OPTIMIZING THE DESIGN OF A FLY WHEEL USING MACHINE LEARNING

J. Bala Bhaskara Rao[1] , M. Jayanthi Rao[2,*] , M. Srinivasa Rao[3] ,A.D.S. Saketh[4], T. Ravi Kumar[5]

[1]Department of Mechanical Engineering, SSCE, Srikakulam, JNTU-GV, India.
[2*]Department of Computer Science & Engineering, AITAM, Tekkali, India.
[3]Department of Computer Science & Engineering, Adikavi Nannaya University, Rajamahendravaram, India.
[4]Department of Mechanical Engineering, SSCE, Srikakulam, JNTU-GV, India.
[5]Department of Computer Science & Engineering, AITAM, Tekkali, India.

*Corresponding author
E-mail address: jayanth.mtech@gmail.com

ABSTRACT

Flywheels are an inertial storage device for energy. It is a mechanical energy absorber and acts as a storage device which stores energy whenever the energy supply is more than the demand, and then releases it when demand for energy exceeds the supply. The flywheel in machines functions as an accumulator, which stores energy when energy input is higher than the demand and releases it when there is a demand for energy higher than the energy input. The internal combustion engine is based on flywheels. The load placed on the flywheel grows and the stresses increase, so too do the loads and stress. The model of the steering wheel is designed using the CATIA tool, and then imported into ANSYS to be analyzed. The Finite Element Analysis is utilized to calculate the stress in the flywheel. The analysis of the flywheel was conducted on a single component. On the massive flywheel with cast iron (Ultimatestress-214Mpa Density-7510 kg/m^3 Poisons Ratio-0.23) the stresses in the flywheel are analyzed and estimated. The web type also analyzes the same material. The third type studies the steering wheel wire analyzes the stress within the steering wheel and then compares the results of 3 steering wheels. The radio steering wheel was modelled with modeling software like CATIA and ANSYS and the results taken and subsequently an analysis of the exact direction of the steering wheel and the proper speed could be identified. Based on the results, machine learning technique i.e., a neural network program to study strain and stress that is known as Generalized Regression Neural Network (GRNN) was designed. This process involves defining certain input parameters (geo, speed and thickness) and output parameters that are pre-defined are immediately available. (weight, strain and stress).

Keywords: Flywheel, GRNN, Stress, Deformation, FEA, Cast Iron, Machine Learning
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Introduction:

Flywheels are mechanical device that pivots that can be used as a storage device for Rotational Energy. Flywheels possess a crucial moment of inertia. They thus resist variations in the speed of rotation. The amount of energy that is stored in a flywheel corresponds to its square rotating speed. Energy is transferred into a flywheel through applying the force on it, thereby increasing its speed, and in turn the energy it stores. However, the flywheel releases put away energy through the application of the force of a mechanical load which in turn reduces its speed of rotation. The principle of the flywheel is traced through the Neolithic Shaft and the potter's wheel. The flywheel as a mechanical device for balancing the speed of the pivot according to the American medievalist Lynn White, kept in the The De diversibusartibus (On various specifics) in the work of German craftman, Theophilus Prebyter (ca. 1070-1125) who relates the device on a handful devices.

At the time of the Modern Upheaval, James Watt contributed to the development of the flywheel of the steam motor. His contemporaneous James Pickard utilized a flywheel coupled with a wrench to convert the response into the revolving motion. There are two stages in the design of the flywheel. In the first what amount of energy needed to provide the best smoothening level should be identified in addition to the (mass) amount of latency that is expected to absorb is not fixed in stone. After that flywheel math needs to be described as a method that cooks the anticipated picture of idleness into an appropriately estimated bundle and is shielded from disappointment with the expected speeds of work.

Flywheels are rotating plate or wheel that has an adequate pivot, so that the rotation is centered around one hub. Energy is stored within the rotor to be used as power for the motor, or more specifically, as rotational energy.

$$E_K = \frac{1}{2} I\omega^2$$

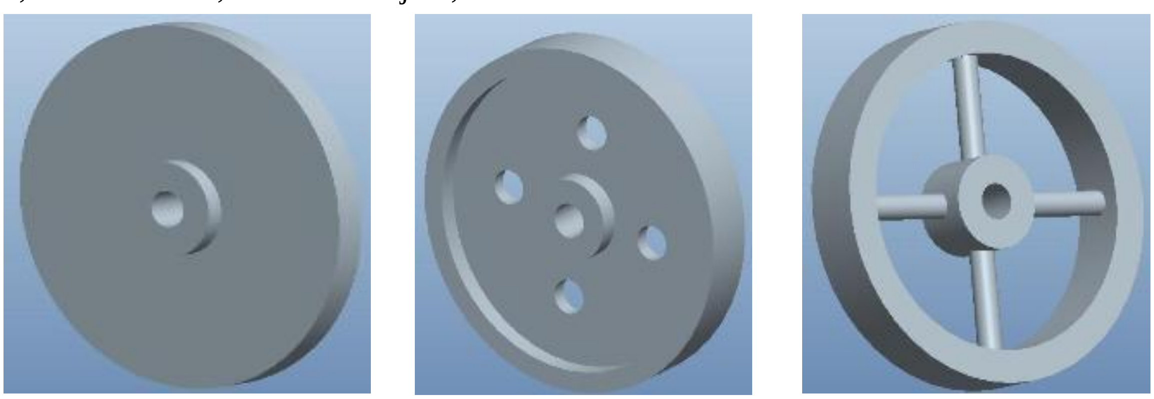
Where:

- ω= angular velocity
- I= moment of inertia of the mass about the center of rotation

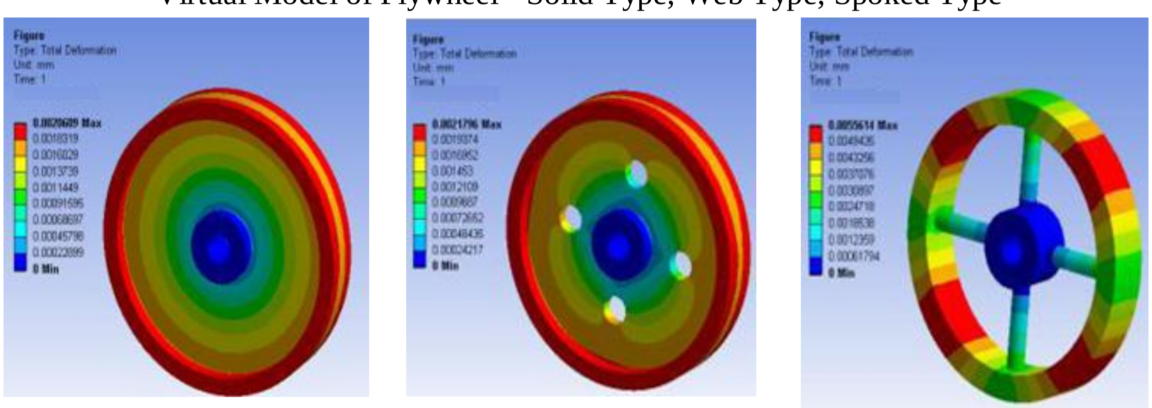
John A. Akpob i& Imafidon A. Lawani proposed PC supported plans of programming for flywheels utilizing object-arranged programming approach of Visual Fundamental. D.Kral et.al. [1] Experiments on the performance of intensity exchangers using the helical perplexes or helixchangers and based on the results of tests driven on different units that have diverse astound computations. They also demonstrated that a perfect edge of a helix is identified where the capability to switch between pressure drop and warm exchangers on the shell side of helixchangers has been enhanced. Qiuwang Wang et.al 2stated the fact that helical confounds can be utilized effectively in shell-and-cylinder heat exchangers (helixchangers) to serve as their primary central points for reducing strain drop and vibration and messing, while at maintaining the exchanger's performance at a higher level. P. Stehlik et.al [3] outlined that the tension drop correction elements utilizing tension drop correction factors based on the Ringer Delaware technique have been examined for a high-level segmentsal riddle heat exchanger, as well as the helical bewilder-heat exchanger. Qincheng Bi et.al [4In this research they completed their research to consider the effect of the puzzle's cover degree on the stream opposition of the shell side and the intensity exchanger's performance of shell-and-cylinder heat exchangers that have bewildering helicals (STHXsHB). Three STHXsHB with a cover-degree of 10 percent and helix edges that range from 20deg, 30deg as well as 40deg, were tried.The various flywheel designs (rimmed or robust) were the basis for improvement in the product [55. Sushama G Bawane A P Ninawe and S K Choudhary were the first to propose a flywheel designs, and also examined the process of material determination. It is the FEA model is illustrated to provide a better understanding of the network's size, type of lattice and limit conditions that are used to complete a compelling FEA design [6]. Saeed Shojaei, Seyyed Mostafa Hossein Ali for Mehdi Tajdari Hamid Reza Chamani have suggested calculations in light of the dynamic examination of the driving rod to design a flywheel for I.C. engine and torsional vibration test result using AVLEXCITE with the exact removal of a crave-free head of the rod. The the notion of weariness as a cause for weak examination of the flywheel are provided [77. Sudipta Saha, Abhik Bose, G. Sai Tejesh, S.P. Srikanth have proposed the importance for the use of the Flywheel Calculation selection and its role in the stockpiling of energy. The commitment is illustrated in the model cross-segments using PC supported investigation and advance method [8]. Bedier B. El-Naggar and Ismail A. Kholeif had suggested the idea of a circle edge flywheel to reduce weight. The flywheel's mass is limited by requirements of a required recording of latency and reasonable weights. The idea of pivoting plates with uniform thickness and thickness is applied to every circle and edge independently with a suitable matching condition in the junction.

MODELLING

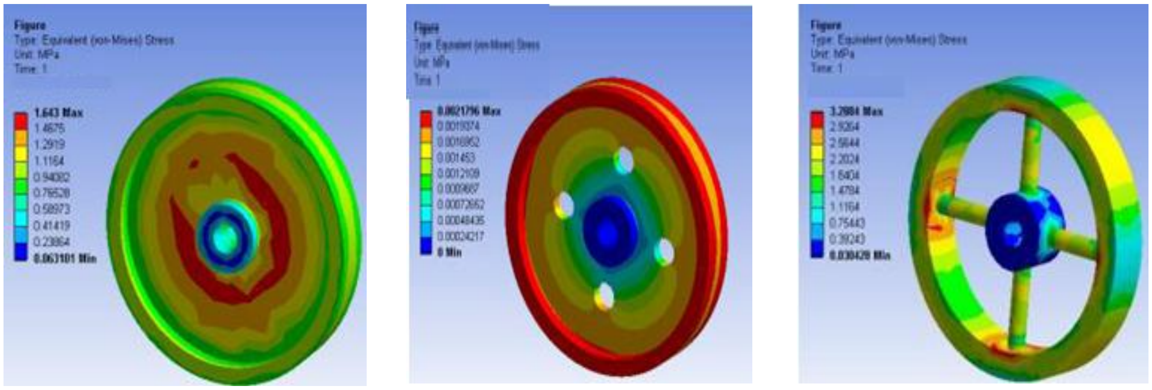
Three different fly wheels were modeled in CATIA whose material is taken as cast iron, one is Solid flywheel, & the other two are web type flywheel & spoked fly wheel



Virtual Model of Flywheel - Solid Type, Web Type, Spoked Type



Total Deformation in various design of flywheels



Equivalent Stresses in various design of flywheels

Stress & deformation analysis were performed on the three different types of flywheels in Ansys and the variations in stress & deformation was taken into consideration.

GEOMETRY PROFILE OF FLY WHEEL

Research has shown that successful flywheel configurations enhance the dormancy of the second material and guarantee the highest reliability and long-lasting life. The cleverness of the flywheel math is the most significant factor that affects its energy performance. The amount of motor energy put into the wheel-shaped structure flywheel is higher than any other flywheel. To quantify the amount of energy absorbed the material used by the spokes/arms of the flywheel is different from that of the other flywheels, which in turn reduces the cost that the flywheel incurs. Based on the study, it has been discovered that the greatest loads are triggered by the edges and the arm intersection.

GRNN IMPLEMENTATION

A generalized neural network is a kind of brain network with probabilities that is extremely helpful in analyzing yields embedding a limited number of data sources. Its primary benefit over other devices with measurable capabilities is the ability to add more factors that are anticipated by the client, with little or no additional contributions from the clients. Relapses in the brain of the free factors (Y) in subordinate factor (X) to conduct this study is reflected in the condition (9 and 10)

$$E(Y/X) = \frac{\int_{\text{lower}}^{\text{upper}} y f(X,Y)\,dy}{\int_{\text{lower}}^{\text{upper}} f(X,Y)\,dy} \quad (9)$$

$$(X) = \frac{\sum_{i=1}^{n} \exp[-\frac{(X-X_i)^T}{2\sigma^2}(X-X_i)]}{\sum_{i=1}^{n} \exp[-\frac{(X-X_i)^T}{2\sigma^2}(X-X_i)]} \frac{\int_{-\infty}^{\infty} y \exp\left[-\frac{(Y-Y_i)^2}{2\sigma^2}\right] dy}{\int_{-\infty}^{\infty} \exp\left[-\frac{(Y-Y_i)^2}{2\sigma^2}\right] dy} \qquad (10)$$

Together with the neural networks, a new assumption, as shown in figure.5 is used to discover an equation that is linear between the input and output, which is described by

$$Y = \frac{\sum_{i=1}^{n} Y_i e^{(D_i{}^2/2\sigma^2)}}{\sum_{i=1}^{n} e^{(D_i{}^2/2\sigma^2)}} \qquad (11)$$

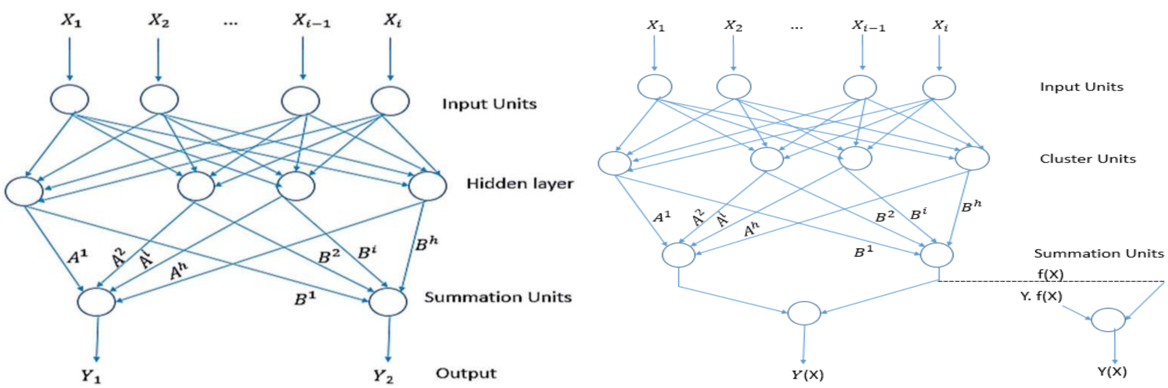


Figure.5 GRNN Implementation into clustering methods of ANN

Final outputs for GRNN inputs and outputs is calculated using the following equation following clustering

$$\text{GRNN output } (Y_{GRNN}) = \frac{\sum_{i=1}^{68} Y_i e^{(D_i{}^2/2\sigma^2)}}{\sum_{i=1}^{68} e^{(D_i{}^2/2\sigma^2)}} \qquad (12)$$

In this study, stresses, disfigurement and loads are identified in the results of geo, speed and thickness. They are used as inputs from table.1. In this case, a total of 54 exploratory indexes and six test informational collections are employed. By using the GRNN exam, the results are obtained for the entire learner data and test data from figure.6 and 7. Following the acquisition of the results of GRNN and exploratory abilities they are compared by locating the mistake the focus between test in figure.8. GRNN devices in figure.8. The generated yields are used when combined with one another.

Table.1 GRNN Datasheet

DEMONSTRATION	INPUT	WEIGHT OF INPUT
X1	Geo	10 - 30
X2	Speed	2.5, 5, 8
X3	Thickness	2 - 7

DEMONSTRATION	INPUT	WEIGHT OF INPUT
Y1	Stress	0.141 – 1.733
Y2	Deformation	5.96, 286.7
Y3	Weight	4.4 – 21.9

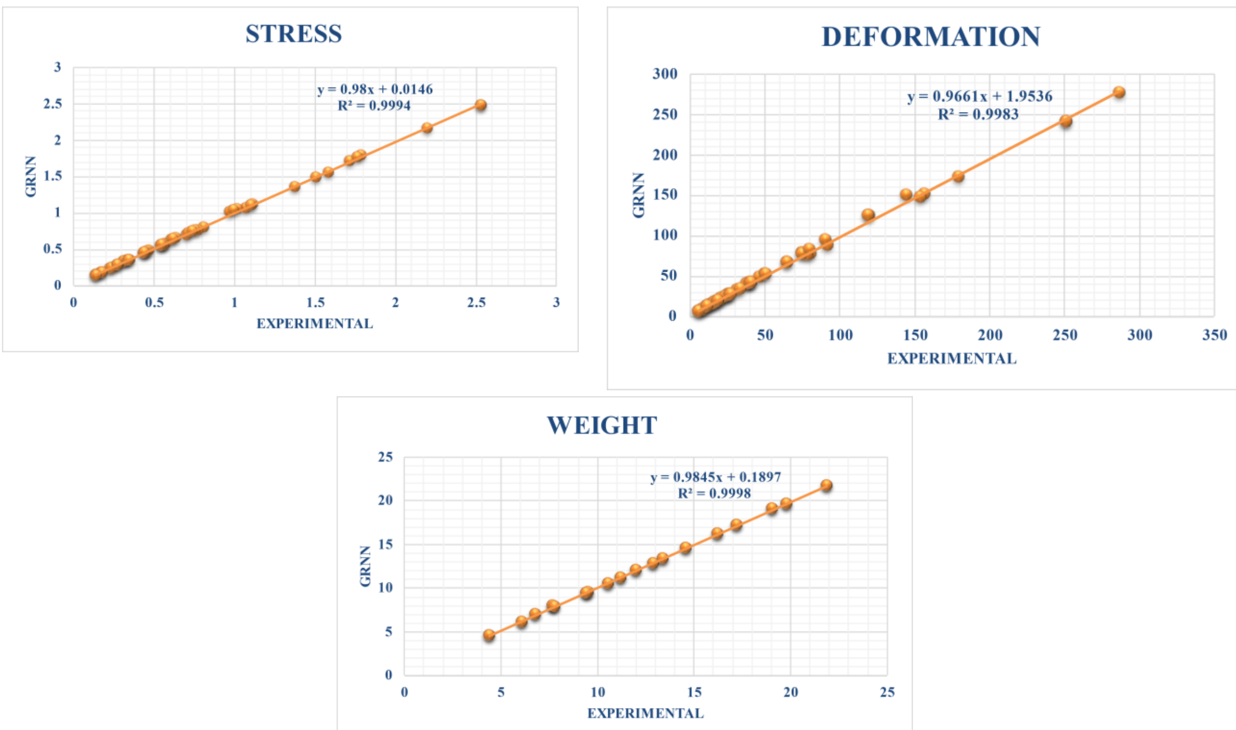
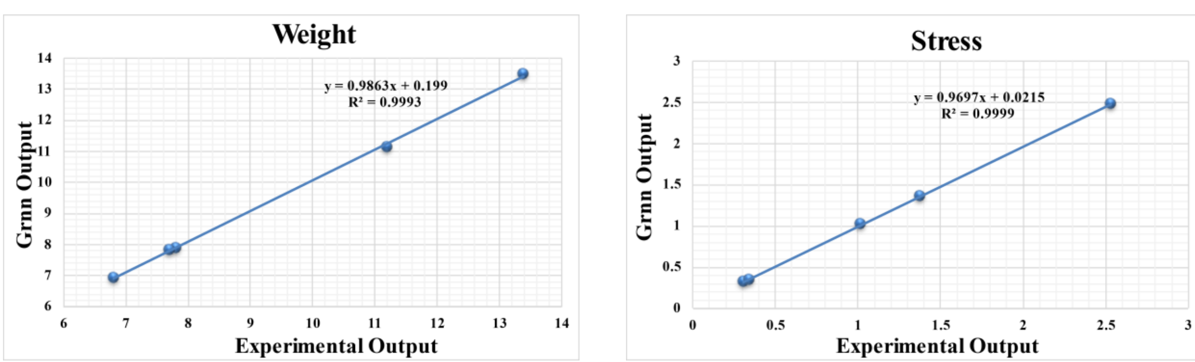


Figure.6 Comparison of GRNN and experimental values for 54 trainee data sets



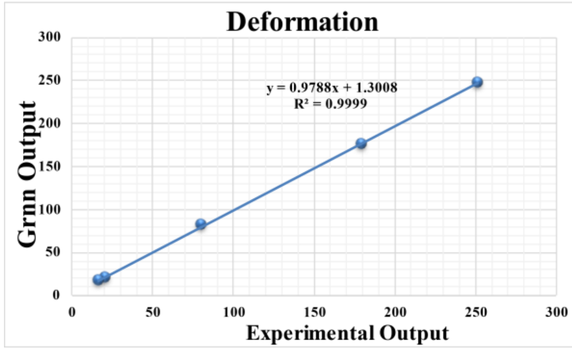


Figure.7 Plotting of GRNN and experimental values for 6 tested data sets

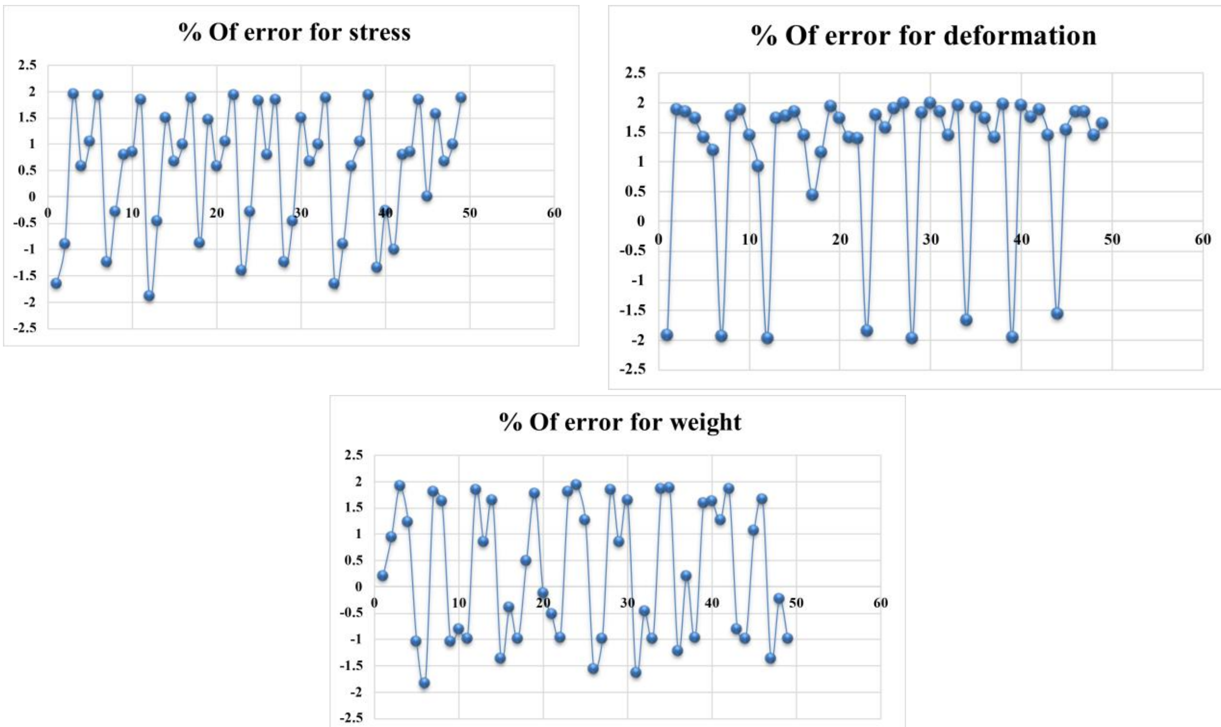


Figure.8 Plot between trainee and tested data for error percentage

Conclusion:

The flywheel's subject is vast and difficult to comprehend in a couple of pages. This project is designed to present a selection of important results by directing the primary investigation to three different types of flywheels made of Cast Iron. The primary study of flywheel stress and disfigurement. These are identified and observed. From the observed results, we concluded that the most effective shape is a web-type flywheel because it is less twisted and less Identical Pressure contrasted to other types of. In this study, a real device that combines a the relapse brain network to create a fake brain structure. By using GRNN various results can be achieved by adding only a few sources of information. Through the effects from trial-and-error it was possible to establish a nonlinear relationship between the data sources and the results were subsequently GRNN was used to establish the connection between information and the result parameters. Utilizing GRNN resulted in faster and better results with errors less than one percent. This paper can be used to discover the relationships between different kinds of intensity exchangers to results and data sources which will be the subject of a future study. In conclusion, the GRNN device could be extremely helpful in locating various outcomes of numerous developing applications in the near future.

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