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MORE PERFORMANCE IN THE MIDDLE OF A WIND FARM THANKS TO THE HETEROGENEOUS WIRELESS SENSOR NETWORK

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ABSTRACT

The maintenance and control of wind turbines is currently becoming a scientific concern, especially with the growth in the number of wind turbines per fleet and with the various difficulties in accessing these machines in the wild. In this paper we propose a wireless network of heterogeneous sensors which allows to solve almost all these problems. This network provides remote maintenance and control of any wind machine. In addition, this monitoring can be taken care of automatically by an off-site computer, even from far away. With this application, each wind turbine is assumed to be equipped with sensors with a cluster head. This cluster head is responsible for collecting the various measures related to the operation of the corresponding wind turbine machine and for remote communications with two local or central stations. The validity and performance of this proposed network are confirmed in the extended paper.

INTRODUCTION

Today, global warming caused by greenhouse gases has had harmful consequences for the survival of the living being on earth. This is strongly linked to the industrial use of fuel-based energy. Today, the use of green energy as a solution to this problem has emerged. Several types of this energy are therefore being produced. Wind farms are one example. They are indeed in full expansion in land sites and in offshore sites. Any wind machine in such a park needs maintenance and control of its operation. This machine is not always accessible in the environment. His follow-up has heavy loads. [1-21] Given the increasing number of wind turbines per park, these tasks are becoming more and more difficult and expensive. A process that facilitates the multiplication and operation of these wind farms is a topical scientific concern. In this work we propose a wireless network of heterogeneous sensors allowing the remote control of any wind machine contained inside or outside of a wind farm (see figure below). This machine is supposed to be fitted with all the sensors necessary for measuring its operating quantities to analyze its environment or for recharging these quantities to switch its operation. All the sensors of this machine therefore form a cluster. Another sensor also on board this machine will be the cluster leader. It will carry out four main tasks:

= memorize the different quantities measured instantaneously by the cluster members,
= carry out light treatments to adapt the sizes,

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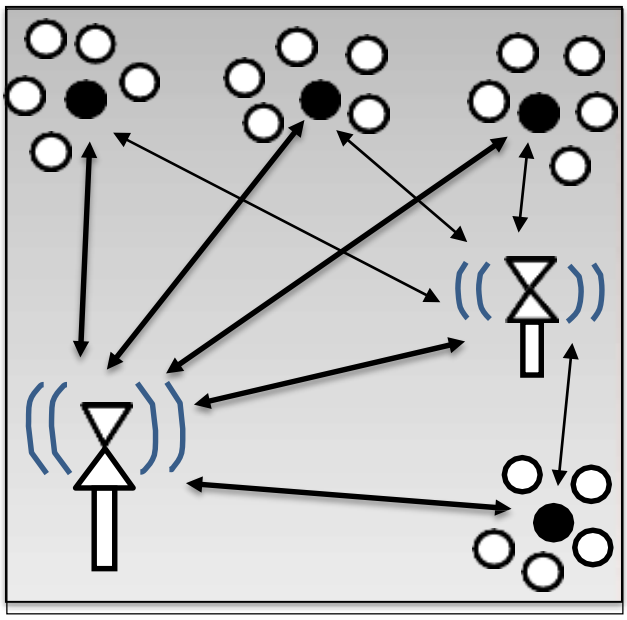
= remotely communicate measurement reports and machine localization, then
= execute orders received remotely.

The leader of each cluster is a node equipped with two modules. The first is for reporting and localization management; while the second is for the realization of remote communications ensuring the follow-up and the execution of any command from the local station LS or the central station CS. This central station can carry out remote communications with cluster leaders and with any wind farm machine. These direct communications with any cluster member are only carried out in the case of rapid intervention. This central station may be outside the park. It can take care of several wind farms of any distribution in the wild at the same time. The service of this main exploitation station can be shared therefore between these parks. Their remote management from far away is made with this remarkable design very pleasant. This process makes it possible to save great costs in maintenance, to ensure complete monitoring of all the park machines and to increase without constraint the number of wind machines in any park. The multiplication of wind farms on land, at sea or at any site of the permanent wind, is made possible for every government. The only remaining constraint in the creation of a wind farm will in this case be the cost of the machines and their installation. The application of a network of heterogeneous intelligent sensors in each wind farm is a considerable and real added value. The confirmation and validation of this application will be shown in the following.



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MANAGEMENT PROBLEMS

To make each machine function correctly in any wind farm, we must constantly monitor its maintenance and be able to control the aerodynamic parameters of its blades [22- 70]. This is to adjust the speed of their rotation as well as the power drawn from the wind:

- In the case of high winds, the rotor may be subjected to mechanical forces which may exceed the allowable stresses. In addition, the power supplied by the rotor is limited by the maximum power of the generator.
- In the case of normal operation, the blades of the wind machine must be able to turn at the desired or at least predefined speed of rotation.

There are two important ways of varying, and therefore controlling the aerodynamic force on the rotor of a wind turbine:
= in the first, the angle of attack is changed and the windward area swept by the wind turbine is reduced.
= in the second, the solution is obtained by shifting the rotor with respect to the direction of the wind, for example, along a vertical axis or for a left-right shift. We focus here on the first solution based on the angle of attack. The most effective way to change this angle is to control it. This can be changed by rotating the blade along its axis. To control the force applied on it, one can proceed in two distinct ways. First, you can increase the pitch angle, to decrease the power or reduce it, to increase the power. Ultimately, if you want to reduce as much as possible the forces exerted on the blades to guarantee their integrity, especially in the presence of high winds, they can be feathered in relation to the direction of the wind. Another way to limit power is to quickly exceed the stall angle, which induces a significant reduction in lift. Unfortunately, for some embodiments, this second method is less efficient than the first. It would apparently be less precise and the forces applied to the blades would be more intermittent. This is due to the strongly unsteady nature of the stall phenomenon.

MANAGEMENT SOLUTION:

This set of tasks constitutes a significant burden for dealing with a wind machine, especially in a difficult to access environment. Management becomes more complex when it comes to one or more wind farms. This problem is easily solved by equipping any fleet with a heterogeneous wireless sensor network. Radio communication enables remote monitoring and control of one or more distribution parks of any kind.

CONCLUSION:

In this paper, we have proposed a process for optimizing the control and maintenance service of wind turbines in one or more wind farms. When normal operation is established, a routine mode is set up. In fact, after several iterations of calculation on board or at the operations center, any wind machine converges towards the optimum operating point. Thus, the maximum power is captured quickly even in

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the presence of large variations in wind speed. Thanks to radio communication, this capture of maximum power is quickly ensured even in the presence of strong fluctuations in wind speed. Power output does not hover around maximum power.

The services offered by any network of heterogeneous wireless sensors, in any wind farm, are much more important than the cost of its installation.
The use of heterogeneous wireless sensor networks in wind farms can be extended to other applications in several areas.

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