Forecasting Algorithm Selection and Implementation

Presented by Borcelle Group

Project Scope

- Connecting incoming data from ultrasonic sensor
- Automating data forecasting

Techniques Considered

- Common techniques considered in Google Apps Script

Simple Moving Average (SMA)

- Uses an equal-weighted average of recent data points
- Strengths:
  - Easy to use and understand
  - Smoothing factor is simple
- Limitations:
  - Lagging indicator
  - Doesn’t respond quickly to changes

Exponential Moving Average (EMA)

- Uses exponentially decreasing weights for past values
- Strengths:
  - More responsive to recent data changes
  - Suitable for short-term forecasting
- Limitations:
  - Smoothing factor needs calibration

Technique Selection

- EMA chosen due to responsiveness
- Implemented in Google Apps Script
- Stores predictions in a new sheet separate from raw data

Google Sheets Forecasting Integration

- Data received from ESP32 via Google Apps Script
- Data stored in Sheet1
- Forecasting script computes predictions from latest values
- Forecasts stored in separate sheet: "Forecast"

Forecast Script (Apps Script)

```
function calculateEMA(current, previousEMA, alpha) {
  return (alpha * current) + ((1 - alpha) * previousEMA);
}
```

ESP32 Configuration

- Ultrasonic sensor sends distance data every 10 seconds
- Sends data as JSON to Google Script Web App
- Example: { "distance": 73.45 }

Sample Forecast Output

1	Timestamp	Forecast	Upper Bound	Lower Bound
2	4/16/2025 3:58:14	120	132	108
3	4/16/2025 3:58:14	120	132	108
4	4/16/2025 4:58:14	128.33	141.16	115.5
5	4/16/2025 5:58:14	140.56	154.62	126.5
6	4/16/2025 6:58:14	143.98	158.38	129.58
7	4/16/2025 7:58:14	129.65	142.62	116.69
8	4/16/2025 8:58:14	113.42	124.76	102.08
9	4/16/2025 9:58:14	129.32	142.25	116.39
10	4/16/2025 10:58:14	130.88	143.97	117.79
11	4/16/2025 11:58:14	131.3	144.43	118.17
12	4/16/2025 12:58:14	129.76	142.74	116.78
13	4/16/2025 13:58:14	127.39	140.13	114.65
14	4/16/2025 14:58:14	127.01	139.71	114.31
15	4/16/2025 15:58:14	129.28	142.21	116.35
16	4/16/2025 16:58:14	129.27	142.2	116.34
17	4/16/2025 17:58:14	129	141.9	116.1
18	4/16/2025 18:58:14	128.62	141.48	115.76
19	4/16/2025 19:58:14	128.43	141.27	115.59
20	4/16/2025 20:58:14	128.6	141.46	115.74
21	4/16/2025 21:58:14	128.87	141.76	115.98
22	4/16/2025 22:58:14	128.8	141.68	115.92
23	4/16/2025 23:58:14	128.72	141.59	115.85
24	4/17/2025 0:58:14	128.67	141.54	115.8

Future Work

- Add confidence intervals to forecast
- Try other methods (ARIMA, Holt-Winters)
- Alerting system for abnormal data trends

Thank You