting methods.
In a very general way, manual detachment methods are used in table olives and mechanized methods for olives intended for oil.
Because mechanized methods can damage olives during the harvesting process.
In mechanized harvesting, the orchard of olives must be made in such a way that access to the machinery is allowed and the plantation must have street access.
The land must be planted and the olives must be planted on the rows at a well-established distance.

Stage of intermediate storage includes a study on storage options.
After harvesting, olives are stored in the middle, regardless of the way they are detached.
The storage of these olives is carried out by merely loading into piles, and under these conditions, pathogenic infections in olives can develop in a short period. Anaerobic microorganisms act in the private pond area and aerobic in ultra-peripheral areas.
To avoid the physical and biological deterioration of olives, which alter the quality of table olives and olive oil, the optimum intermediate storage method is sought and a reduction in the interval between harvesting and processing as much as possible.

3.3 Conclusions on the opportunities in the OHS

The best method of harvesting, from a qualitative point of view, is the classic method (manual, with comb, bats, or manual vibrating devices). The classic method is intended for both consumer and processed oil for oil production.
Using mechanical harvesters, it is possible to harvest more trees in less time and use fewer people. In the case of mechanical harvesting, however, special care should be taken not to damage the olives, degrading their quality and hence the quality of the oil obtained from them (Table 3.1). Also, certain types of machines have the disadvantage that, along with the harvesting of the olives, they also harvest vegetation, but also damage the tree, forming wounds that are entry gates for pathogens. Olives must also be in the appropriate maturity stage, and tree shaping must be appropriate.

Table 3.1 Comparison of planting types

Type of the plantation	Production kg/ hectare	Olive Variety	Olive for oil	Olives for consumption	The service

					life of the plantation
Classical method	200-4000	All varieties	YES – High quality	Yes-Superior quality	>100 years
Mechanized method Dense Plantation	3000-12000	Almost all varieties	YES – Very good quality	YES – under certain conditions- very good quality	25-30 years
Mechanized method very dense plantation	10000-22000	Koroneiki Arbequina Arbosana	YES – good quality	Not	10-15 years

Chapter 4

EXPERIMENTAL RESEARCH ON THE OPTIMIZATION OF TECHNOLOGICAL SYSTEMS FOR THE INTEGRATION OF THE ROBOTIC ELEMENTS IN THE PERFORMANCE OF A SYSTEM FOR THE RECOVERY OF OLIVES

These researches were structured on five distinct stages.
Stage I - The 3D modeling of a small-sized olive to gather information on the shaking forces, making it possible to make a prototype small shake device.
Stage II - The realization of a prototype of small olive shakes, to study the transmission of vibrations to olive trees (trunk and branches), but also the influence of the diameter of the olive trunk on the vibrations.
Stage III - 3D modeling of an olive-tree from a traditional-modern orchard (predominant in Greece) to determine optimum shaking values.
Stage IV - Attempts at which the olives were shaken for different values of frequency and amplitude, to obtain the maturity of the olives.
Stage V - To integrate robotic elements into olives harvesting systems by creating a program that, based on the diameter of the olive tree trunk, determines optimal shaking values.

4.1 Experimental research on 3D modelling

The objectives of the researches in stages I and III are to determine the optimum olive harvesting forces, and based on these results, then a robotic protrusion will be developed by truncated vibration for both the experimental part of small dimensions and for the big part of the development.

In order to create the 3D olive model in Autodesk Inventor I had to perform the measurements of the olive tree and define the characteristics of the olive tree in the program, namely the elasticity modulus of 2200 N / cm2, the mechanical stiffness of 0.00731 N / cm and the force of shaking of 2.56 daN, frequency values were taken between 15 and 35 Hz, values known to be necessary for the detachment of olives.

4.2 Research on the integration of robotics in olive harvesting systems

The purpose of this research is to study the integration of robotics in olives harvesting. We studied a correlation between olive diameter and olive harvesting, causing less damage to the olive. This also depends on the elasticity of wood, so we can use this principle to harvest other fruits that have SRM on the same principle as the olive.
For this purpose, we developed a small robotic arm from ARDUINO (total length 400mm and a maximum height of 500mm), to which we added an eccentric electric motor, proximity sensors and vibration sensors (sensor reading frequencies from 8Hz up to 1000 Hz, rotations from 480 rpm to 60000 rpm) Figure 4.1.

Fig. 4.1. The test of the robotic arm

4.3 Research on the influence of amplitude and frequency on shark harvesting of olives

The purpose of this research is to determine whether there is an influence of amplitude and frequency on the harvesting of olives and whether olives of different degrees of maturity can be harvested.
We varied the vibration frequency during the harvest between 23 Hz and 32 Hz, as well as the amplitude value from 0.01 m to 0.10 m, and the acceleration ranged between 160.1 ms-2 and 212.1 ms-2, the benefits being theoretically and from other experiments.
The results indicated the optimal value of the frequency and amplitude of the olives detachment for each maturity stage (Table 4.1)

Table 4.1 The optimum value of the detachment rate for olives.

Olive	Green (unripe)	Brown (semi-ripe)	Black (ripe)
Frequency (*Hz*)	24	26	29
Amplitude(*mm*)	0.1	0.75	0.05

4.4 Research on the integration of robotic elements in olives harvesting systems

The purpose of this research is to determine the forces needed to shake the olive for optimum harvesting of the olives (shake), depending on the diameter of the olive tree trunk, with the highest harvesting yield and with the lowest possible damage to the trunk in the contact area This study took place in Greece, at an olive grove in the Halkidiki region, Poligiros village, in autumn 2018, between 20-28 October. The Livada had a total of 202 olive trees with diameters ranging from 17 to 26 cm, the orchard being a modern-day orchard, the 15 to 25-year-old olive groves of the Halkidiki variety (Figure 4.2).

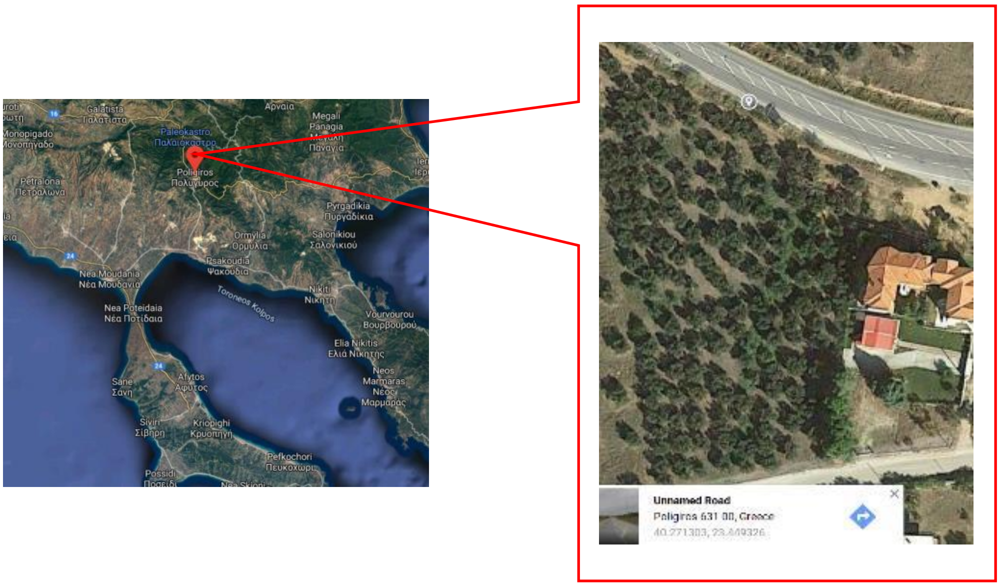

Fig. **Error! No text of specified style in document.**.2. Olive orchard in Halkidiki, Poligiros, Greece

We have a program that, depending on the diameter, will determine the power and amplitude required for the spin. This program was made easier by the JavaScript (JS) programming language, with a PHP extension (Figure 4.3), which is easier to use when entering data into a web interface and the JavaScript code can run directly from the browser.

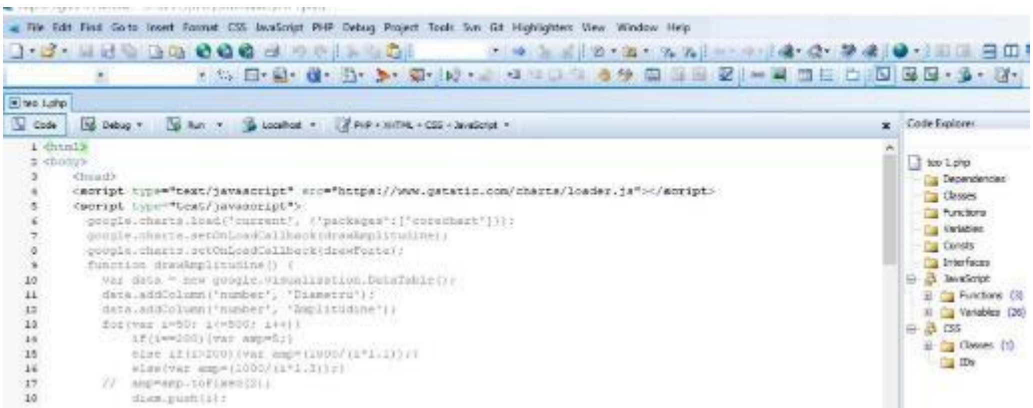

Fig. **Error! No text of specified style in document.**.3. Making the source code in JS

We carried out an experiment, which consisted of mechanized harvesting, variant A, and mechanized harvesting by adjusting the parameters according to the diameter of the B variant. On the A variant, we noticed a deterioration of the olive trunk in the bark. This deterioration is

mainly determined by the power and amplitude that are too large in relation to the diameter. We have not noticed a direct causal link between the diameter of the bark and the damage to the bark of the olive.
On the B variant, we noticed a much lower deterioration of the trunk of the olive in the bark compared to variant B. Deterioration is mainly based on the adjustment of the power and the amplitude to the diameter of the trunk. Also, in this variant, we did not notice a direct link between the diameter of the trunk and the level of deterioration of the olive bark.
On the A variant, out of a total of 105 olive trees, none were assigned to the first damage group (no visible injuries or very low injuries), 40 olive trees were in the 2nd category (with visible lesions small size), 33 in the 3rd category and 32 in the IV category (with large lesions on the trunk bark). In contrast, On the B variant (with the use of the robotic element), the values were significantly improved, no olives were classified in damage groups III and IV, 42 out of a total of 97 were assigned to the first group of damage and the rest in group II of deterioration (Table 4.4).

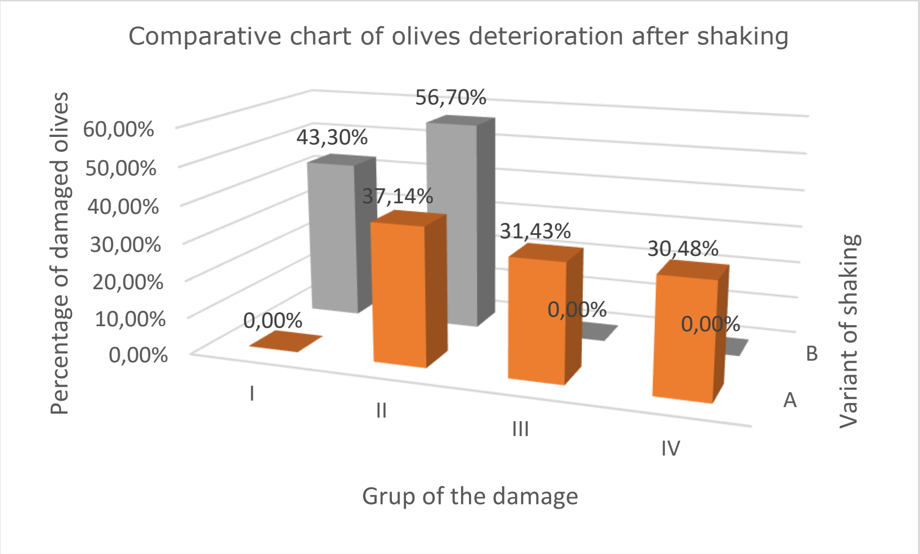

Fig. **Error! No text of specified style in document.**.4. The comparative graph of the deterioration of the olives

Chapter 5

CONCLUSIONS AND PERSONAL CONTRIBUTIONS. PERSPECTIVES OF RESEARCH

5.1 Conclusions

With the evolution and development of technology, the interest in robotizing agriculture has increased. In recent years, investing more and more in researching and developing the most efficient harvesting solutions, but also researching viable solutions to meet the needs of the consumer market. This research focused on the study of the olive's behavior at the time of harvesting through trunk vibration, at different diameters and at various degrees of maturity of the olives.
The detachment of olives according to the thickness of the olive trunk was analyzed by modifying the applied power to obtain the magnitude and the frequency already set by the technological restrictions, thus making the olives as small as possible.
3D modelling and sensor measurements performed this analysis, and the results obtained at

the end of each experiment were centralized and analyzed.
Also, based on the analysis of the olives detachment, a study was carried out on the influence of frequency and amplitude at the time of detachment, related to the maturity degree of the olives.
Finally, the research confirmed the initial assumptions that the specificities of the harvesting activities require a particular approach to the management of such processes.

5.2 Personal contributions

The work brings a large number of experimental contributions, of which the ones with significant significance and impact are presented:

- study of vibrations in a virtual olive model;
- studying the vibrations of a real olive;
- comparative study of shaking parameters in a virtual olive (3D modelling) and real (validation of the theoretical model);
- the study of the influence of amplitude and frequency on the process of detaching the olives by the degree of maturity of the olives;
- identifying the main elements needed for an olive harvesting system (SRM);
- experimental determination of calculation formula for optimum shaking power;
- realizing a program for calculating the shaking parameters (amplitude and shaking power), depending on the diameter of the shaft in the contact area with the shaking device, in order to determine the optimum shaking power;
- analysis of the correlation between the degree of deterioration of the olives in the contact area with the shaking device and the technical and functional parameters of the device;
- comparative analysis of the classic shaking system with the proposed system that integrates robotics elements.

5.3 Development perspectives

The most important directions of the study identified from the experience gained in this research are:

- - the possibility of expanding experimental research for harvesting systems used on other trees, where fruit can be harvested/detached by shaking;
- - extension of experimental research on the influence of vibrations and the cases of other orchards and trees;
- - deepening and expanding research to increase productivity by using robotic elements in fruit harvesting, but also for other operations that need to be done such as: trimming trees, spraying or cleaning the ground;
- - Real-time analysis of various samples, leaves, fruits, soil, etc.;
- - Performing a prototype for harvesting, with a dynamic correction system based on trunk diameter and modulus of elasticity.

Selective bibliography:

[1] Amirante, P., Catalano, P., Giametta F., Leone A. and Montel, G.L. *Vibration Analysis of an Olives Mechanical Harvesting System*. Agricultural Engineering International: the CIGR Ejournal, 2007

[2] Babanatis Merce, R. M., **Babanatsas, T.** and Glavan, D. O. *Experimental study of decreasing the damage to the olive tree during mechanized harvesting*. Acta Technica Napocensis, Series: Applied Mathematics, Mechanics and Engineering, 62, Issue I, 2019
[3] **Babanatsas, T.**, Babanatis Merce, R. M., Glavan, D. O. and Komjaty, A. *Value analysis of harvesting systems for olives*. Acta Technica Napocensis, Series: Applied Mathematics, Mechanics and Engineering, 62, Issue I, 2019
[4] **Babanatsas, T.**, Glăvan, D. O. and Babanatis Merce, R. M. *Concept of an automating olive harvesting system*. ANNALS of Faculty Engineering Hunedoara – International Journal of Engineering, Tome XV – Fascicule 3, 2017
[5] **Babanatsas**, **T.,** Glăvan, D. O., Babanatis Merce, R. M. and Maris, S. A. *Modelling in 3D the olive trees cultures in order to establish the forces (interval) needed for automatic harvesting*. International Conference on Applied Sciences, 294, 2018
[6] **Babanatsas, T.**, Glăvan, D. O., Babanatis Merce, R. M., Radu, I. and Maris, S. A. *Harvesting olive tree using accurate vibrations generated by a robotic system*. The 10th International Symposium Machine and Industrial Design in Mechanical Engineering (KOD 2018) Novi Sad, Serbia, 2018
[7] Bazakos, C. *Means to detect adulteration in olive oil.* Ms thesis, Mediterranean Agronomic Institute of Chania, Crete, 2007
[8] Berenguer, M.J., Vossen, P.M., Grattan, S.R., Connell, J.H. and Polito, V.S. *Tree irrigation levels for optimum chemical and sensory properties of olive oil*. 2006
[9] Birbili, D. *Wood properties*. Larisa, Ed. TEI, 2012
[10] Castillo-Ruiz F.J., Agüera-Vega J., Blanco-Roldán G.L., Sola-Guirado R.R., Jiménez-Jiménez F., CastroGarcia S., Gil-Ribes, J.A. *Criteria for olive orchard design aimed at its mechanical harvesting*. VII congreso ibérico de agroingeniería y ciencias hortícolas, 1781-1786, 26-29 August, Madrid, Spain, 2013
[11] Castro-García, S., Blanco-Roldán, G. L. and Gil-Ribes, J. *Table olive orchards for trunk shaker harvesting*. Biosyst. Eng. Vol. 129, pp. 388–395, 2015
[12] Chatzissavvidis C., Therios I., Evagelinou D., Tsaprali E., Chouliaras V., Malissovas N. and Mantzoutsos I. *The effect of fertilization treatments on productivity, maturation, carotenoid content and nutritional status of the table olive cultivar*. Balkan Agriculture Congress, Edirne, Turkey, 2014
[13] Costelenus, G. D. *Elemente de cultivare a măslinelor*. Athens, Ed. Ianuarios, 2016 [26]
[14] Di Giovacchino, L. Technological Aspects. Handbook of Olive Oil: Analysis and Properties. New York: Springer, 2013
[15] Fabbri, A. *Olive Propagation Manual*. Landlinks Press, 2004 [25]
[16] Farinelli, D., Boco, M. and Tombesi, A. Intensity and growth period of the fruit components of olive varieties. Acta Horticulturae 568, pp. 607–610, 2002
[17] Farinelli, D., Tombesi, S., Famiani, F. and Tombesi, A. *The fruit detachment force/fruit weight ratio can be used to predict the harvesting yield and the efficiency of trunk shakers on mechanical olive harvesting*. Acta Horticulturae, 965, pp. 61-64, 2012
[18] Glavan, D. O., **Babanatsas, T.**, Babanatis Merce, R. M. *Comparative research bedframe behavior on a lathe normal variations caused molded or welded to the requests of forced vibrations*. Annals of the University of Petroşani, Mechanical Engineering, vol. 17, 2015
[19] Glavan, D. O., **Babanatsas, T.** and Babanatis Merce, R. M. *3D modeling of olive tree and simulating the harvesting forces*. MSE 2017 -Trends in New Industrial Revolution, 121, 2017
[20] Glavan, D. O., **Babanatsas, T.** and Babanatis Merce, R. M. *Study of harvesting methods and necessity of olive harvesting robot*. ANNALS of Faculty Engineering Hunedoara – International Journal of Engineering, Tome XIV, ISSN 1584-2673, 2016 [45]
[21] Glavan, D. O., **Babanatsas, T.**, Babanatis Merce, R. M. and Maris, S. A. *Comparative study of tool machinery sliding systems; comparison between plane and cylindrical basic shapes*.

IOP Conference Series: Materials Science and Engineering- International Conference on Applied Science, Hunedoara. Romania, 2017
[22] Glavan, D. O., Radu, I., **Babanatsas, T.**, Babanatis Merce, R. M., Kiss, I. and Gaspar, M. C. *3D modeling of olive tree and simulating the harvesting forces*, 8th International Conference on Manufacturing Science and Education – MSE 2017 "Trends in New Industrial Revolution", vol 121, Sibiu, Romania, 2017
[23] Likudis, Z.; Costarelli, V.; Vitoratos, A.; Apostolopoulos, C. *Determination of pesticide residues in olive oils with protected geographical indication or designation of origin*. Int. J. Food Sci. Technol, 49, pp. 484–492, 2014
[24] Lychnou, N. *The tree of the olive tree*. Athens, Pirsos Publications, 2008.
[25] Markou, N. *Olive oil the miraculous*. Athens, Ed. Kodmos, 2017
[26] Manuel, P. R. et al. *Evaluation of Over-The-Row Harvester Damage in a Super-High-Density Olive Orchard Using On-Board Sensing Techniques*. Sensors. 18. 1242. 10.3390/s18041242, 2018
[27] Peri, C. *Olive handling, storage and transportation*. Wiley-Blackwell, Italy, 2014
[28] Stefanidis, G. P. and Tsimpliaris, D. *Study about olive shake system*. Doctoral thesis, 2015
[29] Therios, I. *Olives*. Athens, Ed. CABI, 2008
[30] Therios, I. *Olives*. Athens, Ed. Colums Design, 2014
[31] Tucu, D., Golimba, A., Mnerie, D. *Grippers design integrated in handling systems destinated to agriculture mechanization*. Actual tasks on agricultural engineering, proceedings. Book Series: Actual Tasks on Agricultural Engineering-Zagreb Volume: 38, pp. 447-454, 2010
[32] Tucu, D., Golimba, A., Slavici, T. *Fuzzy methods in renewable energy optimization investments*. Actual tasks on agricultural engineering, proceedings. Book Series: Actual Tasks on Agricultural Engineering-Zagreb Volume: 38, pp. 455-462, 2010
[33] www.olivenews.gr/el/article/8664/τα-πάντα-για-το-κλάδεμα-της-ελιάς-σχ, accesat 10.06.2017
[34] www.2gym-chanion.chan.sch.gr/autosch/joomla15/index.php/activities/19-2011-12-21-08-07-52/140-2011-12-q-q, accesat 15.07.2018
[35] www.agem.gr/προϊόντα/μηχανήματα-συγκομιδής-ελιάς/βενζινοκίνητο-ελαιοραβδιστικό-δόνησ/, accesat 29.10.2018
[36] www.agronews.gr/ekmetaleuseis/elaiones-kai-abelones/arthro/137234/ana-kilo-to-kostos-paragogis-elaioladou, accesat 21.11.2018
[37] www.refan.gr/catalog/product/krema-hmeras-elias.547, accesat 10.06.2017
[38] www.skai.gr/news/health/article/357948/ta-proioda-elias-prostateuoun-to-soma-apo-to-oxeidotiko-stres/, accesat 27.08.2018
[39] www.stihl.gr/Προϊόντα-STIHL/Συγκομιδή-ελιάς/Επαναφορτιζόμενο-ελαιοραβδιστικό/22644-1658/SPA-65.aspx, accesat 21.10.2018
[40] www.thebest.gr/news/index/viewStory/417126, accesat 04.10.2018
[41] www.worldatlas.com/articles/olive-oil-production-by-country.html, accesat 24.08.2018
[42] www.wolivenews.gr/el/article/8664/τα-πάντα-για-το-κλάδεμα-της-ελιάς-σχ, accesat 24.09.2018