X SICEL 2021

Transición energética en la 4ta revolución industrial

Universidad Tecnológica de Pereira

UNIVERSIDAD NACIONAL DE COLOMBIA

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Voltage Forecasting Methods for Voltage Monitoring and Control Strategies

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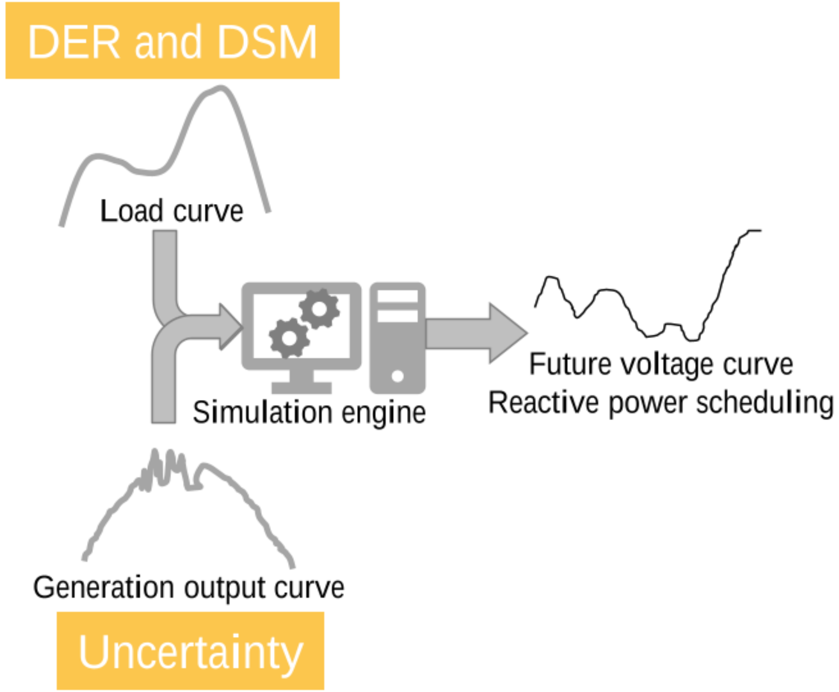
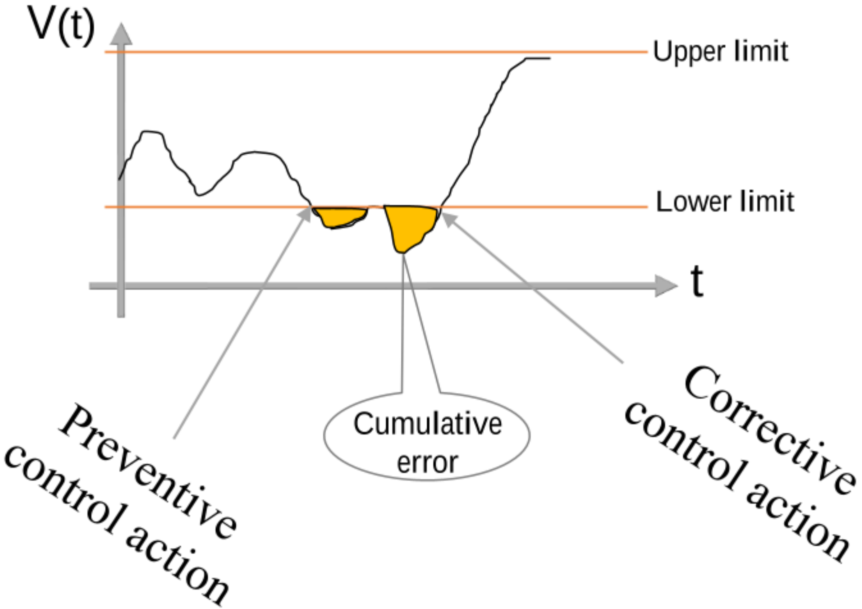
I. Introduction: Challenges

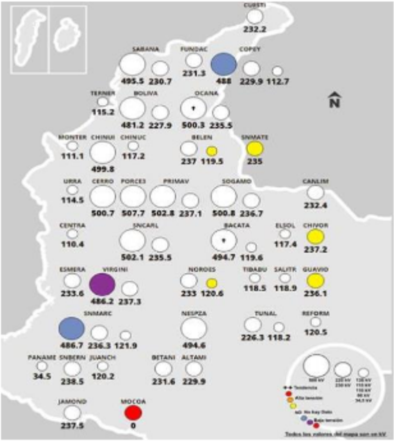




II. Proposed alternative

Control limits can vary:

- From node to node depending on:
    - Operational scenario
    - Network topology
    - SCR
    - Reactive power resources



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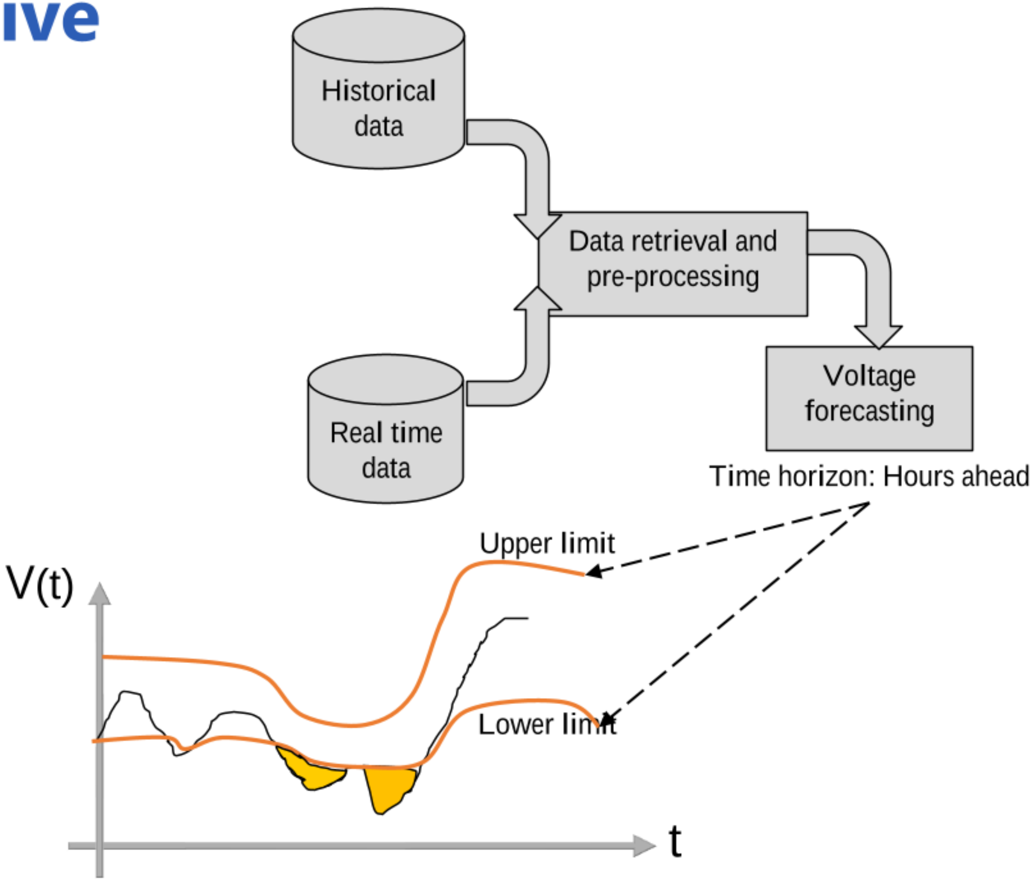


III. Real-World Cases

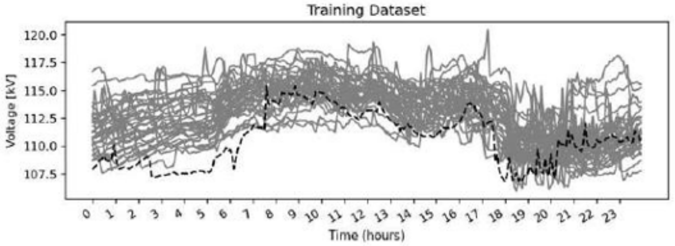


Fig.4.(a). Voltage time series with PV plant connected at 110 kV bus.

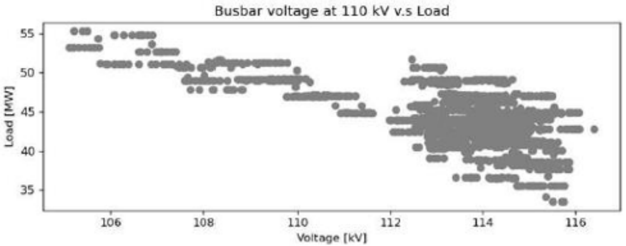


Fig.4.(b). Highly time-dependent voltage time series.

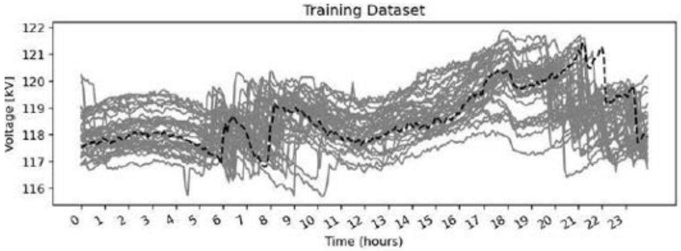


Fig.4.(c). Voltage time series with discrete control.

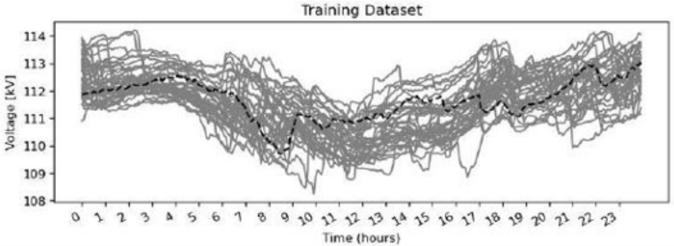
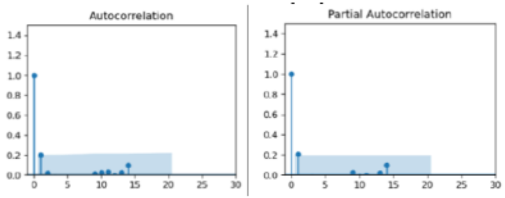


Fig.4.(d). Voltage time series in meshed grid (pilot node).

II. Model's performance comparison

ARIMA(1,0,0) or Autoregresive (AR)



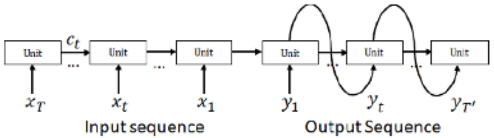
Simple Exponential Smoothing (SES)

$$V_t = \sum_{i=0}^{T-1} \alpha(1-\alpha)^i V_{T-i} + (1-\alpha)^T \widehat{V}_1, \quad 0 < \alpha \leq 1$$

Seasonal Historical Median (SHM)

$$V_t = V_{t-1} \frac{1}{V_{max}^H \, T} \sum_{i=1}^{H} V_{t-i,D}, \qquad V_{t-i,D} > 0.5\, p.u$$

Recurrent Neural Networks (RNN)



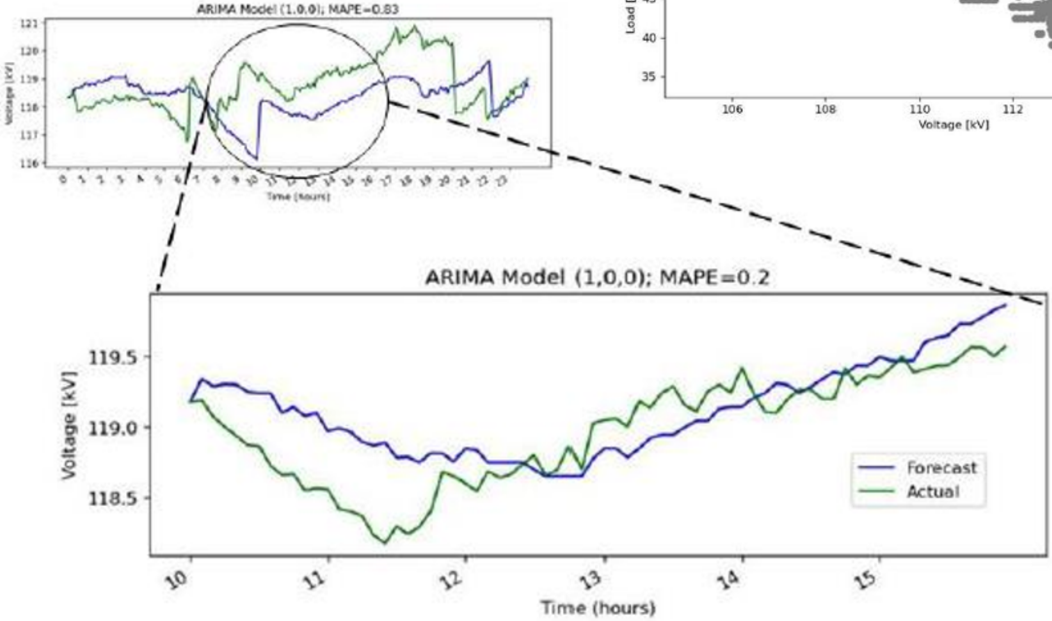
Model name	**Metrics**		
	Processing time [s]	***Training dataset size***	***Time Horizon [h]***
ARIMA(1,0,0)	Less than 1s	50 series	6,12,24
SES	Less than 1s		
SHM	Less than 1s		
RNN	73,76,92		
ARIMA(1,0,0)	Less than 1s	200 series	6,12,24
SES	Less than 1s		
SHM	Less than 1s		
RNN	29,94,23		

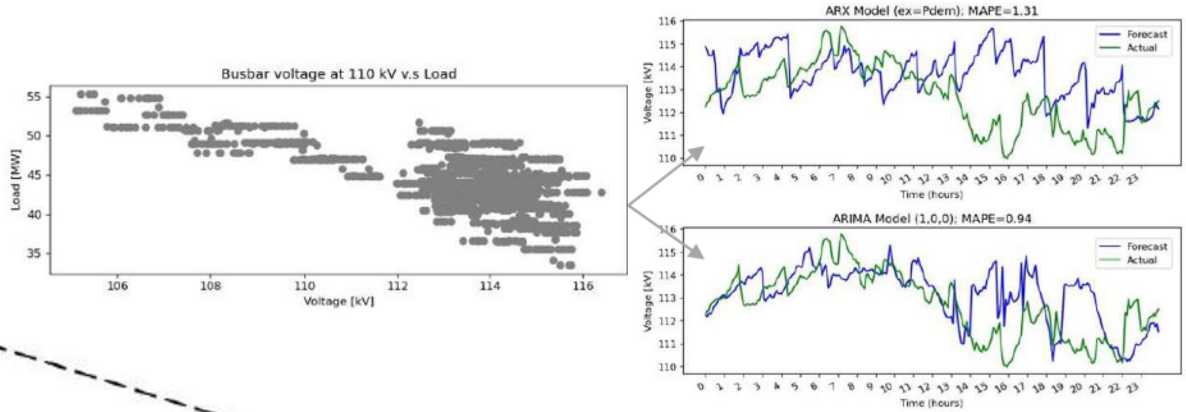
Model name	**Metrics**		
	Average MAPE [%]	***Cases 1,2,3,4,5 MAPE [%]***	***Time Horizon [h]***
ARIMA(1,0,0)	0.70	1.14, 0.92, 0.52, 0.41, 0.51	6
SES	0.71	1.18, 0.90, 0.52, 0.42, 0.52	
SHM	0.67	1.04, 1.10, 0.41, 0.39, 0.42	
RNN	1.02	1.72, 1.63, 0.6, 0.55, 0.60	
Persistence	1.10	2.01, 1.77, 0.6, 0.59, 0.51	
ARIMA(1,0,0)	0.89	1.1, 1.46, 0.68, 0.49, 0.70	12
SES	0.90	1.18, 1.47, 0.70, 0.50, 0.69	
SHM	0.68	0.93, 1.19, 0.42, 0.41, 0.47	
RNN	1.20	2.01, 1.97, 0.57, 0.66, 0.78	
Persistence	1.22	2.23, 1.99, 0.6, 0.65, 0.63	
ARIMA(1,0,0)	0.83	1.16, 1.20, 0.65, 0.52, 0.64	24
SES	0.84	1.18, 1.21, 0.66, 0.52, 0.64	
SHM	0.68	0.95, 1.04, 0.48, 0.41, 0.53	
RNN	1.27	2.2, 2.06, 0.69, 0.58, 0.84	
Persistence	1.27	2.40, 1.81,0.68, 0.60, 0.85	

IV. Improving accuracy

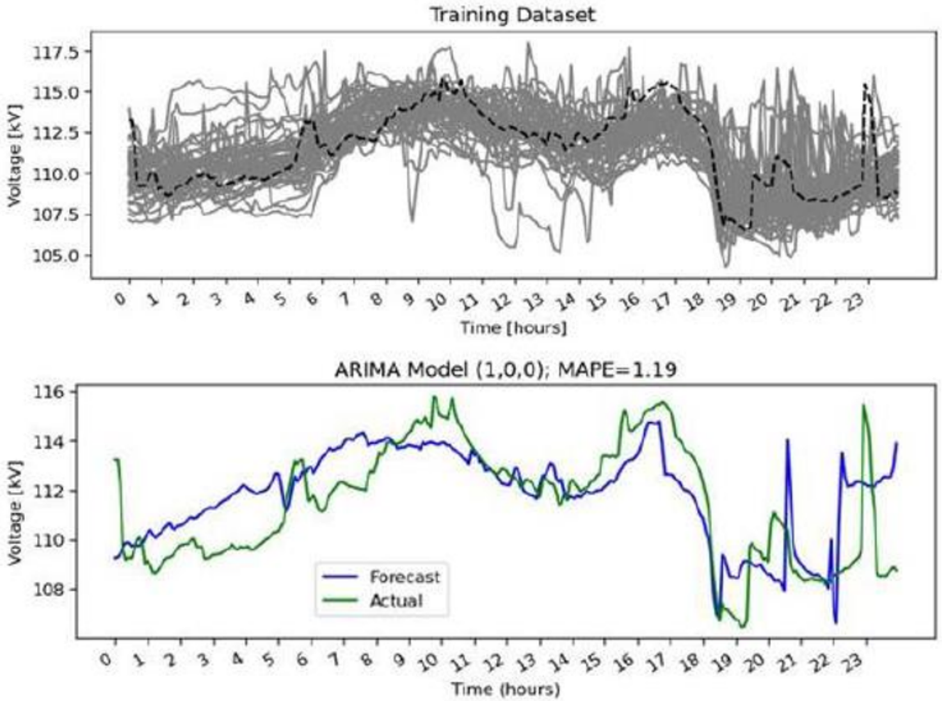
AR or ARX Models

Time horizon: 6 hours ahead





II. Covid 19 Scenario



Gracias

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