# Research Paper Presentation

## Prediction of weld area based on image recognition and machine learning in laser oscillation welding of aluminum alloy.

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# I INTRODUCTION

- **Despite being efficient and effective,it is easy to form porosity defects in laser welding of Aluminium.During the rapid cooling process of molten pool of aluminum alloy,the precipitation of supersaturated hydrogen will cause the formation of metallurgical porosity**
- **The welds obtained by laser oscillating welding have low porosity, few cracks, good microstructure and high tensile strength and are better than traditional laser welding.**
- **The welding quality can be evaluated according to weld geometry,weld area being the index of weld geometry has great influence on joint strength.**

Laser oscillation welding is an advanced welding technique that uses a high-energy laser beam combined with oscillatory motion to join materials,Laser oscillation welding is widely used in industries such as aerospace, automotive, and electronics, where aluminum alloys like 6061 are frequently utilized due to their high strength-to-weight ratio.

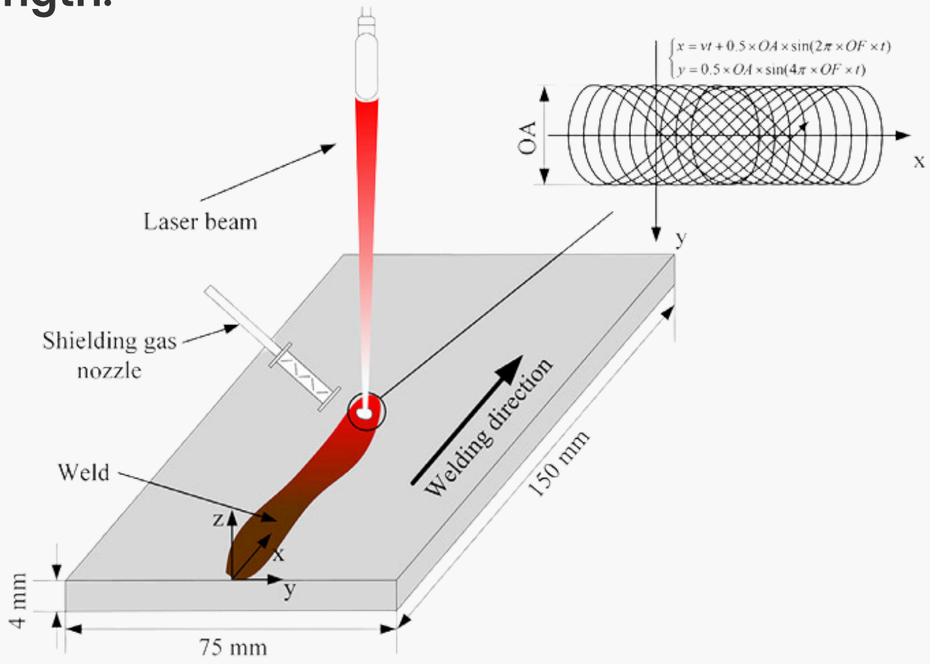



**Fig. 1.** The schematic diagram of laser oscillation welding.

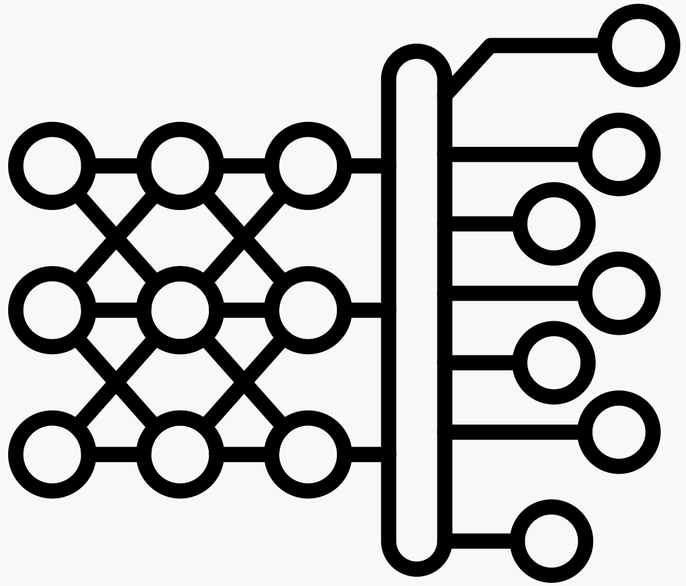
## I INTRODUCTION

We use Machine learning Algorithm(BPNN)to predict the weld area based on four Process Parameters namely Laser Power(LP),Welding Speed(WS),Oscillation Frequency(OF) and Oscillation Amplitude(OA).

- A prediction model (Back Propagation Neural Network) for weld area based on image recognition technology is proposed to improve the welding quality in the aluminum alloy laser oscillation welding.

- Backpropagation is a fundamental genetic algorithm in training artificial neural networks, particularly in feedforward networks. It's a method for supervised learning, where the goal is to minimize the error between the network's predictions and the actual target outputs.

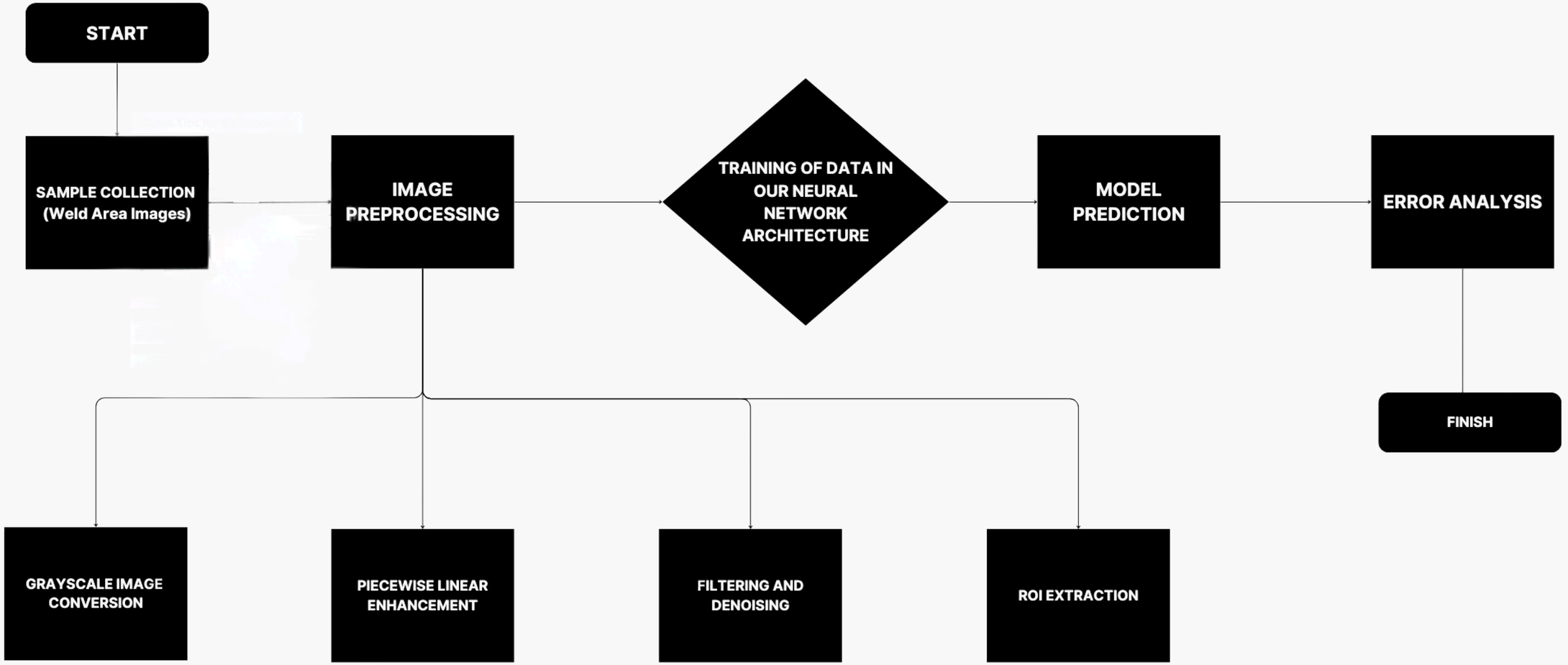
## II OBJECTIVE



### Prediction of Weld area for Aluminium 6061 in Laser Oscillation welding

- In this paper, we are trying to predict weld area based on process parameters proposed for laser oscillation welding of 6061 aluminum alloy.
  From the metallographic micrographs of welding experiments, the cross-sectional area of weld will be calculated by image recognition technology.(BPNN- RNN,CNN .etc.)
- Additionally, comparing results from various machine learning models like BPNNs, Linear Regression, Polynomial Regression with R square and mean squared error loss function.
- Proposing a method that can be used for selecting the optimal process condition for the ideal welded joints with the desired weld geometry to improve the quality of laser oscillation welding.

## III Methodology



## III METHODOLOGY

Image Preprocessing

Collected a series of asymmetric laser weld images and improved the image contrast by different image enhancement techniques.

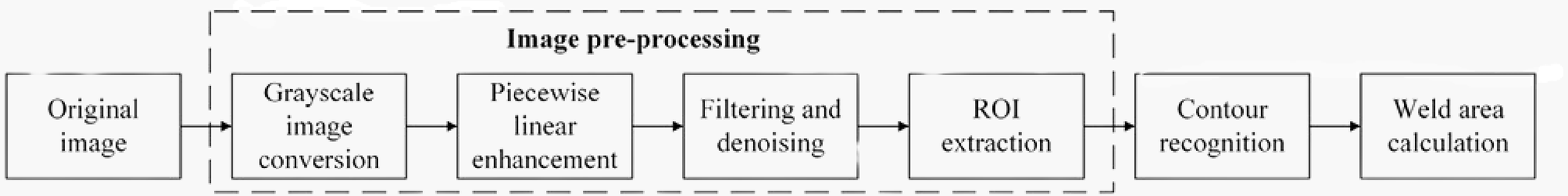



**Fig. 2.** The flowchart of the weld area calculation.

## III METHODOLOGY

Model Training

Our Model trains on the data given to it by various sample cases and parameters are tuned to best fit the desired output. Each Node independently is logistic regression unit with a loss mean squared error or R-square loss function. .The first layer of the architecture is an input layer followed by several hidden layers and lastly the output layer.

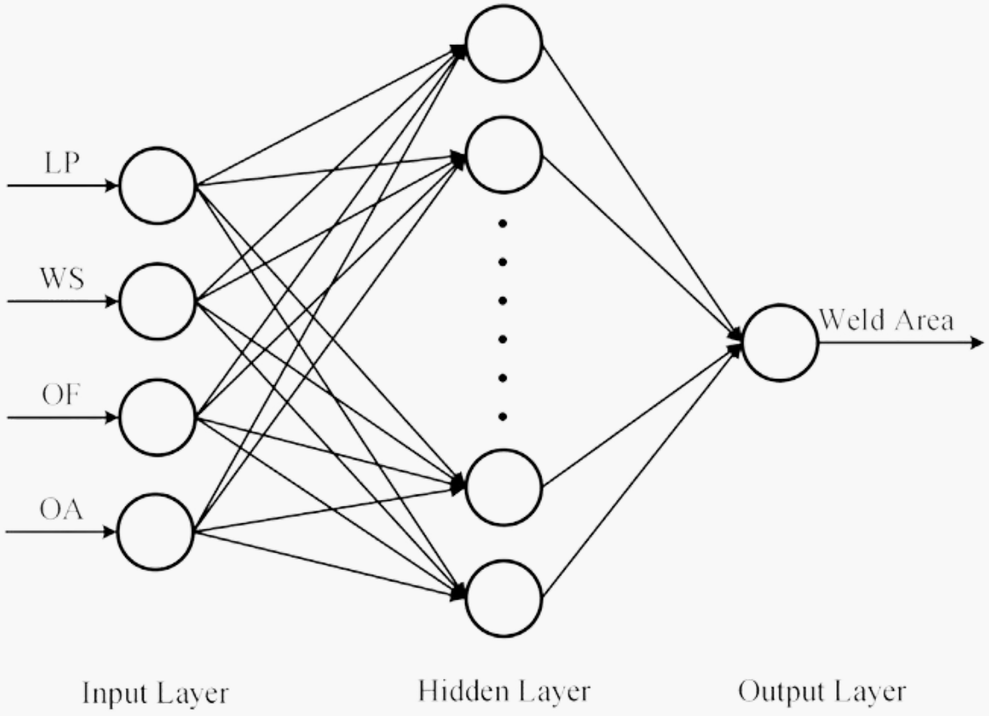



**Fig. 3.** The structure of BPNN.

# III METHODOLOGY

## Material and Experimental Setup

The composition of the 6061 aluminum alloy.

| Composition | Si | Fe | Cu | Mn | Mg | Zn | Ti | Cr | Al |
|---|---|---|---|---|---|---|---|---|---|
| Content (wt%) | 0.56 | 0.70 | 0.30 | 0.89 | 0.93 | 0.25 | 0.15 | 0.04 | Bal. |

The 6061 aluminum alloy with good corrosion resistance and mechanical properties is selected as the base material for our experiment.

The laser oscillation welding experimental system is mainly composed of laser, oscillation welding head, moving platform and other equipments.
Continuous Fiber Laser is used in the experiment with argon as the shielding gas.

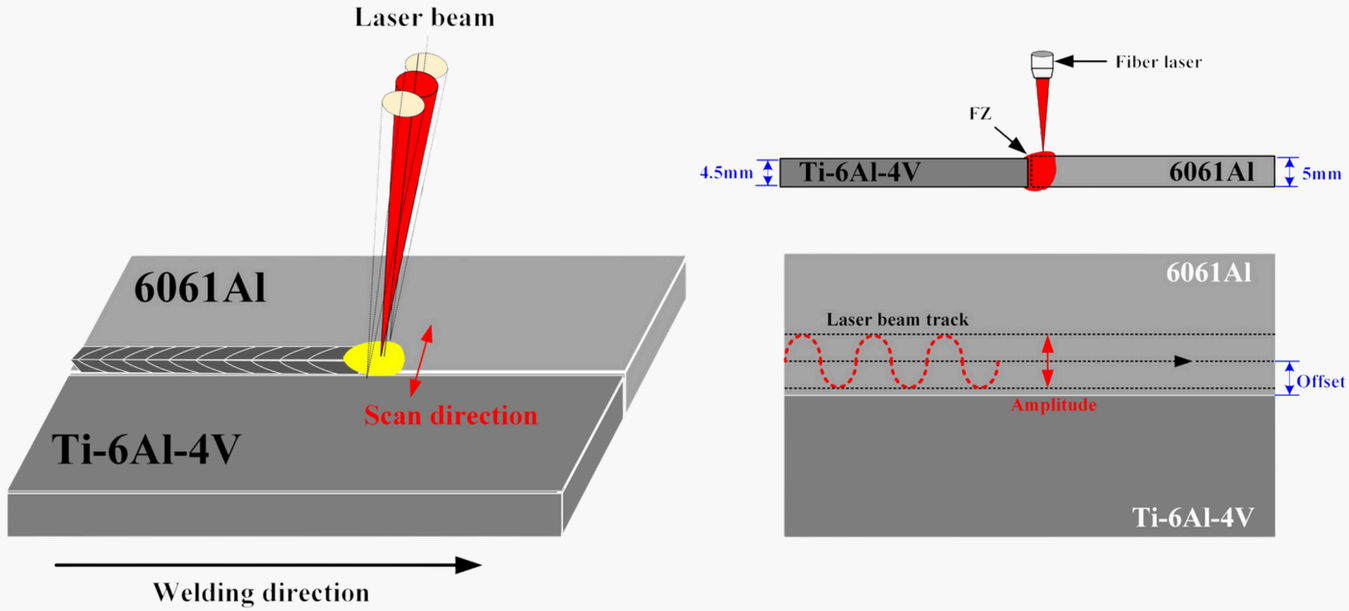
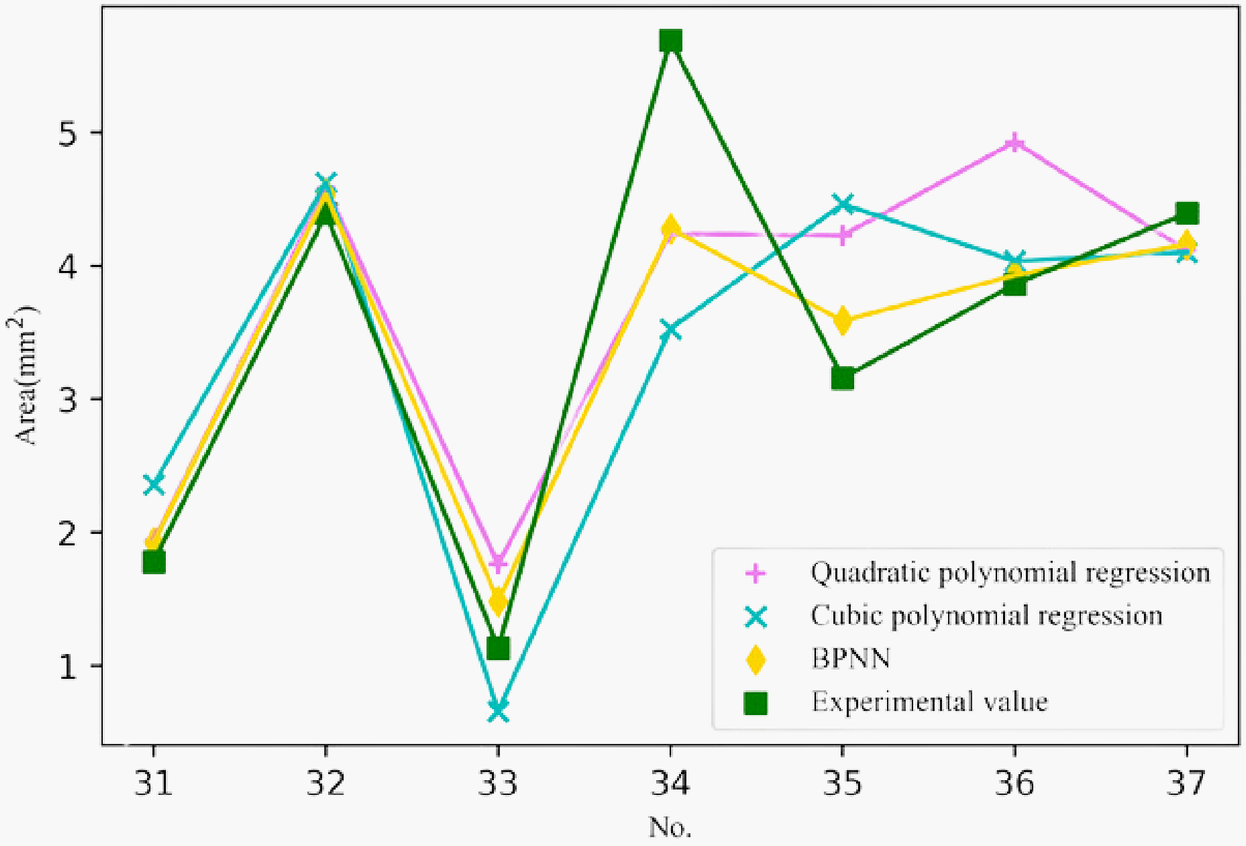
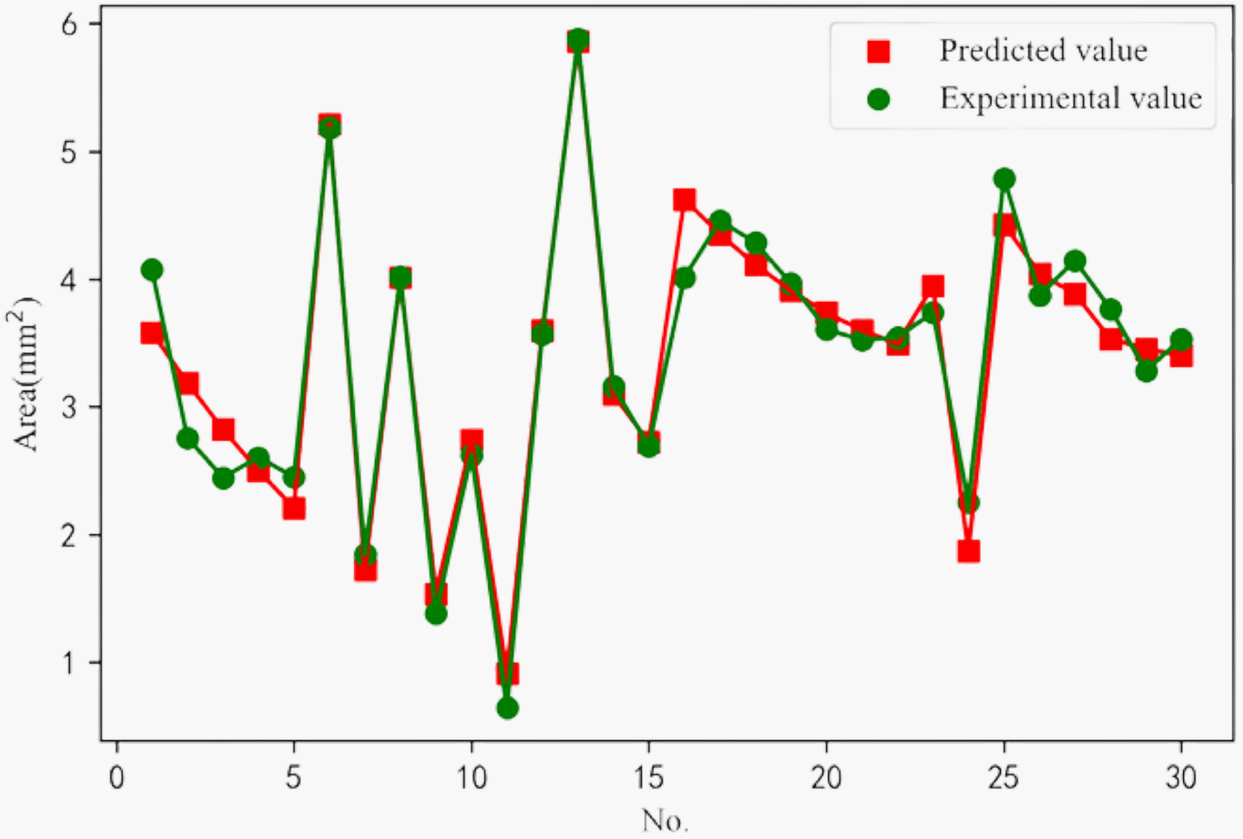



**Fig 4: Schematic Model of oscillating laser beam**

## IV Research Results

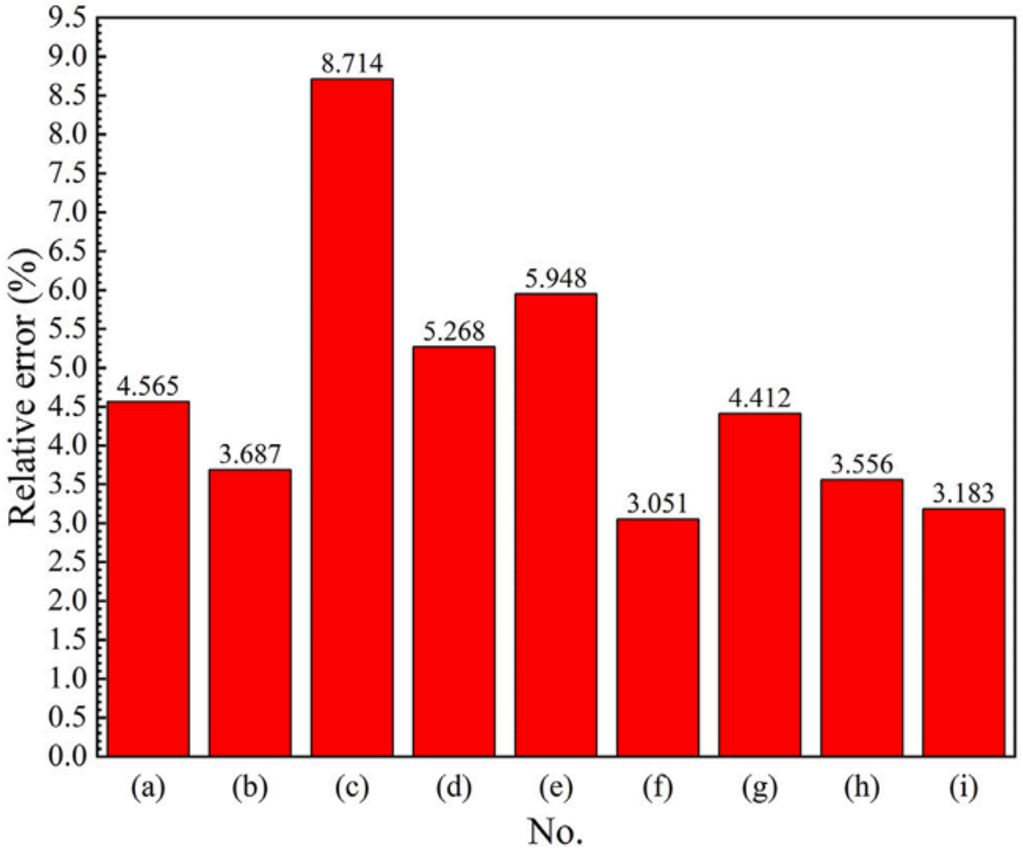



Comparison between
Linear reg, polynomial reg and BPNN.

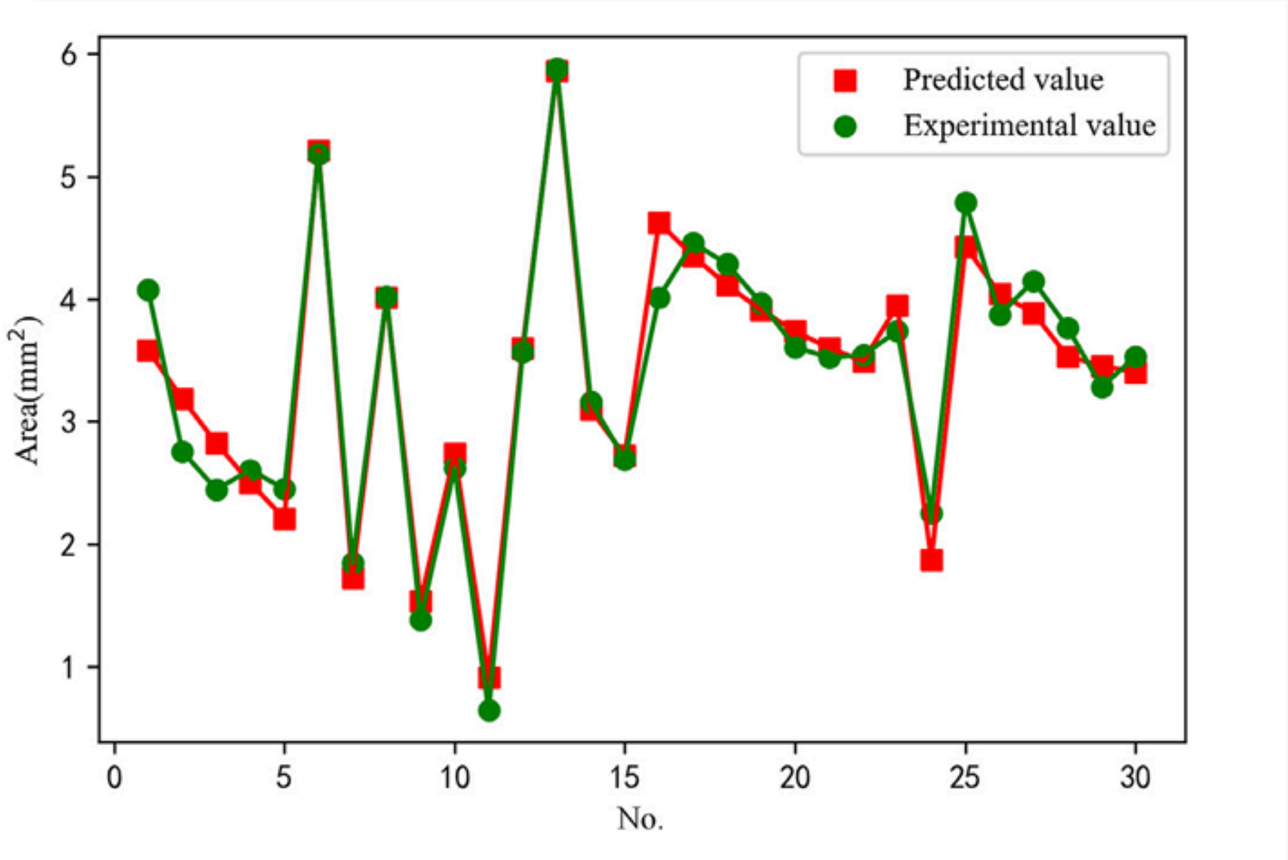



Plot b/w exp and predicted val for
polynomial regression.

# IV Research Results




Relative errors between the recognized value and experimental value at different magnifications, angles and perspectives.




Plot b/w exp and predicted val for BPNN.

## V Conclusion

- The metallographic micrographs of welding experiments, the cross-sectional area of weld is calculated by image recognition technology and the error of recognized weld area is less than 8.8%.
- During the prediction process, the BPNN model shows better robustness and prediction accuracy than linear and polynomial regression.
- We saw how process parameters LP,WS,OF and OA affect weld area and consecutively weld strength.

## VI Future Recommendations

- We can use RNN(Recurrent Neural Network) instead of BPNN(Back Propagation Neural Network). As there is memory retention in case of RNNs and are better suited for sequential data.

- We can use ReLu(Rectified Linear Unit or Rectifier Activation Function) rather than sigmoid activation function for better convergence because of its non saturating nature.

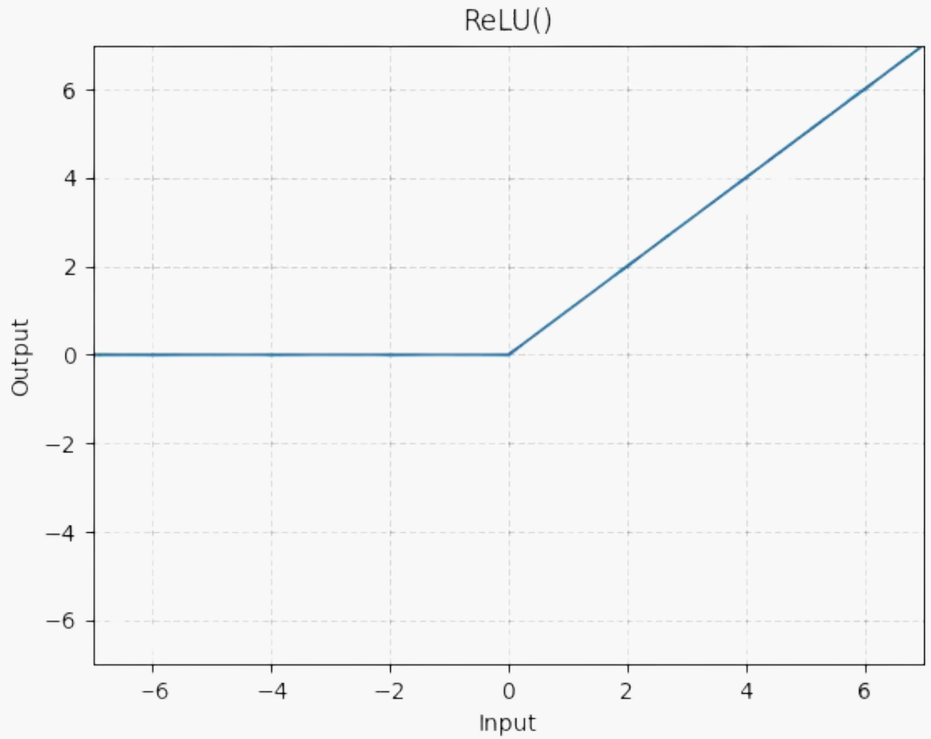



**Fig 5: RELU activation function**

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# Thank you!!