AI-Based Inspection and Maintenance of Transmission Lines of OPTCL

Introduction

OPTCL has about 38000 lattice towers. Every year several towers collapse during cyclones and sometimes due to high speed winds. Almost always, the towers that collapse have missing members/ parts. Rampant theft is the main cause and prevention of this my routine inspection is not feasible. Manual inspections are costly, inadequate and inefficient.

This concept introduces AI-based inspections, predictive analytics, and creating digital twins to boost grid reliability, cut costs, and improve resilience. Aligned with inspection norms and global smart grid trends, it supports Odisha's shift toward a more sustainable, intelligent energy future.

Challenges in Odisha's Power Grid

Odisha's grid operates under demanding conditions:

- **Rugged Terrain and Dense Forests**: Hilly regions and vegetation hinder inspections, increasing time and cost.

- **Frequent Cyclones**: Coastal areas face infrastructure damage and outages.

- **Aging Infrastructure**: Old towers, insulators, and conductors require frequent maintenance.

- **Frequent** theft: A routine inspection of any transmission line reveals missing bars/ members in lattice towers. Routine inspections are inadequate to prevent. After detection, police cases are filed regularly but the thieves are rarely cought.

- **Safety and Cost Concerns**: Manual inspections are costly and inadequate.

Proposed Solution

The solution integrates three technologies to address checklist requirements and Odisha's challenges:

AI-Based Inspection

- **Drones**: Equipped with high-resolution cameras, thermal sensors, and LIDAR to capture data on towers, insulators, conductors, and vegetation. Drones access remote areas, reducing safety risks.

- **AI/ML Models**: Analyse imagery to detect defects (e.g., rust, cracks, hotspots) and predict failures, enabling risk-based maintenance. This will be done by comparing with the digital twin. Each member of the tower such as angles, bars, nuts etc will have a unique reference no. Since each tower is already GIS tagged, as a drone approaches a tower, its digital twin will be made available to the software. The drone will transmit images from all angles and those will be compared with the stored image. Any discrepancy will be treated as an action point and the list of missing parts will be computed by the software. The list will be conveyed to the procurement cell for further action.

- **Cloud-Based Analysis**: Stores geo-tagged data, generates dashboards, and integrates with GIS, ERP, and SCADA for real-time insights.

Predictive Analytics

- Analyses historical and real-time data to forecast equipment failures and prioritize maintenance.

- Optimizes inspection schedules, reducing downtime and extending asset life.

Digital Twinning

- **Creation**: Virtual models of grid assets using LIDAR and sensor data. Digital image of each type of tower will be created. Each part of the tower such as angles, bars, nuts etc will be given a unique reference no.
- **Simulation**: Models cyclone impacts, load changes, or failures to predict issues.
- **Optimization**: Enhances maintenance planning and supports renewable energy integration.

Alignment with 41 Points Inspection Checklist

The solution addresses inspection checklist points across five categories:

- **Tower Checking**: AI detects missing members, corrosion, and structural issues; digital twins simulate cyclone resilience.
- **Insulator Status**: AI identifies cracks and hardware issues; predictive analytics schedules replacements.
- **Conductor and Hardware**: Thermal imaging and AI detect hotspots and damages; digital twins monitor load conditions.
- **Vegetation and Clearances**: LIDAR ensures statutory clearances; predictive analytics forecasts growth.
- **Other Information**: AI flags anomalies; digital twins store comprehensive data.

Benefits

- **Enhanced Efficiency**: Drones and AI reduce inspection time by up to 30% compared to manual methods.
- **Improved Reliability**: Real-time monitoring and predictive maintenance minimize outages.
- **Cost Reduction**: This will free up manpower for other important jobs. Also quicker maintenance and reduced damage to towers during natural calamities.
- **Cyclone Resilience**: Digital twins simulate adverse scenarios, ensuring preparedness.
- **Sustainability**: Optimizes energy distribution, supporting Odisha's green energy goals.
- **Drones will detect the missing members/ parts, rusted parts and loose ends and the data will be compiled at the central server**. The list will be compiled and transferred to procurement division. Maintenance will be quick.

Road map: OPTCL will prepare an RFP and seek proposals from organizations with experience in the field with proven record to participate. The services will include drones, software, creating digital twins of each type of tower, training the AI system and operation of the system. The data will be stored in our data centre