Freezing Prevention and Open Area Control System for Automatic Weather Stations

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Abstract- There is an increasing demand for the observational data, in particular from remote areas, for several applications. With the recent developments of GSM technologies in last two decade, data acquisition from remote sites became easier and widely used. One of the important usages is for automatic weather stations (AWS) and many commercial systems are developed in order to fulfill the needs of meteorological and hydrological services. Although automatic weather stations provide some solutions for the data acquisition from the areas in which manual observations not possible for continuous and sustainable observational data, measurement of solid precipitation still remains an important problem in such areas that required energy for heating the instrument cannot be provided. Vandalism is also another important problem for the sustainability of the observing systems installed in remote areas

This paper focuses on two important problems which affect the sustainability and measurement quality of AWS's. First, we introduce a microchip controlled de-icing device independent of the AWS brand, which can be operated with solar power in order to prevent freezing of precipitation sensors. Second, in order to determine damages from animals and human beings, details of motion-triggered surveillance system connected to cloud servers explained.

Index Terms- Freezing, de-icing, software controlled heating, solid precipitation, area control system, motion sensing alarm

I. INTRODUCTION

Accurate and continuous measurements play an important role in the quality of meteorological services. With the developments of communication technologies, data acquisition from different sites like high mountains and upper catchments became possible. Currently, thousands of AWSs have been operated by Turkish State Meteorological Service (TSMS) for proper measurements.

During the services of this devices, we determined two major problems which affect the sustainability and the measurement quality. The first problem is freezing of precipitation sensors on the sites where the devices only powered by solar energy. The second one is the physical security of AWS and detecting the reasons for damages in the open area.

In order to solve these problems, we started a development process with a local telemetry company. This paper explains the details of the resulting system of this development process. In the second section, we describe a low power de-icing system for freezing prevention. On the third section, details of open area control system has been shared.

II. FREEZING PREVENTION SYSTEM

The concept of freezing prevention (anti-icing) and de-icing is a well-studied concept nearly for a century [1]. Beside physical cleaning by man-power, two ways of de-icing are heat application and use of dry or liquid chemicals that lower the freezing point of water.

Continuous usage of chemicals is not suitable for AWS's within sites on high mountains and also the operating cost is very high. The only feasible way of freezing prevention is applying heat. There are solutions provided from different AWS vendors for heating precipitation sensor [2].

After years of observations and data collection, we spotted problems with this kind of devices on the area of power consumption and efficiency. Amount of energy required for heating and operation way not suitable for sites without direct energy from power lines and only powered by batteries and solar energy.

By the guidance of de-icing experience of Telix [3], we made many test studies on different brand precipitation sensors in winter conditions. The results from this test studies led us to a conclusion that if a proper heating can be provided for the instrument before the falling of the precipitation into catch pit of the sensor, freezing can be prevented by using less energy and evaporation caused by excessive heat can also be avoided. It should be stated that this approach can be applied to all other sensors which are exposed to freezing.

A software controlled freezing prevention system developed consists of a liquid-tight carbon heater unit triggered by a sensor for precipitation availability. If there is an information on the availability of the precipitation from the sensor, and the temperature goes down +4 °C then the heating system starts to heat the instrument for avoiding the freezing on the catch pit and discharge unit. When precipitation stops, the heating control unit can go on heating from 5 minutes to 60 minutes however it is adjusted by the user.

III. OPEN AREA CONTROL SYSTEM

During the operation of remote AWS's, one of the biggest problems is the determine causes of physical damages on stations and prevent robbery. Physical damages may be caused by animals but also can be a result of vandalism.

After a study of the various field structure of remote AWS sites, a system triggered from microwave motions sensors designed. Selected microwave sensors have features for adjusting the size of the targets to detect in order to prevent activation of the system on small animals.

When the system triggered from the sensor, an audial alarm activated and also continuous recording from cameras will be stored on hard-drives. Meanwhile, an SMS and E-Mail alarm sent from the cloud server to authorities, and the current status of the site can be watched from any device.

In the presence of high band connection like 3G, continuous streaming from security cameras is available but if only the GPRS is active, telemetry modem is sending pictures to the cloud server.

With the presence of the telemetry system, the status of devices on site, like the condition of batteries, sensors and any data provided by AWS can be checked and transmitted to the central cloud server. Also if it's required heating device can be activated from the cloud for testing and

possible to monitor the whole network of the stations on the map and to generate detailed reports of the system status.

Any information of failure in the system or any type of alarm can be sent to the pre-defined users and/or terminals by SMS or e-mail. Web service feature makes it easy to integrate with any other application software.

IV. CONCLUSION

For meteorological and hydrological services and other public or private agencies which are operating AWS's in remote sites like high mountain areas, it is difficult to operate the AWSs properly because of environmental conditions and insufficient powering which causes the loss of data or interrupt the operation due to the freezing of the sensors. On the other hand, AWS or other systems are open for several risks due to the lack of sufficient security.

An integrated system for freezing prevention and open area control presented to overcome the mentioned problems above. The granted system successfully passed all the field test and planned to be applied all the AWS sites belongs to Turkish meteorological systems.

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