1st International & 28th National Conference on Nuclear Science & Technology 2022 (ICNST22)
Nuclear Science & Technology Research Institute

Investigation of defects in tree trunks using the gamma-ray radiography

Beigzadeh A.M.[1*], KouchakPour J.[1] , Askari M.[1] , Taheri, A.[1]

[1] Radiation Application Research School, Nuclear Science and Technology Research Institute, AEOI, P.O.Box: 11365-3486, Tehran - Iran

[*] Email: abeigzadeh@aeoi.org.ir

Abstract
Trees have many benefits for the environment and human life, leading to clean air, oxygen production, fruit production, and cooling the air, conserving water resources and reducing soil erosion. Extensive studies have been conducted to evaluate the health of trees, structural and physical properties of different types of wood prepared from trees, so far. In this study, using gamma ray radiography, the presence of artificial 20 mm diameter defects inside the trunk of a tree will be investigated with 1% increase in the recorded count equivalent to 8,000 counts in detector. The results showed that the use of radiographic methods by 4.6×4.6 mm^2 array detector and Cs-137 gamma source can be effective in this field as a non-destructive and fast method.

Keywords: Environment, radiography, nondestructive tree investigate

Introduction
Wood and forestry have a prominent place in the global economy. Oxygen production and reduction of pollutants are the most important effects of forests on human life In total, 60% of the world's oxygen consumption is produced by vegetation. According to some estimates, each hectare of forest is able to release 2.5 tons of oxygen per year (the need of 10 people per year) while absorbing carbon dioxide too. Reducing noise pollution, absorbing dust, absorbing some chemical gases and killing many bacteria, single-celled fungi and harmful insects are other benefits of forest trees. Trees, like all living things, can suffer from disease, old age, and rot in their roots or trunks but unlike many organisms, they do not easily show the disease and its cause. In some cases, even with the naked eye, it is difficult to tell if a tree is in poor condition, either in terms of aging or common diseases. A tree may suffer severe rot on its trunk but look normal. There are various methods that can be used to detect disease, rot and other problems in the tree without causing any cuts or physical damage to the tree. These methods include moisture measuring, ultrasound, radar and nuclear tests, and gamma-ray tomography. For example, the density of the trunk can be determined using nuclear densitometers. In this study, using a transmission gamma-ray imaging system, the internal defects of the tree trunk is investigated[1-3]. Most of the nuclear measurement methods are in two categories: transmision and back scattering methods. In the transmision method, the sample is placed between the detector and the source, and in the back scattering method, the source and the detector are both on the same side of the sample.

Experimental

Preparation of the materials
First, a tree trunk with approximate dimensions of 16 cm in diameter and 50 cm in height was prepared. Using a chainsaw, the dimensions of the trunk reached a height of 23 cm, and then to create a defect in the internal structure inside the trunk, a hole with a diameter of about 2 cm was created inside it using a drill. A view of the tree trunk is shown in Figure 1.

Figure 1. Trunk sample

A gamma-ray cargo scanner system was used for imaging. The components of the system include a 700 mCi cesium-137 source, a $CdWO_4$ array detector with 4.6×4.6 mm^2 resolution, mechanical parts for moving the trunk and a software part. An image of the layout is shown in Figure 2. Gamma rays pass through the tree trunk sample and after attenuation are recorded in the detection system. The degree of attenuation depends on the internal structure and the density distribution of the tree trunk.

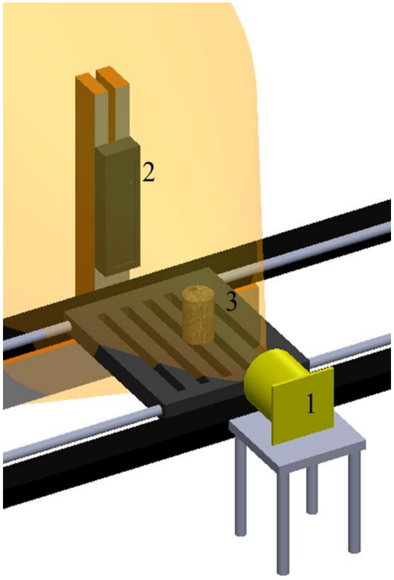

Figure 2. 1) Gamma-ray collimator and Cs-137 Source, 2) array detector, 3) tree trunk.

Results and discussion

The recorded image of the tree trunk by the detection system is shown in Figure 3.

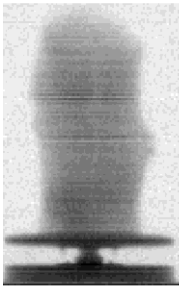

Figure 3. Recorded Image of the trunk with 4.6 mm resolution

Using the algorithm written in MATLAB and by scanning the image line by line, the existence of a defect inside the tree trunk was determined. Results of line-by-line investigation of radiographic image For both normal and defective parts of the trunk are shown in figure 4 and figure 5.

As the figure 4 shows, by examining the normal part of the tree with no internal defects, the normalized intensity decreases uniformly and due to the cylindrical cross section structure of the tree, the intensity increases again uniformly with decreasing trunk thickness at the corners. But with the presence of a defect inside the trunk, figure 5 an increase in the intensity profile occurs due to the lower reduction in the recorded flux in the detector due to the presence of a defect. In reality, these defects can be due to cracks, rot, cavities inside the trunks of living trees.

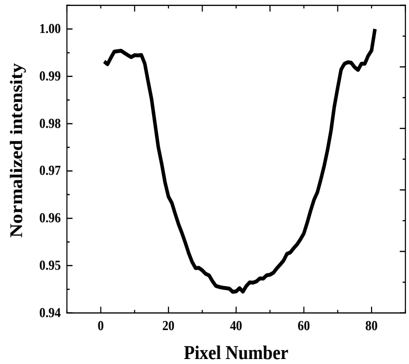

Figure 4. Linear intensity of the normal part of the trunk

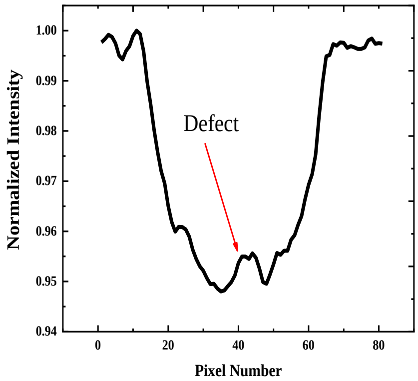

Figure 5. Linear intensity of the defect part of the trunk

Conclusions

In this study, the presence of defects inside a tree trunk was investigated using gamma-ray imaging. The results showed the appropriate accuracy of this method in determining the presence of defects inside the tree trunk. the presence of artificial 20 mm diameter defects inside the trunk of a tree will be investigated with 1% increase in the recorded count in detector equivalent to 8,000 counts. This method can be used as a fast and efficient method in environmental monitoring.

References

[1] X. Xiayang, et al. *Detecting and measuring internal anomalies in tree trunks using radar data for layer identification*. J. Sens. (2018).

[2] A. M. Beigzadeh, et al. *Design and improvement of a simple and easy-to-use gamma-ray densitometer for application in wood industry*. MEAS. 138 (2019)

[3] M. Askari, A. M. Beigzadeh, A. Taheri, *A new method for detecting the radioactive materials using X or γ-ray cargo inspection systems*, Nucl. Instrum. Methods Phys. Res. At, 1003, 165325(2021).