SOFTWARE DEFINED COGNITIVE RADIO

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OBJECTIVE:

- To pick up downlink frequency 136-138Mhz from NOAA-19 satellite
- Hardware based processing: using RTL-SDR V3
  Software based signal processing : using GNU radio(AM demodulation techniques)
- Converting the demodulation signal into an audio file(.wav format)
  - using WXtoImg software to convert audio file to image file
- De-noising the convert image using Super Resolution Convolutional Neural Network

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HARDWARE DESIGN

Section 1 : Mathematical formulation of antenna design

The fundamental parameters for designing a Quadrifilar Helix Antenna (QHA) are:

- Operating Frequency: $f = 137$ MHz
- Wavelength: $\lambda = \frac{c}{f}$, where $c = 3 \times 10^8$ m/s
- Helix Radius (r): $r = \frac{\lambda}{\pi K}$, where K is an empirical factor (typically $K = 4.5$)
- Pitch Angle (α): $\alpha = \tan^{-1}\left(\frac{S}{\pi D}\right)$, where S is the axial length per turn
- Total Length of Helix (L): $L = NS$, where N is the number of turns

1. Wavelength Calculation

$$\lambda = \frac{3 \times 10^8}{137 \times 10^6} = 2.19 \text{ m}$$

2. Helix Radius Calculation

$$r = \frac{\lambda}{\pi K} = \frac{2.19}{\pi \times 4.5} \approx 0.155 \text{ m} = 15.5 \text{ cm}$$

3. Axial Length per Turn (S) Calculation

$$S = \frac{\lambda}{N}$$

Assuming $N = 1.25$ turns:

$$S = \frac{2.19}{1.25} = 1.75 \text{ m}$$

4. Pitch Angle Calculation

$$\alpha = \tan^{-1}\left(\frac{S}{\pi D}\right) = \tan^{-1}\left(\frac{1.75}{\pi \times 0.31}\right)$$

$$\alpha \approx 60^\circ$$

5. Total Length of Helix

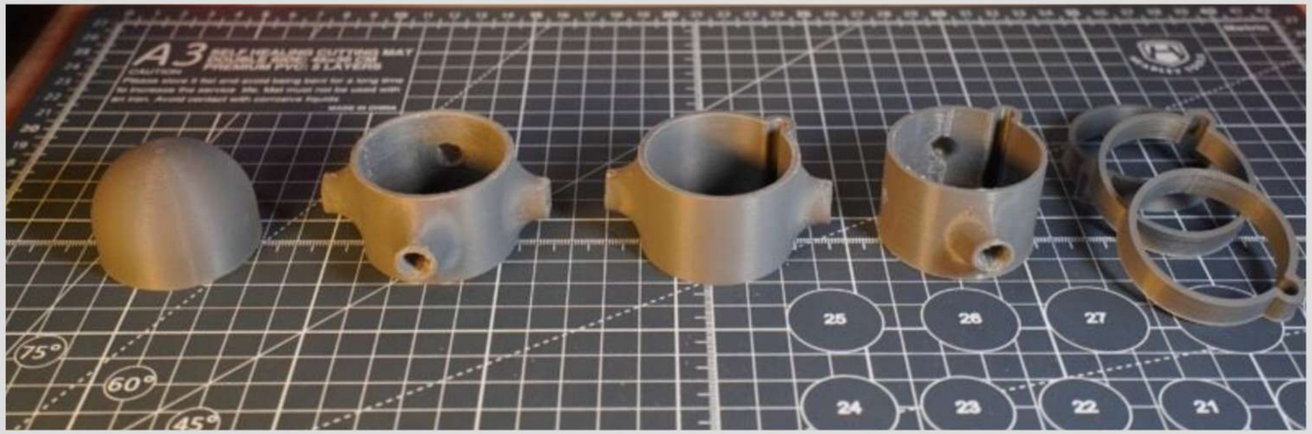
$$L = N \times S = 1.25 \times 1.75 = 2.19 \text{ m}$$

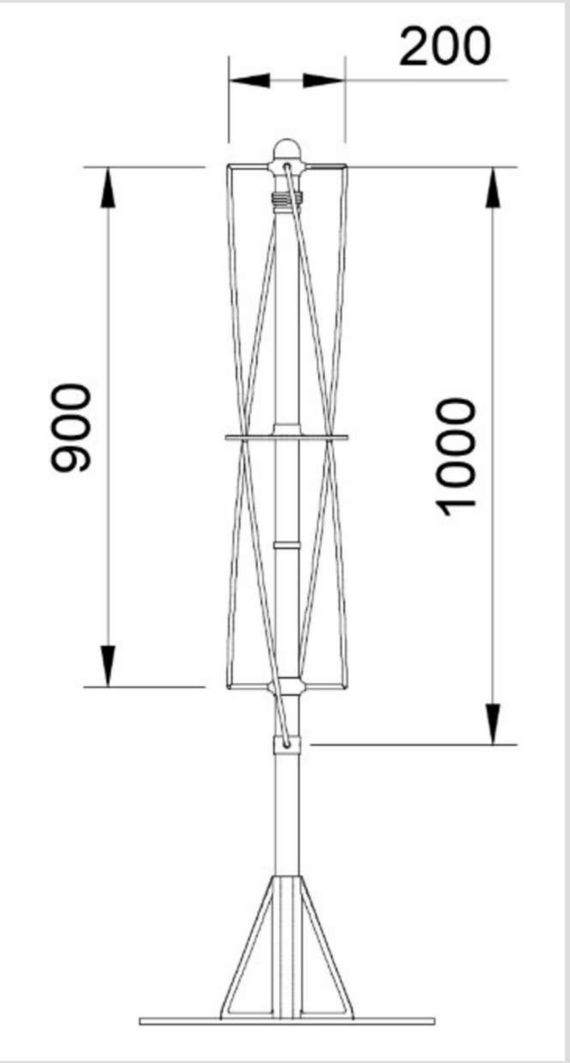
6. Summary of QHA Design

Parameter	Value
Frequency (f)	137 MHz
Wavelength (λ)	2.19 m
Helix Radius (r)	15.5 cm
Axial Length per Turn (S)	1.75 m
Number of Turns (N)	1.25
Pitch Angle (α)	60°
Total Length of Helix (L)	2.19 m

HARDWARE DESIGN

Section 2 : assembling components for antenna

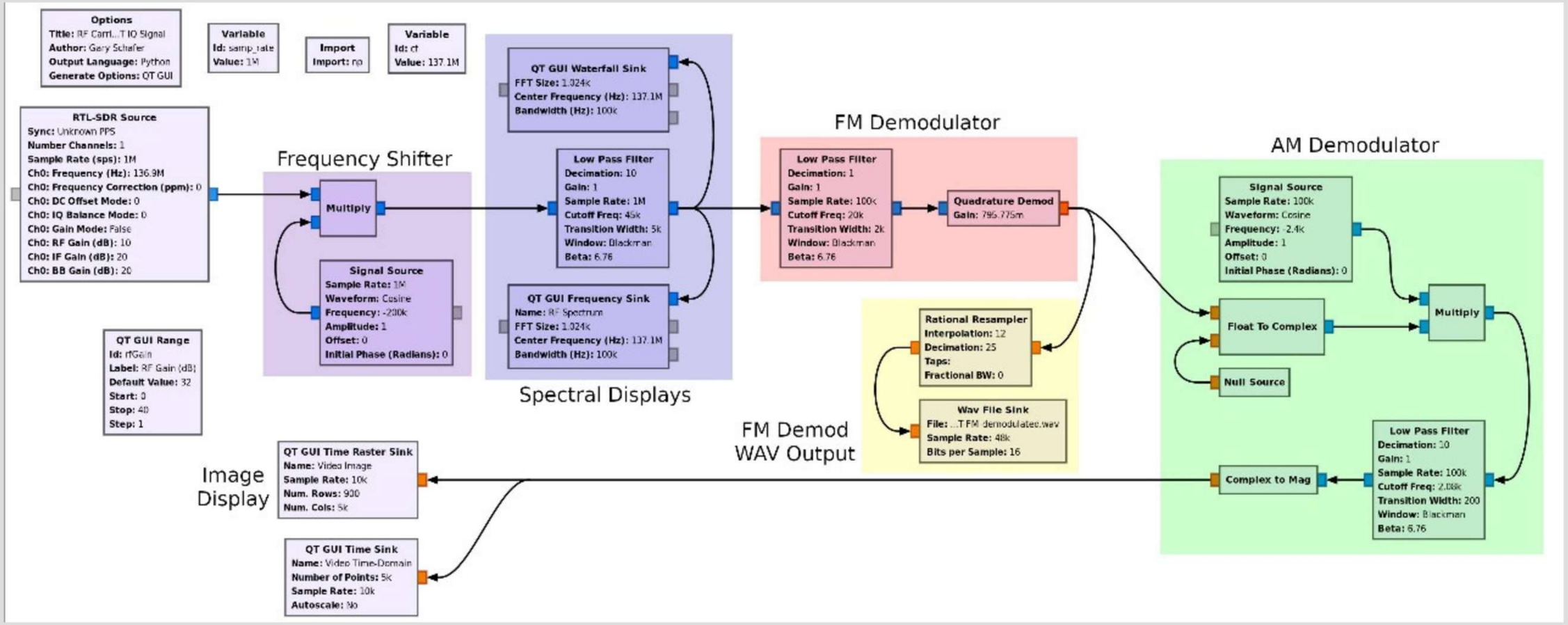




REAL TIME TESTING

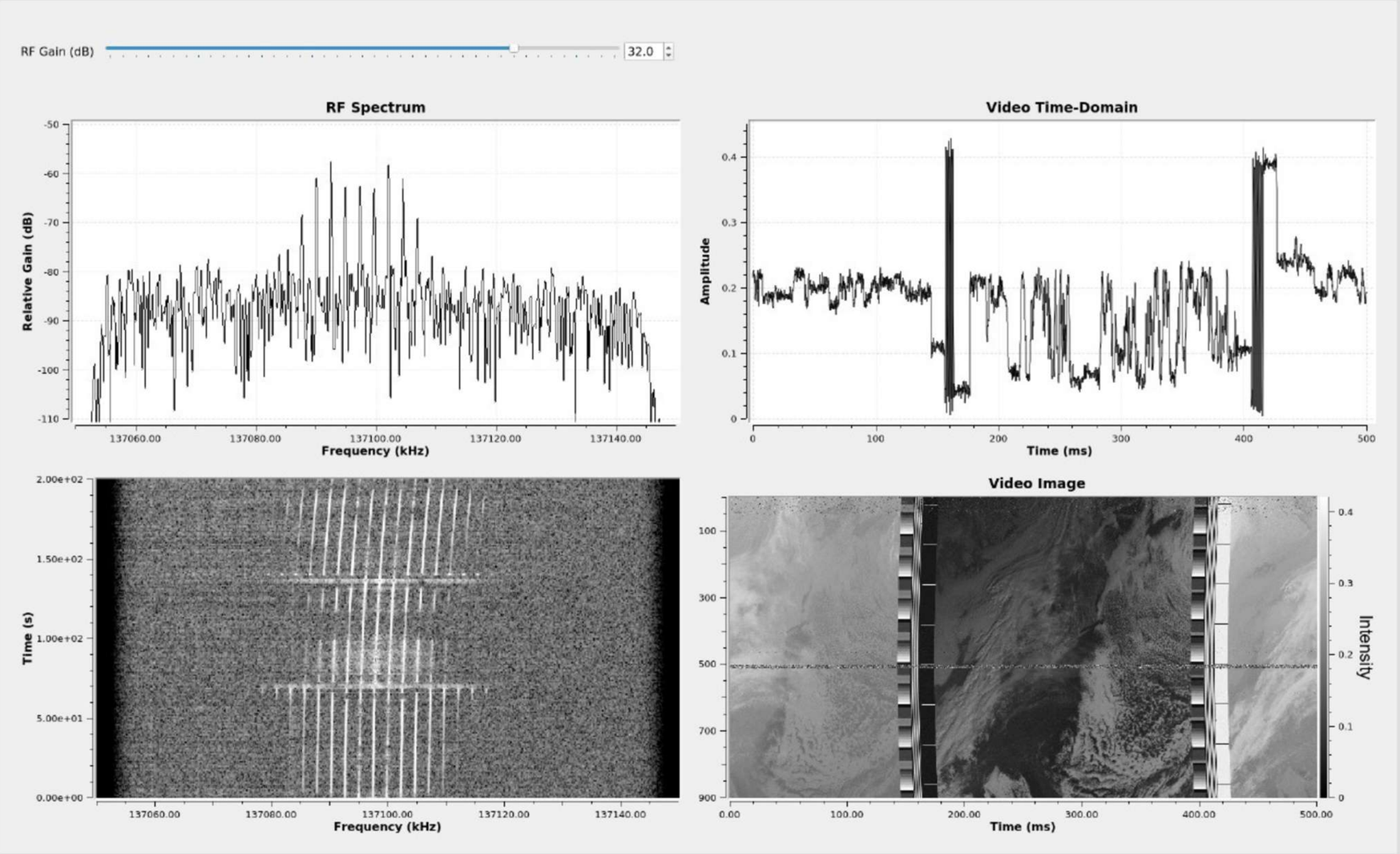
SOFTWARE DESIGN

1. After recieving the signals, demodulation was performed as follows:



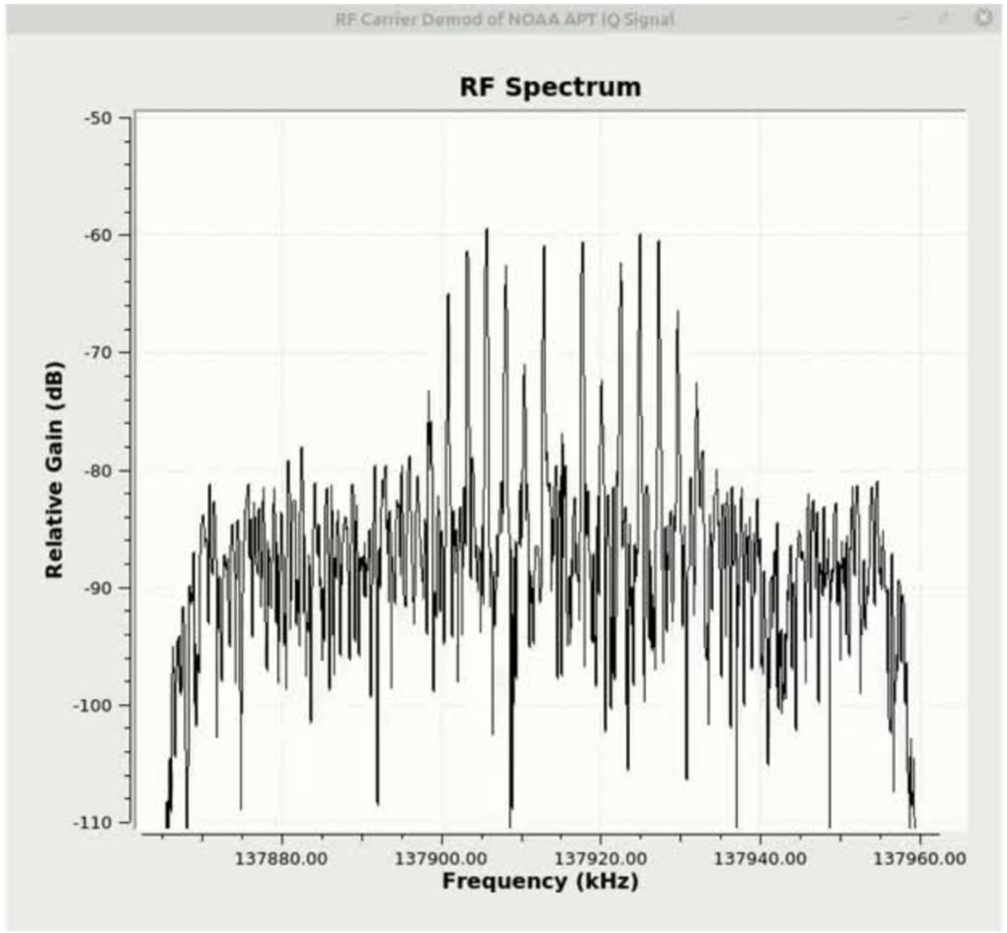
SOFTWARE DESIGN

2. Simulation results for the program are as follows :



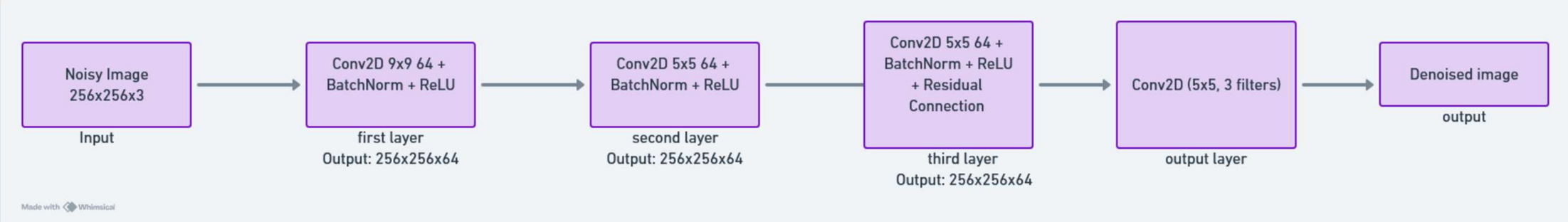
SOFTWARE DESIGN

3. Simulation results for the program are as follows :

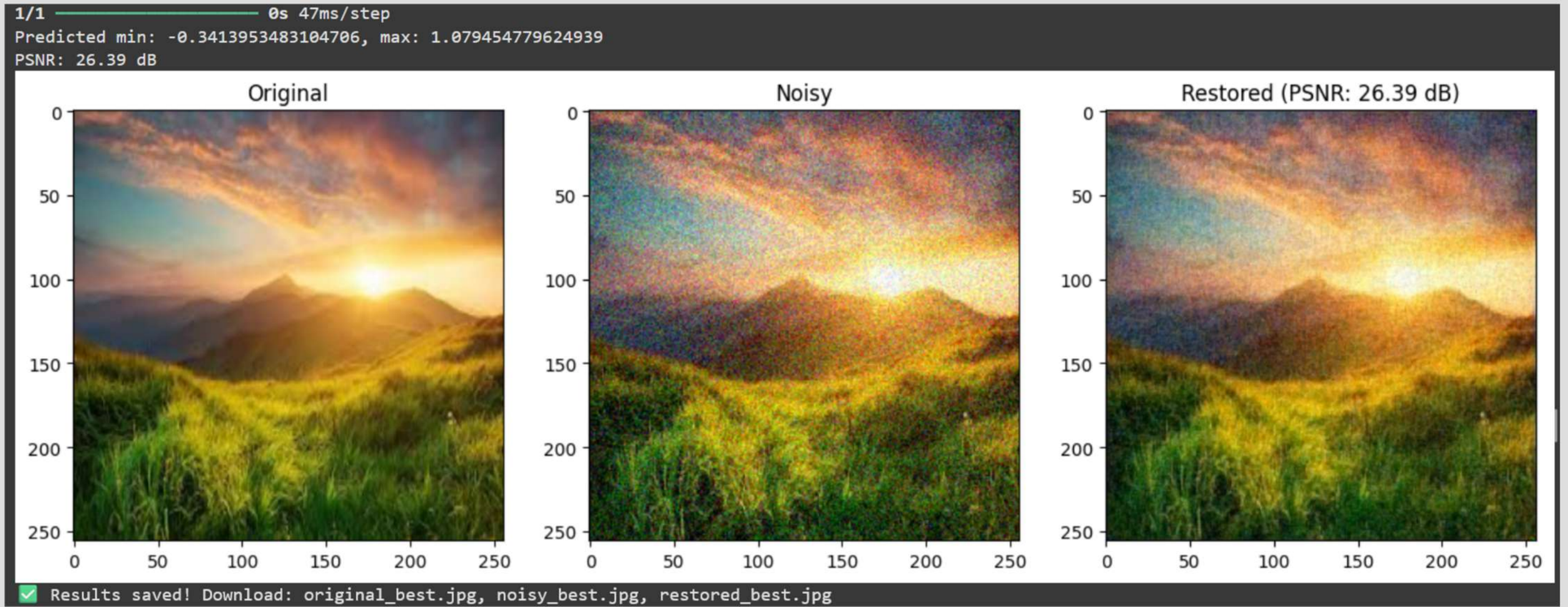


SOFTWARE DESIGN

SRCNN model architecture

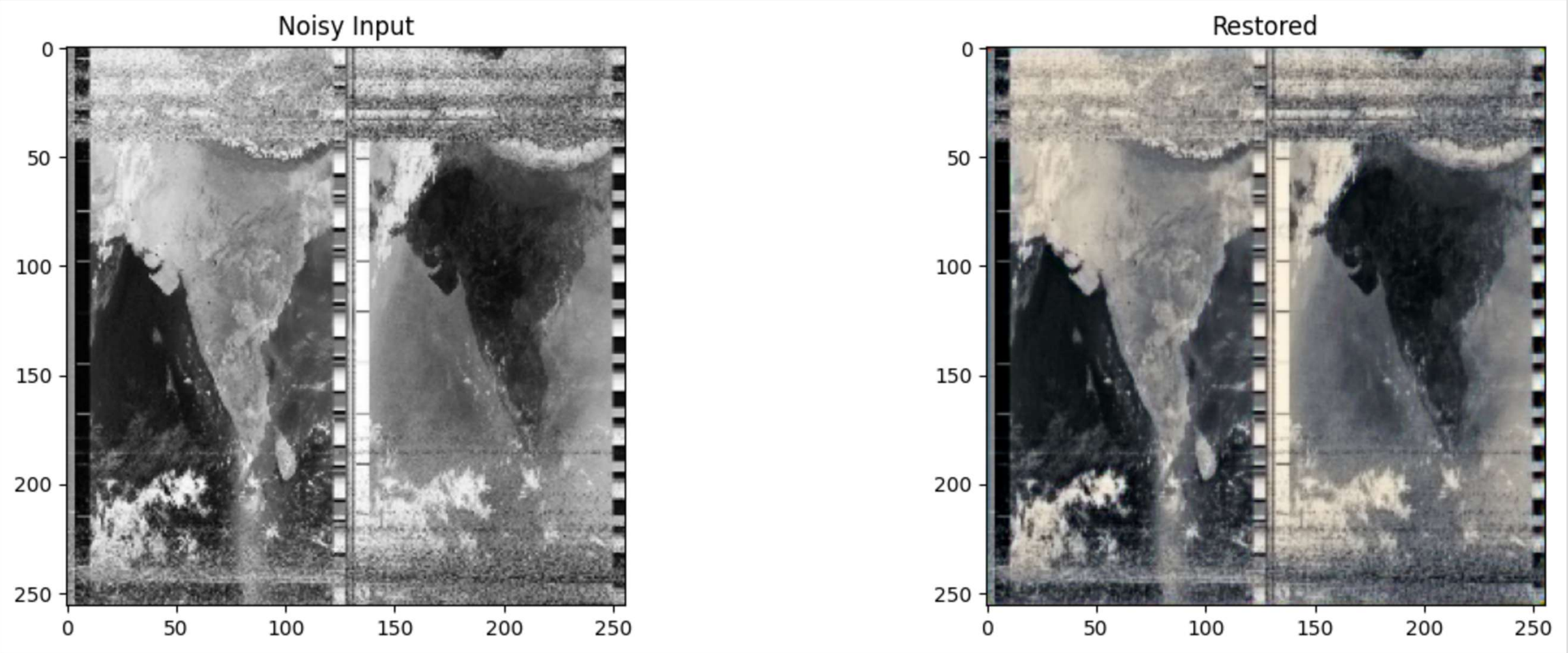


Model efficiency



RESULT

Previous audio file was converted into a desired image :



This image had heavy noise which then filtered out using a deep learning model

CONCLUSION

Our SDR system successfully captured and enhanced NOAA-19 weather images, proving cost-effective functionality within constraints, paving the way for future improvements.

FUTURE PLANS

- Enhance SRCNN with diverse noise training for better denoising.
- Upgrade QHA with ABS parts for improved outdoor durability.

THANK YOU