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%% Solar Tracker Simulation Setup (With Real Sun Model)

% Panel and simulation parameters
panel_area = 1.6;           % m^2
panel_eff  = 0.15;          % 15%
irradiance_amp = 1000;      % Peak irradiance (W/m^2)
day_sec = 86400;            % One day in seconds

% PID values
PID.Kp = 1.2;
PID.Ki = 0.5;
PID.Kd = 0.1;

% Assign variables to workspace
assignin('base','panel_area', panel_area);
assignin('base','panel_eff', panel_eff);
assignin('base','PID', PID);

%% ☀ Sun Model Using Time and Latitude (Hyderabad)
latitude = deg2rad(17.385); % in radians
t = linspace(0, day_sec, day_sec + 1); % 86401 points (1/sec resolution)
hours = t / 3600;
omega = 2 * pi * (hours - 12) / 24; % hour angle

solar_elevation = asin(sin(latitude) .* sin(deg2rad(23.45)) + ...
                        cos(latitude) .* cos(deg2rad(23.45)) .* cos(omega));

irradiance = irradiance_amp * max(0, sin(solar_elevation));
irradiance_data = [t' irradiance']; % time-series for Simulink

% Send to base workspace
assignin('base', 'irradiance_data', irradiance_data);

%% ☒ Build Simulink Model
model = 'SolarTracker';
new_system(model);

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A system named 'SolarTracker' already exists

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open_system(model);

% Add From Workspace block for Irradiance
add_block('simulink/Sources/From Workspace', [model '/Sun_Irradiance'], ...
    'VariableName', 'irradiance_data', ...
    'Position', [30 50 120 80]);

% Gain for panel area
add_block('simulink/Commonly Used Blocks/Gain', [model '/Area'], ...
    'Gain', 'panel_area', 'Position', [150 50 180 80]);

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% Gain for panel efficiency
add_block('simulink/Commonly Used Blocks/Gain', [model '/Efficiency'], ...
    'Gain', 'panel_eff', 'Position', [210 50 240 80]);

% Power = Irradiance × Area × Efficiency
add_block('simulink/Math Operations/Product', [model '/Power'], ...
    'Position', [270 50 300 80]);

% PID Controller
add_block('simulink/Continuous/PID Controller', [model '/PID'], ...
    'P', 'PID.Kp', 'I', 'PID.Ki', 'D', 'PID.Kd', ...
    'Position', [330 50 380 90]);

% Scope for PID output
add_block('simulink/Sinks/Scope', [model '/PIDScope'], ...
    'Position', [410 50 450 80]);

% Scope for Power output
add_block('simulink/Sinks/Scope', [model '/PowerScope'], ...
    'Position', [270 120 310 150]);

%% ☒ Connect Blocks
add_line(model, 'Sun_Irradiance/1', 'Area/1');
add_line(model, 'Area/1', 'Efficiency/1');
add_line(model, 'Efficiency/1', 'Power/1');
add_line(model, 'Power/1', 'PID/1');
add_line(model, 'PID/1', 'PIDScope/1');

% Connect Power to PowerScope
add_line(model, 'Power/1', 'PowerScope/1');

%% ► Simulate
set_param(model, 'StopTime', num2str(day_sec));
simOut = sim(model);

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