Developing IoT Monitoring System for Transmission Tower Weather Sensors

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I. Introduction

Extreme weather caused by climate changes, i.e. severe typhoons and heavy downpours, have become a new normal, and cause damages to the security of transmission towers and jeopardize the stability of power transmission.

This study aims to verify the resilience of the tower bases of TPC transmission lines against extreme weather and expedite the implementation of smart grid by applying internet of things (IoT) technology and installing wireless mini-weather stations on transmission towers in the areas vulnerable to extreme weather. The sensors used at the aforesaid weather stations include ultrasonic anemometers and rain gauges.

Three overhead power lines were selected for the installations, respectively the 161 kV Pinglin-Yuanshan line , the 345 kV Shenmei-Dongshan lineand the 161 kV NPP3-Fenggang line. The first two lines are under the administration of Taipei Power Supply Branch, and the thirdt line, under the administration of Kao-Ping Power Supply Branch.

II. The Components, Functions and Structure of the Monitoring System

The monitoring system are composed of mini-weather stations, a database server and a web application for condition monitoring and data analysis.

The mini-weather stations are self-powered and capable to collect real time data. The collected data is then wirelessly transmitted to the database server. The methods of observation fully comply with the guidelines published by the Central Weather Bureau (CWB) .

Eventually, a total of 15 transmission towers had been selected (serial numbers shown as Table 1) as targets of mini-weather station installations.

Table 1. Serial numbers of selected transmission towers

Location	Serial Number	Total Number of Towers
New Taipei City and Yilan County	Pinglin-Yuanshan line: #34、#35、#36、#50、#51 Shenmei-Dongshan line: #87、#88、#94、#95、#96、#97	11
Hengchun	NPP3-Fenggang line: #55、#56、#57、#58	4
	Total	15

Wireless sensor networks (WSNs) are formed among nearby weather stations. One station in each WSN is selected to act as gateway node to connect to the Internet. Weather data collected from each station will be gathered at each gateway node through WSN and transmitted to the database server over Internet, currently installed at Shulin Branch TPRI.

As for the WSN, each weather station is connected to the adjacent stations to form a chain-like network, and the station at the end of the chain acts as the gateway node. The collected data, such as wind direction, wind speed, rainfall, battery percentage, is passed along the chain to the gateway node. In the event of a failure along the chain, the data can transmit along the backup routes by skipping the malfunctioning station.

The stations are powered by solar panels together with a battery device. When the battery percentage drops below the designated level (≦ 30%), a warning notification will be issued through the web application.

The web application adopts responsive web design (RWD) and serves as an user interface, carrying the features of data visualization, data searching, and an embedded map marked with the locations of the towers under monitoring. The markers are shown in different colors according to the levels of the alarm.

The warning mechanism is a “3 value 4 level system”, consisting 4 alert levels separated by 3 threshold values (shown as Figure 1), namely the attention value, the alert value and the action value. These threshold values can be adjusted in the web application. The levels of alert are represented by 4 different colors (green, yellow, orange and red). When indicating orange or red alerts, a scrolling text banner warning will display on the application.

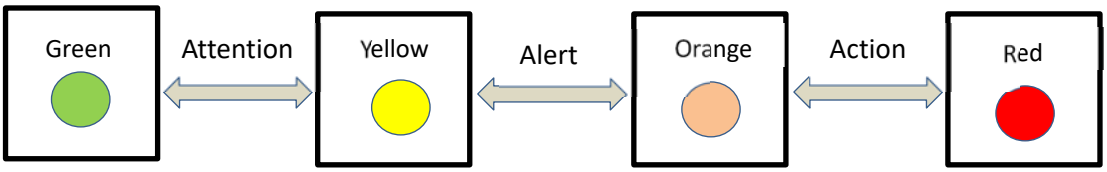

Fig. 1. The 3 value 4 level warning system

The system schematic of both hardware and software are shown as Figure 2.

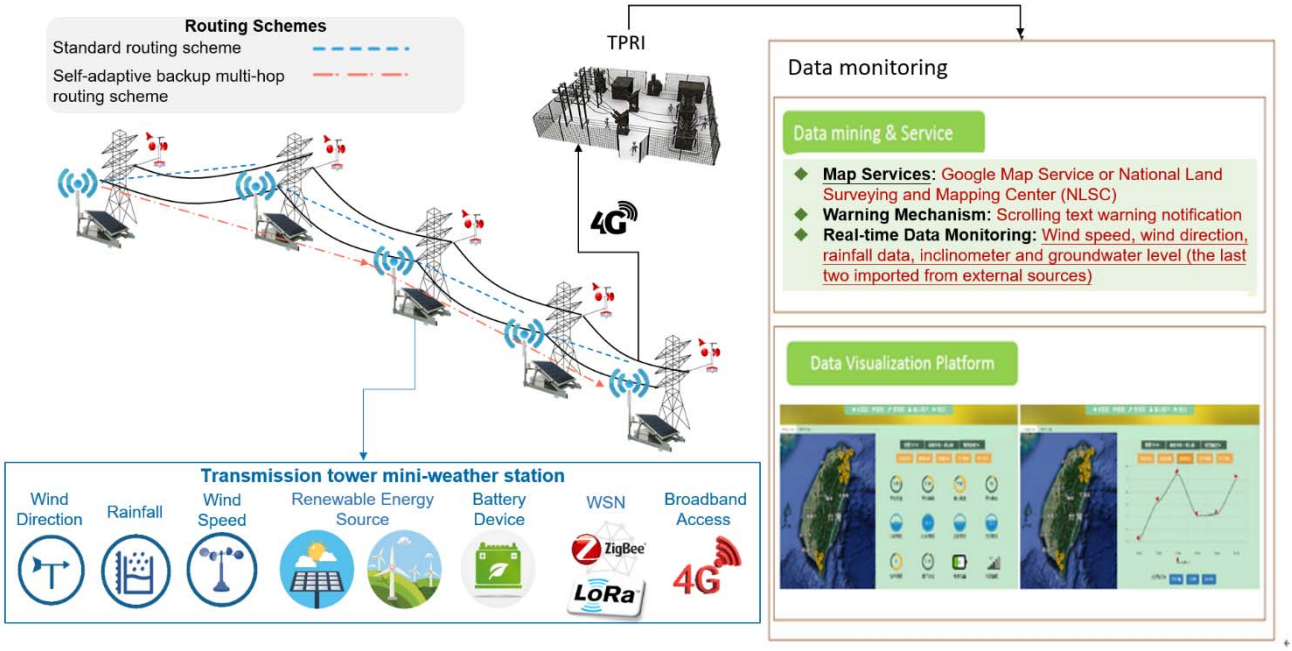

Fig. 2. System schematic diagram

III. Research Results

The monitoring system has started operation in October 2019. No data transmission errors have been detected so far, confirming the system's stability and reliability. The collected data may be used to analyze the local wind fields, verify the resilience of the tower bases and revise the current warning mechanism.