# Development and Validation of an Artificial Neural Network Model for Robot-assisted implant Osteotomy Drilling

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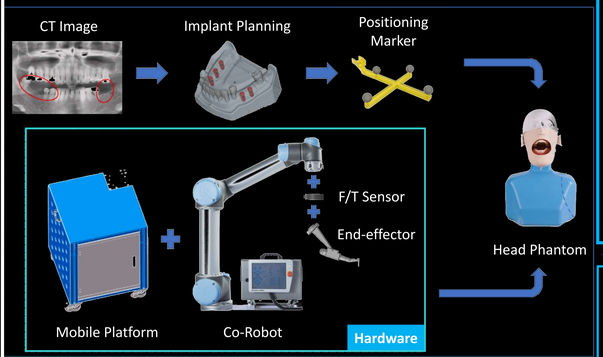
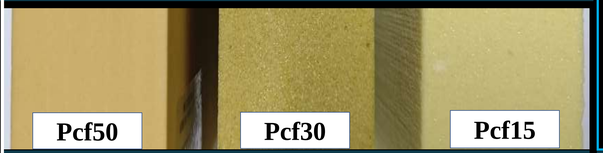
## BACKGROUND

Bone density is one of the important factors which affects osteocyte survival from frictional heat generated by implant osteotomy drilling. More dense bone usually creates higher heat during osteotomy. Forces required to apply to an osteotomy site drilling are also related to the quality of the bone. It is significantly beneficial to apply artificial intelligent technology to a robotic drilling device to detect bone density and feed-back to the system to adjust cutting parameters used at the osteotomy drilling site in a real-time.



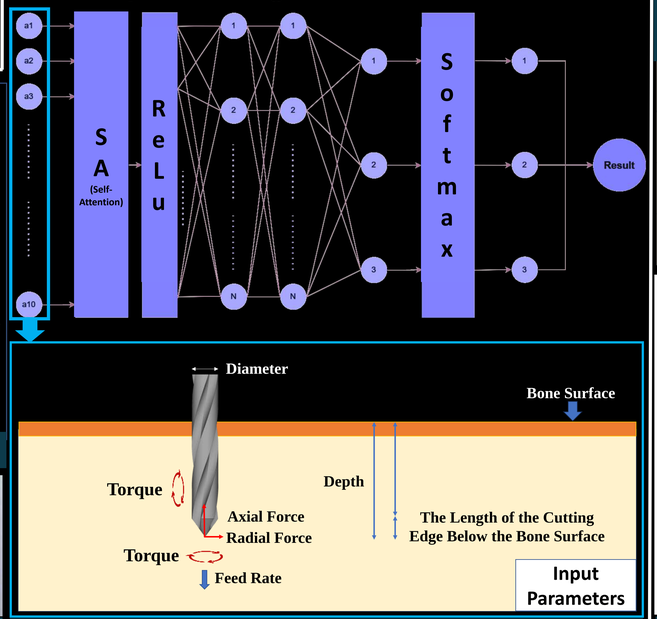

**Platform : HRCDIS**




**Artificial Bone Blocks of Different Densities**

## METHODS

A data-driven artificial neural network (ANN) model for bone density identification was developed. The bone density at the cutting position was evaluated by the model based on cutting parameters and forces. Total 18 groups of data with different cutting parameters were tested and analyzed. The feasibility of the method was verified by an in-vitro experiment using artificial bone blocks.



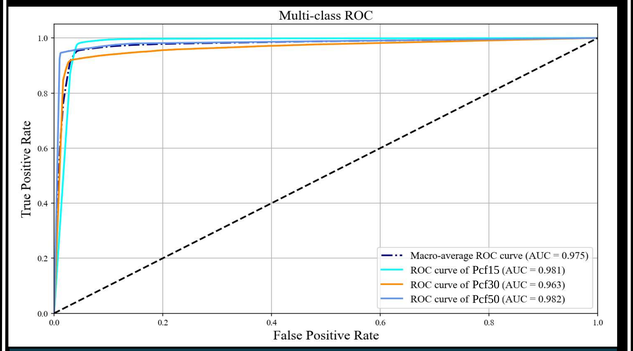

**Artificial Neural Network Architecture**

**Classification Model Performance on Training and Validation Sets**

| Class | Pcf50 | Pcf30 | Pcf15 |
|---|---|---|---|
| Precision | 97.25% | 95.26% | 90.87% |
| Recall | 94.56% | 91.71% | 97.73% |
| F1-Score | 0.96 | 0.93 | 0.94 |

**Classification Model Performance on Real-Time Testing**

| Class | Pcf50 | Pcf30 | Pcf15 |
|---|---|---|---|
| Precision | 96.01% | 92.78% | 90.26% |
| Recall | 95.24% | 85.96% | 97.56% |
| F1-Score | 0.96 | 0.89 | 0.94 |




**ROC Curve for Classification Performance**

## RESULTS

The bone density identification model showed 94.42% accuracy for the training and the validation sets, with the 92.94% accuracy of three selected bone densities used in in-vitro

## CONCLUSION

The bone density identification model in our research can recognize bone density at an osteotomy site with great accuracy. The online test results demonstrated that the method exhibited a good real-time performance and stability. The method allows the robot to receive bone density information based on real-time data, thereby providing a basis for the robot's adaptive control.

## REFERENCES

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