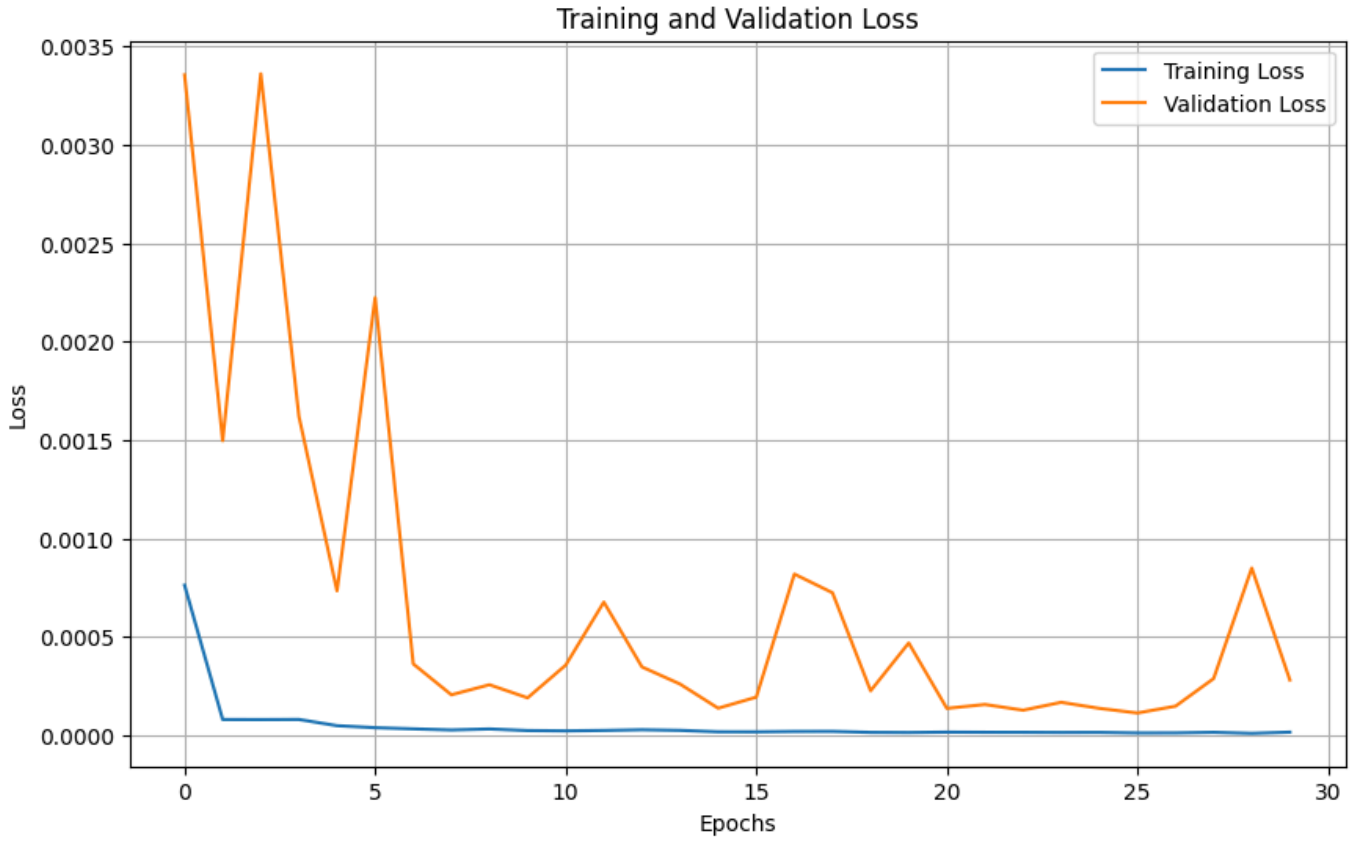
Some Literature and Projects I Reviewed

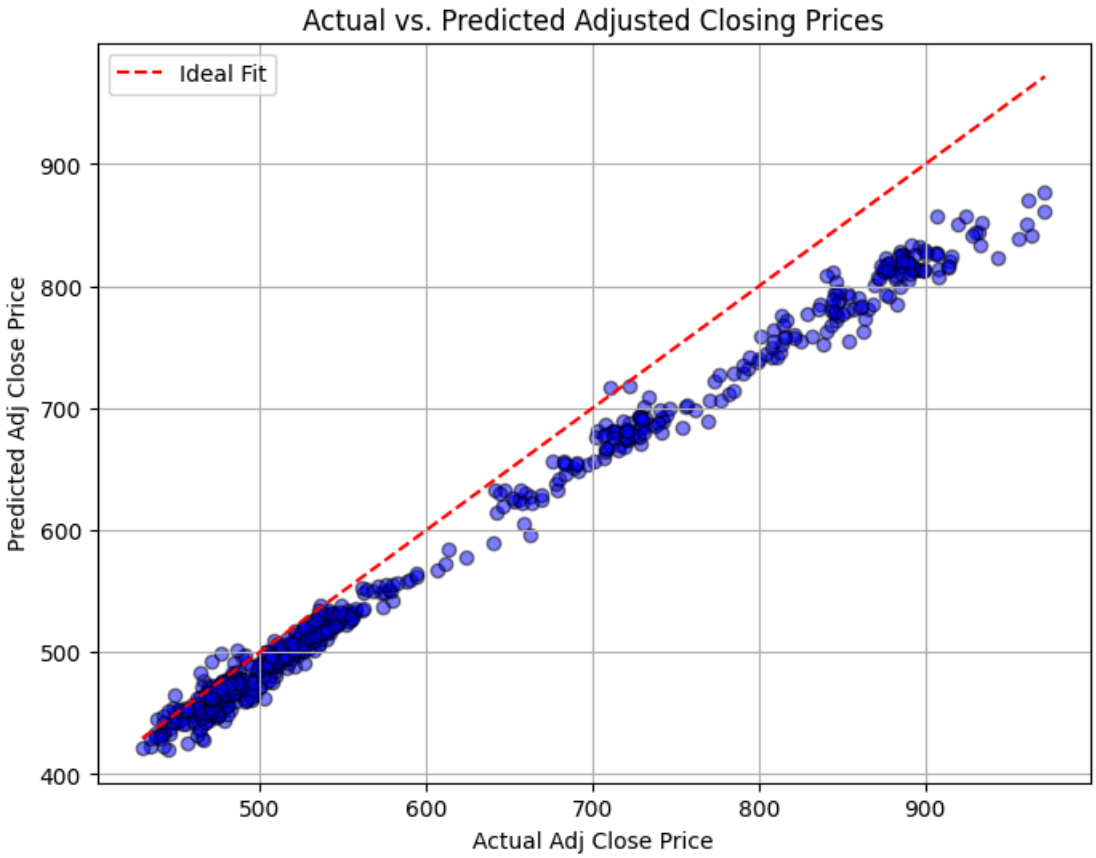
1. Tara N. Sainath, Oriol Vinyals, Andrew Senior, Has¸im Sak, (2015). CONVOLUTIONAL, LONG SHORT-TERM MEMORY, FULLY CONNECTED DEEP NEURAL NETWORKS. Retrieved from https://static.googleusercontent.com/media/research.google.com/en//pubs/archive/43455.pdf
2. SIMA SIAMI NAMIN, AKBAR SIAMI NAMIN, (2018). FORECASTING ECONOMIC AND FINANCIAL TIME SERIES: ARIMA VS. LSTM. arXiv:1803.06386 [cs.CL]. Retrieved from https://arxiv.org/pdf/1803.06386
3. Andrej Karpathy, Justin Johnson, Li Fei-Fei, (2015). VISUALIZING AND UNDERSTANDING RECURRENT NETWORKS. arXiv:1506.02078 [cs.CL]. Retrieved from https://arxiv.org/pdf/1506.02078
4. Shabbir, S. (n.d.). Pytorch_LSTMs,RNN,GRU_for_time_series_data.ipynb [Jupyter Notebook]. GitHub. Retrieved from https://github.com/SheezaShabbir/Time-series-Analysis-using-LSTM-RNN-and-GRU/blob/main/Pytorch_LSTMs%2CRNN%2CGRU_for_time_series_data.ipynb
5. Shaojie Bai, J. Zico Kolter, Vladlen Koltun, (2018). An Empirical Evaluation of Generic Convolutional and Recurrent Networks for Sequence Modeling. arXiv:1803.01271 [cs.CL]. Retrieved from https://arxiv.org/pdf/1803.01271

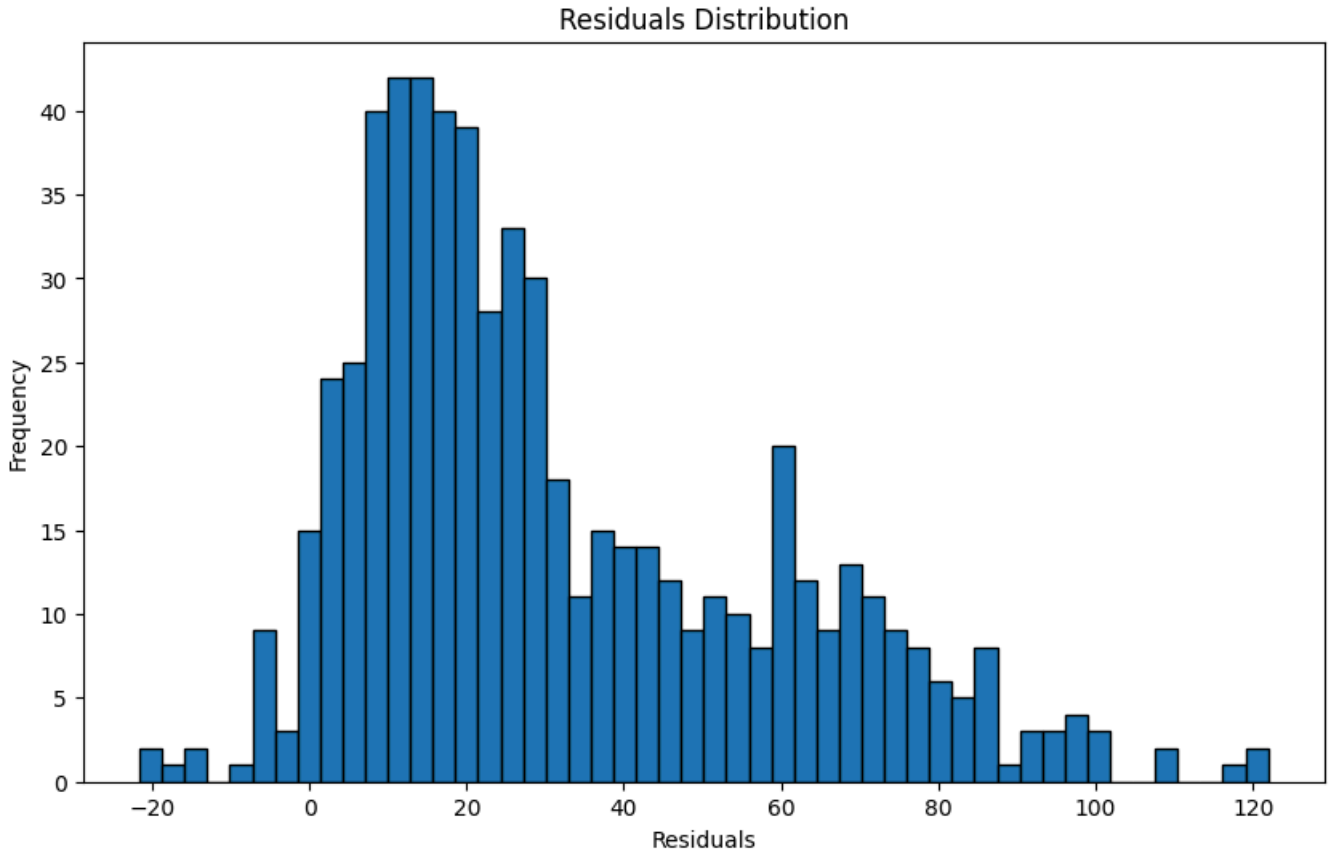
Using LSTM Arcitecture

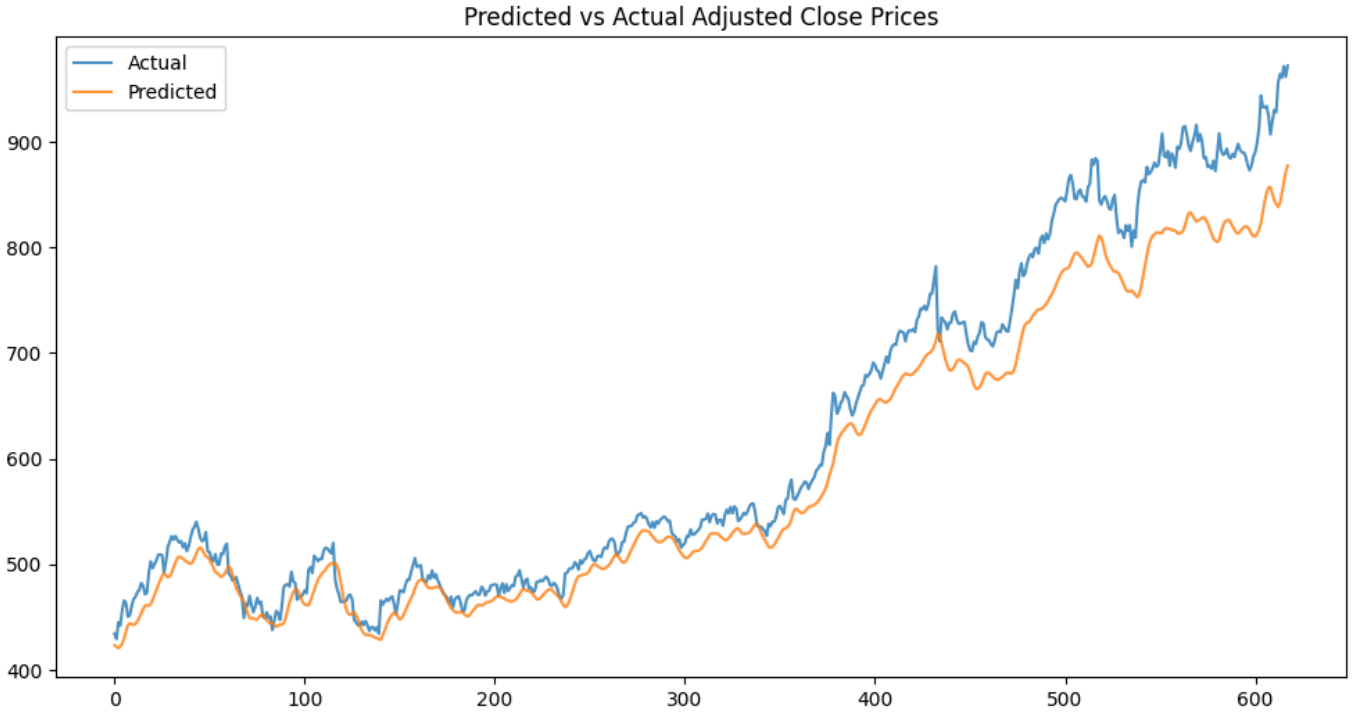
```
Epoch 1/30, Train Loss: 0.000762, Val Loss: 0.003355
Epoch 2/30, Train Loss: 0.000079, Val Loss: 0.001496
Epoch 3/30, Train Loss: 0.000079, Val Loss: 0.003360
Epoch 4/30, Train Loss: 0.000079, Val Loss: 0.001620
Epoch 5/30, Train Loss: 0.000048, Val Loss: 0.000733
Epoch 6/30, Train Loss: 0.000037, Val Loss: 0.002223
Epoch 7/30, Train Loss: 0.000031, Val Loss: 0.000362
Epoch 8/30, Train Loss: 0.000026, Val Loss: 0.000205
Epoch 9/30, Train Loss: 0.000031, Val Loss: 0.000256
Epoch 10/30, Train Loss: 0.000023, Val Loss: 0.000189
Epoch 11/30, Train Loss: 0.000021, Val Loss: 0.000355
Epoch 12/30, Train Loss: 0.000023, Val Loss: 0.000676
Epoch 13/30, Train Loss: 0.000027, Val Loss: 0.000346
Epoch 14/30, Train Loss: 0.000024, Val Loss: 0.000259
Epoch 15/30, Train Loss: 0.000016, Val Loss: 0.000136
Epoch 16/30, Train Loss: 0.000016, Val Loss: 0.000193
Epoch 17/30, Train Loss: 0.000018, Val Loss: 0.000818
Epoch 18/30, Train Loss: 0.000019, Val Loss: 0.000723
Epoch 19/30, Train Loss: 0.000014, Val Loss: 0.000225
Epoch 20/30, Train Loss: 0.000013, Val Loss: 0.000468
Epoch 21/30, Train Loss: 0.000015, Val Loss: 0.000136
Epoch 22/30, Train Loss: 0.000014, Val Loss: 0.000155
Epoch 23/30, Train Loss: 0.000014, Val Loss: 0.000126
Epoch 24/30, Train Loss: 0.000013, Val Loss: 0.000166
Epoch 25/30, Train Loss: 0.000013, Val Loss: 0.000136
Epoch 26/30, Train Loss: 0.000011, Val Loss: 0.000112
Epoch 27/30, Train Loss: 0.000011, Val Loss: 0.000147
Epoch 28/30, Train Loss: 0.000014, Val Loss: 0.000287
Epoch 29/30, Train Loss: 0.000009, Val Loss: 0.000849
Epoch 30/30, Train Loss: 0.000015, Val Loss: 0.000280
```




```
Test MSE: 1693.19
Test RMSE: 41.15
Test MAE: 32.22
R2 Score: 0.9329
```


Actual vs. Predicted Adjusted Closing Prices
Ideal Fit
Predicted Adj Close Price
Actual Adj Close Price
400
500
600
700
800
900


Residuals Distribution
Frequency
Residuals
0
5
10
15
20
25
30
35
40
−20
0
20
40
60
80
100
120

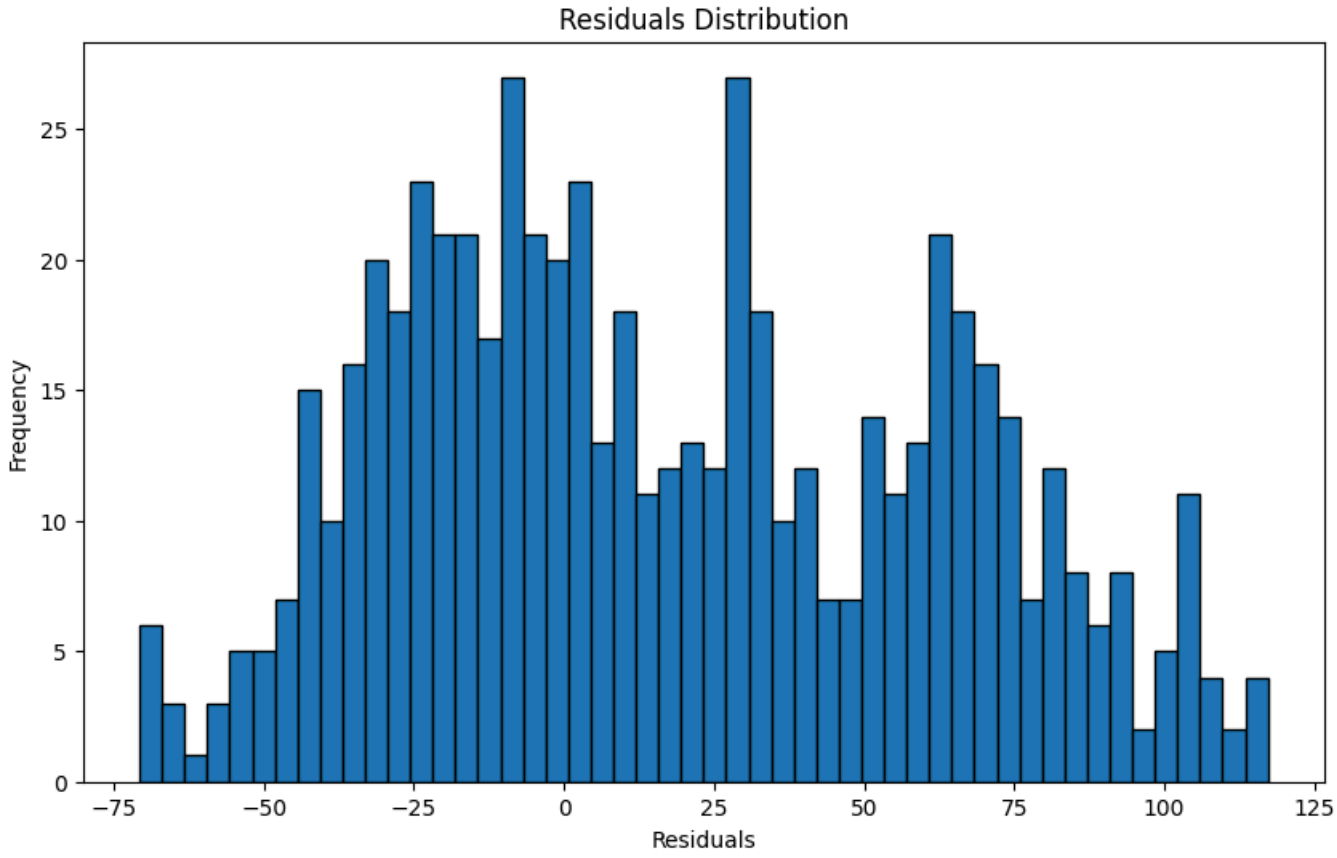


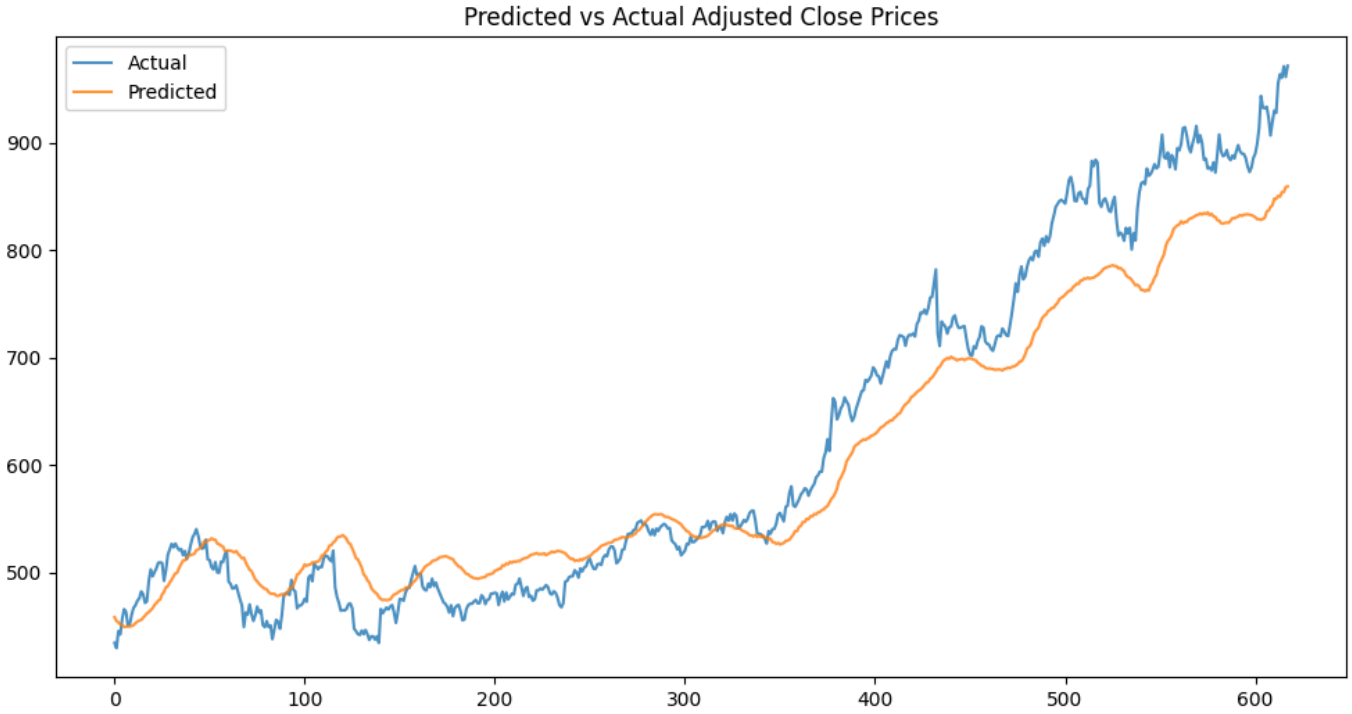
Using CNN-LSTM Hybrid Arcitecture

```
Epoch 1/30, Train Loss: 0.001296, Val Loss: 0.001315
Epoch 2/30, Train Loss: 0.000100, Val Loss: 0.001235
Epoch 3/30, Train Loss: 0.000080, Val Loss: 0.002325
Epoch 4/30, Train Loss: 0.000090, Val Loss: 0.001186
Epoch 5/30, Train Loss: 0.000075, Val Loss: 0.001053
Epoch 6/30, Train Loss: 0.000074, Val Loss: 0.004984
Epoch 7/30, Train Loss: 0.000066, Val Loss: 0.001110
Epoch 8/30, Train Loss: 0.000058, Val Loss: 0.002250
Epoch 9/30, Train Loss: 0.000059, Val Loss: 0.000954
Epoch 10/30, Train Loss: 0.000057, Val Loss: 0.000906
Epoch 11/30, Train Loss: 0.000058, Val Loss: 0.001980
Epoch 12/30, Train Loss: 0.000049, Val Loss: 0.001511
Epoch 13/30, Train Loss: 0.000048, Val Loss: 0.001299
Epoch 14/30, Train Loss: 0.000063, Val Loss: 0.002013
Epoch 15/30, Train Loss: 0.000043, Val Loss: 0.001306
Epoch 16/30, Train Loss: 0.000043, Val Loss: 0.003978
Epoch 17/30, Train Loss: 0.000043, Val Loss: 0.002885
Epoch 18/30, Train Loss: 0.000036, Val Loss: 0.001605
Epoch 19/30, Train Loss: 0.000044, Val Loss: 0.000706
Epoch 20/30, Train Loss: 0.000043, Val Loss: 0.002379
Epoch 21/30, Train Loss: 0.000037, Val Loss: 0.000732
Epoch 22/30, Train Loss: 0.000036, Val Loss: 0.002396
Epoch 23/30, Train Loss: 0.000032, Val Loss: 0.001175
Epoch 24/30, Train Loss: 0.000032, Val Loss: 0.002722
Epoch 25/30, Train Loss: 0.000036, Val Loss: 0.001307
Epoch 26/30, Train Loss: 0.000031, Val Loss: 0.001421
Epoch 27/30, Train Loss: 0.000038, Val Loss: 0.001579
Epoch 28/30, Train Loss: 0.000027, Val Loss: 0.000695
Epoch 29/30, Train Loss: 0.000026, Val Loss: 0.000751
Epoch 30/30, Train Loss: 0.000025, Val Loss: 0.001056
```


```
Test MSE: 2254.62
Test RMSE: 47.48
Test MAE: 38.18
R2 Score: 0.9106
```

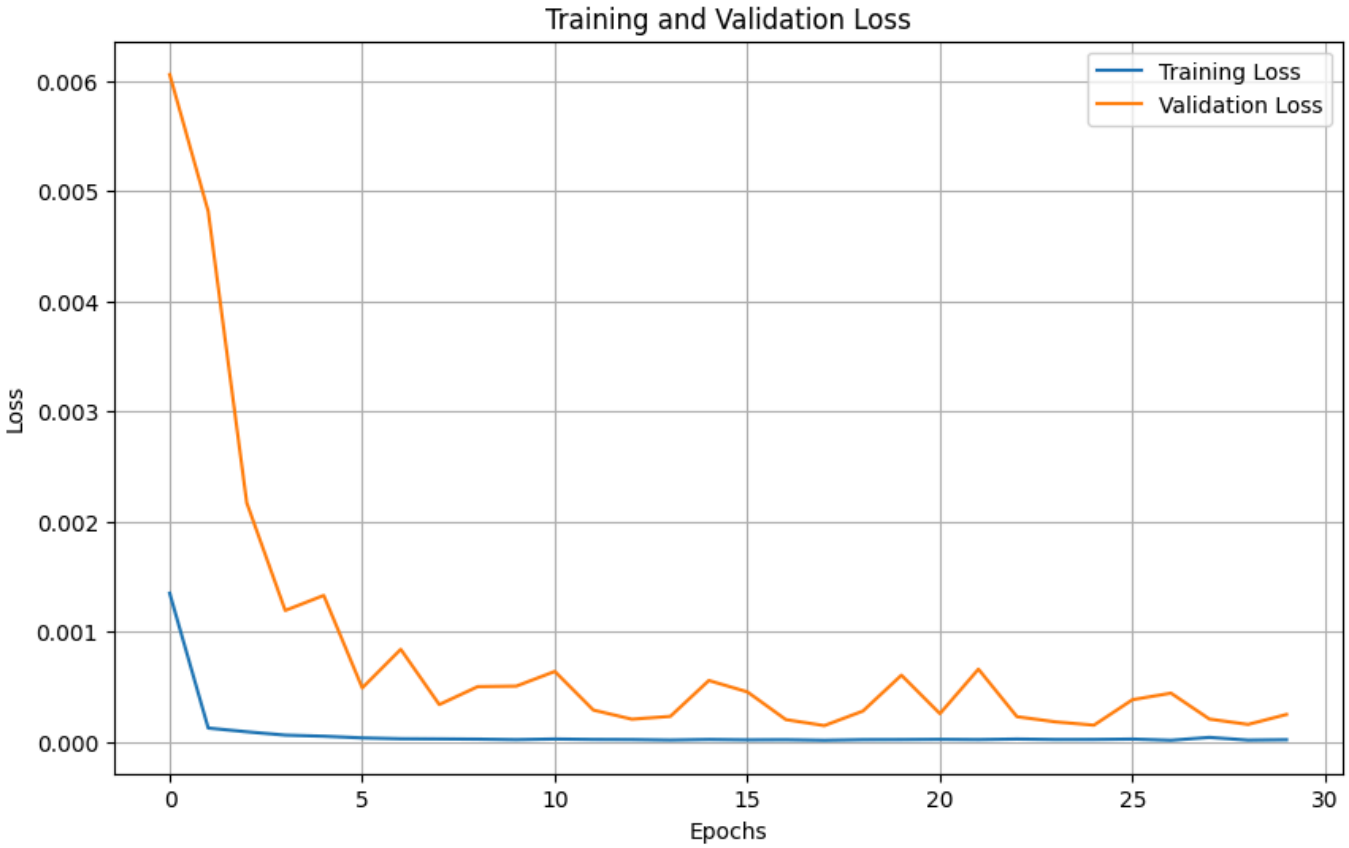

Actual vs. Predicted Adjusted Closing Prices
Ideal Fit
Predicted Adj Close Price
Actual Adj Close Price
500
600
700
800
900


Residuals Distribution
Frequency
Residuals
0
5
10
15
20
25
−75
−50
−25
0
25
50
75
100
125

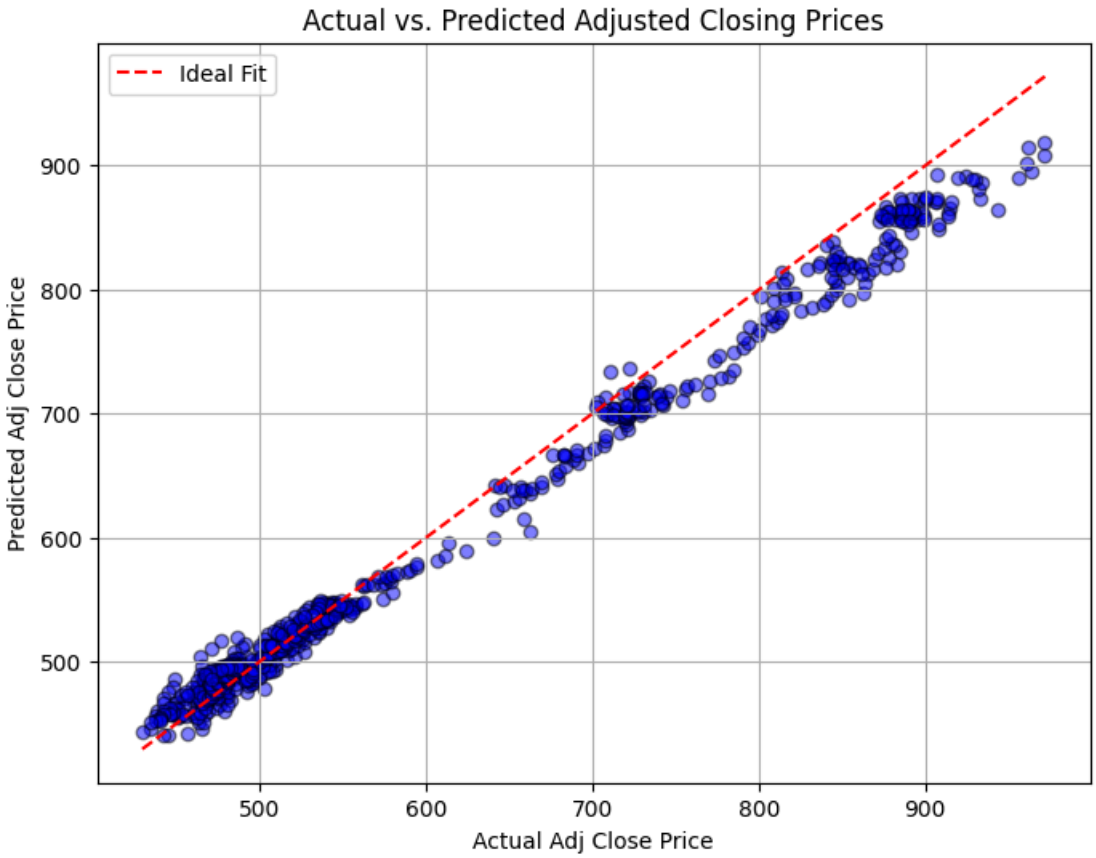


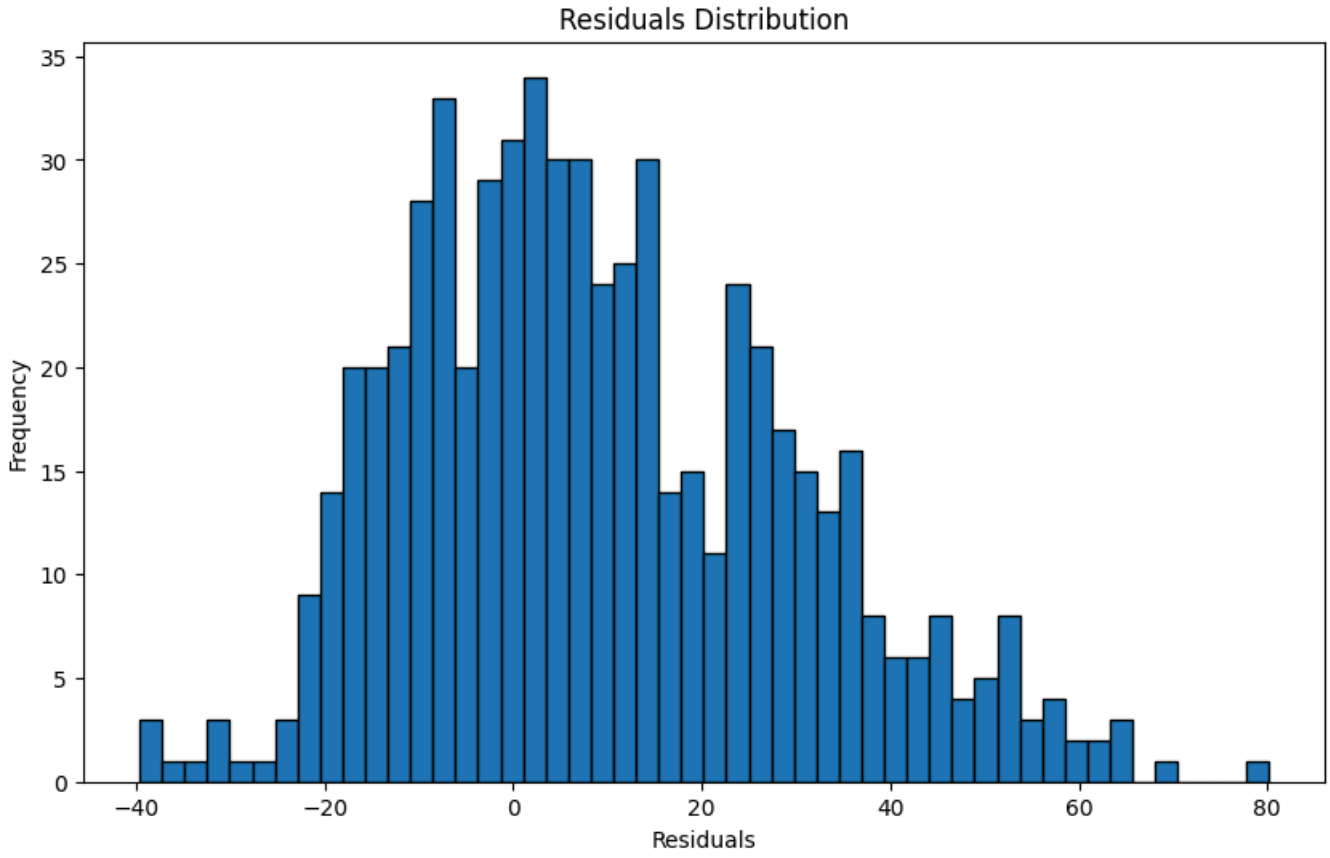
Using GRU Arcitecture

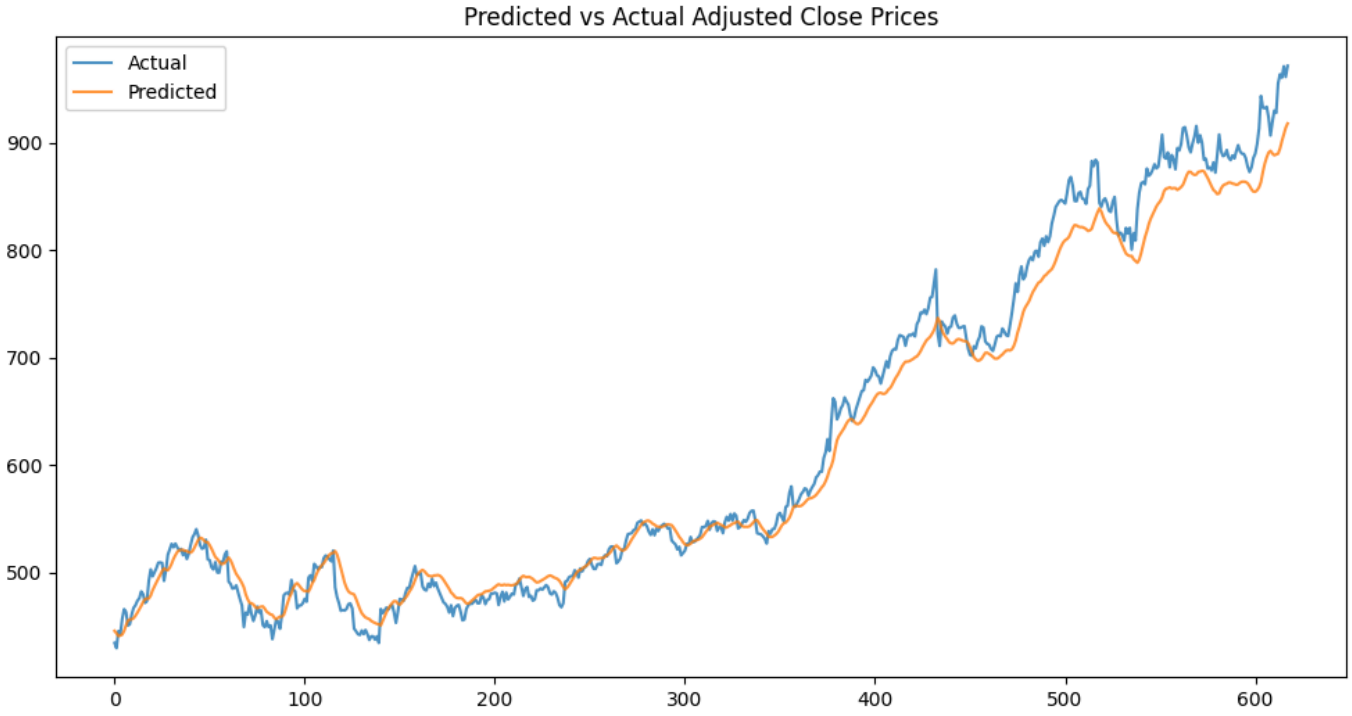
```
Epoch 1/30, Train Loss: 0.001348, Val Loss: 0.006056
Epoch 2/30, Train Loss: 0.000125, Val Loss: 0.004814
Epoch 3/30, Train Loss: 0.000091, Val Loss: 0.002170
Epoch 4/30, Train Loss: 0.000061, Val Loss: 0.001192
Epoch 5/30, Train Loss: 0.000051, Val Loss: 0.001328
Epoch 6/30, Train Loss: 0.000035, Val Loss: 0.000489
Epoch 7/30, Train Loss: 0.000028, Val Loss: 0.000839
Epoch 8/30, Train Loss: 0.000026, Val Loss: 0.000338
Epoch 9/30, Train Loss: 0.000024, Val Loss: 0.000501
Epoch 10/30, Train Loss: 0.000019, Val Loss: 0.000505
Epoch 11/30, Train Loss: 0.000025, Val Loss: 0.000639
Epoch 12/30, Train Loss: 0.000021, Val Loss: 0.000288
Epoch 13/30, Train Loss: 0.000020, Val Loss: 0.000205
Epoch 14/30, Train Loss: 0.000016, Val Loss: 0.000231
Epoch 15/30, Train Loss: 0.000021, Val Loss: 0.000556
Epoch 16/30, Train Loss: 0.000017, Val Loss: 0.000453
Epoch 17/30, Train Loss: 0.000019, Val Loss: 0.000201
Epoch 18/30, Train Loss: 0.000014, Val Loss: 0.000147
Epoch 19/30, Train Loss: 0.000019, Val Loss: 0.000279
Epoch 20/30, Train Loss: 0.000020, Val Loss: 0.000605
Epoch 21/30, Train Loss: 0.000022, Val Loss: 0.000256
Epoch 22/30, Train Loss: 0.000020, Val Loss: 0.000659
Epoch 23/30, Train Loss: 0.000025, Val Loss: 0.000228
Epoch 24/30, Train Loss: 0.000021, Val Loss: 0.000181
Epoch 25/30, Train Loss: 0.000021, Val Loss: 0.000151
Epoch 26/30, Train Loss: 0.000025, Val Loss: 0.000382
Epoch 27/30, Train Loss: 0.000014, Val Loss: 0.000441
Epoch 28/30, Train Loss: 0.000040, Val Loss: 0.000206
Epoch 29/30, Train Loss: 0.000015, Val Loss: 0.000158
Epoch 30/30, Train Loss: 0.000019, Val Loss: 0.000248
```




```
Test MSE: 509.21
Test RMSE: 22.57
Test MAE: 17.29
R2 Score: 0.9798
```


Actual vs. Predicted Adjusted Closing Prices
Ideal Fit
Predicted Adj Close Price
Actual Adj Close Price
500
600
700
800
900


Residuals Distribution
Frequency
Residuals
0
5
10
15
20
25
30
35
−40
−20
0
20
40
60
80


Predicted vs Actual Adjusted Close Prices
Actual
Predicted
900
800
700
600
500
0
100
200
300
400
500
600