Model for remote data acquisition and monitoring integrating social media, NTIC´s and 3G cell phone Networks applied to monitoring small wind turbine.

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Abstract—This article shows the development of a platform model that can monitor, acquire, store and transmit data remotely using sensors, 3G cell phone network and social media to be applied to the design of small wind turbine, aiming at generating a product which presents a good cost/effectiveness ratio, using management and manufacturing materials and processes adapted to world reality. A new model of a data acquisition system is presented based on the integration of the new information and communication technologies (NTIC’s), social media and analog and digital signal processing techniques, intending to study the performance of variables generated in the bench wind turbine. This system will allow continuous monitoring, at foreseen sampling intervals, of changes in the parameters analyzed through the sensors installed in the wind turbine. The results of the analysis of these sensors can be acquired and transmitted remotely through the 3G network, directly to an operations room, or also be made available on the Web through social media, supporting decision-making. The information studied here shows results useful to any market segment and to all scientific, economic and environmental areas which intend to develop and become acquainted with a small wind energy generation system. Although wind turbine variables were used in the experiment in the experiment, other possible applications for data acquisition and monitoring and remote experiments are shown, using the 3G cell phone communication channel and social media.

Index Terms—Wind Turbine, Remote Monitoring, Communications System, 3G Cell Phone Networks.

1 INTRODUCTION

It is not an easy task to provide monitoring platforms, supervision and real time on-line data control in machines and equipment. A major factor for the success of the data to be monitored in the investment strategy is the appropriate choice of technologies and the means to establish this communication and integrate the equipment distributed to different “remote” sites. Information and communication technologies are very useful resources that can be applied to integrate different technological systems with learning and remote experiments. The internet has helped extend these media in the field of monitoring, experimentation and data control, potentiating remote experiences and establishing new learning paradigms.

From a pedagogical perspective, experimental activity essential to teach engineering encourages the construction of mental models based on the practical observation of concepts and principles, providing a connection between theory and reality. Experimental activity based on a remote laboratory may create an approach between the laboratory and real life for the students, since laboratory activities play a critical role in education, especially in courses on natural and technological sciences; they are also a way for teaching institutions to share resources, thus reducing their costs, besides enriching the educational experience [1]. And the more this activity can instill the capacity to solve practical problems, the more important it will be, enriching and solidifying theoretical knowledge as opposed to forms of abstract and often volatile knowledge.

From the perspective of industry, learning from what is ready in real time is to overcome the obstacles of competition with the lowest investment possible in solving problems and continuous improvement to increase production.

From an engineering perspective, the development of new ways to access information has considerably extended the need for education in all areas. According to Juarez Bento da Silva (2006), one of the essential aspects of teaching in the fields of technology and natural sciences is the practice the students can acquire when they handle different devices and electronic and mechanical instruments. This will allow them to apply and develop the theoretical knowledge acquired. Data transmission is increasingly becoming a fundamental resource for the different market sectors. Currently, there
is a growing need of instantaneous communication for economic development and technological advancement. The strategy is to survive in markets where real time information will be the determining factor to win new customers [2].

2 NEW INFORMATION TECHNOLOGIES AND COMMUNICATION (NTICs)

This article shows the integration of NTICs and social media by developing a platform for the remote acquisition and monitoring of data using sensors and 3G cell phone networks applied to a small size wind turbine mounted on a test bench. Monitoring flaws [3] [4], controlling and knowing these wind energy generation systems will be very important to improve a technology) that is growing apace, worldwide, and will make it more attractive for energy generation, both in economic terms and as regards increased energy security, not to mention the benefits to economic development and the environment.

There is a growing use of renewable energies, such as that generated from wind. Conscientious countries seek to reduce CO2 emissions, and the energy revolution may be a reality [5], increasing our daily comfort and consuming less and cleaner energy. Wind generation systems are greatly expanding [6], as seen in figure 01 below. The demand for this technology is growing above the expected average, indeed many manufacturers have a delivery time on the order of two years or more [7].

![Figure 01 – World total installed capacity](image)


Overall, there are prospects for the growth of wind capacity, despite low oil prices, since the energy security of countries and environmental concerns require diversification of sources of energy, figure 02. In Brazil, a firmer, more credible government commitment, contracting for annual minimum amounts of wind energy over the medium and long-term, is considered crucial to ensure the presence of wind turbine manufacturers and the growth of wind capacity in Brazil. These systems are known to require increased monitoring [8], since they are usually installed in remote places, far from technological resources.

![Figure 02 – Total Installed Wind Capacity 1997-2020 [MW] Development and Prognosis](image)


The rate at which the world has been changing has created a new organizational paradigm conducted and pressured by social, environmental and technological vectors. This gives an innovative, dynamic character to the capacity of formulating a strategy and intelligent and synchronized connection of related activities. The reorganization process imposed by the era of economics and knowledge supports the need for new information management models and projects that are more effectively adjusted to comply with the strategic objectives.

3 SENSORS AND THE ACQUISITION OF SIGNALS

Specifying the sensors and signals for the desired monitoring correctly is extremely important for the system to work well as a whole. The data acquisition system is divided into three parts: sensor element, signal converter and display) [9].

Sensors are equipment that, on receiving a stimulus (presence, position, pressure, flow, temperature, etc.) responds by generating an electrical signal that can be analog or digital. These are the main factors responsible for the acquisition of information, followed by elements conditioning the signals generated; therefore, it is very important to study the transient and temporal behavior of the variable to be measured, so that the sensor will be specified correctly. Figure 03 shows blocks with a signal acquisition system.

![Figure 03 – Signal acquisition system](image)
4 Wind Turbines

This is a device with a generator to convert wind energy\(^1\) into electric energy, figure 04, or else, a wind turbine that actuates an electric energy generator. This type of generator has quickly become popular because wind energy is renewable, different from burning fossil fuel. It is also considered “clean energy” (environment-friendly), since it does not require combustion which will produce polluting residues, nor the destruction of natural resources\([10]\).

Figure 04 – Wind generator with a horizontal axis and windmill

5 Cell Technology

Cell phones are the fastest growing branch of telecommunications. This success is due to terminal mobility, service coverage area, increasing possibility of roaming, and, especially, the competition of private enterprises that, by using an improved marketing technique, have challenged state-owned companies to do something. Add to this the levels of price of subscription and charges, considered reasonable by the users\([11]\).

Nowadays more digital cameras are sold as part of the phones than alone. In coming years, the mobile telephone network will be responsible for most internet hits\([12]\). The evolution of voice and data technologies and the technology standards of existing cell phone systems, worldwide, are presented in figure 05, below.

Figure 05 – Evolution of Generations of cell phone systems

\(^1\) The use of wind energy consists of converting the kinetic energy of a mass of moving air into mechanical energy. This is generated by rotation of the vanes around an axis which, through an electric generator, converts it into electric energy.

The 3rd Generation (3G) of cell phone networks aims at offering telephone, messaging, video and data services, with high rates of transmission\([13]\).

6 Social Media

According to Marteleto, social networks are “[...] a set of autonomous participants, gathering ideas and resources around shared values and interests”\([14]\). Communication from all to all, while a few years ago mass communication was from one to all, i.e., television to viewer, newspaper to reader, radio to listener. Whoever had the means to communicate had power, now everyone can produce and receive information through the greatest communication network of all, the internet. “Media” are the means, “Social” are the relationships. As important tools for anyone who works in a web related field, currently, the social media have been crucial for companies and their entire diffusion process for brands and products.

The social media shown in figure 06 are part of our daily communication among social networks, as a working tool, and they are used in business with many network options that include the novelties.

Figure 06 – Some Social Media. Source: http://comunicacaochapabranca.com.br

They describe the online tools people use to share content, profiles, opinions, views, experiences, perspectives and the media itself, thus facilitating on-line conversations and interaction among groups of persons. These tools include, forums, podcasts, microblogs, lifestreams, bookmarks, networks, communities, wikis and blogs. In order to be successful, there must be constant monitoring of those who join and what they say about their product and working based on these opinions and users, is essential for its success.

7 Methodology Applied to Monitoring the Variables of a Small Wind Turbine

Below the model of a data acquisition and monitoring system using the 3G networks and social media for distant monitoring is presented. This model for remote data acquisition and monitoring via 3G Cell phone...
network is composed of five key elements of the process, figure 07:

01 – Intelligent Machines and Sensors - Devices that monitor control and measure some type of activity locally. There may be several sensors at a given place (Signal acquisition board, Programmable Logic Controller / PLC, and others).

02 – Application Interface - Interface between the sensors and the communication network. For remote applications, there is a Remote Terminal Unit – RTU.

03 – Communication Base (Backbone) - The system can use fixed lines or radio, and it can transmit information from the sensors through the application interface to a central command computer and a control center. The system will transmit the data to an Internet server. For this the system must have the capacity to connect to the Internet. Therefore, it was decided to use the transmission and reception technology via 3G network, employing the network structure of a local phone system operator.

04 – Transmission and reception system for remote data monitoring - The transmission and reception system shown and assembled here is an electronic system that uses the Modem and 3G Router technology, which allows transmitting and receiving input and output signals at a distance via cell phone network. This system has an RS-232 and TCP-IP serial interface that can be connected to systems such as Data acquisition plaques, CLPs, switches, network servers, etc., connecting via 3G cell phone transmission. The characteristics of this electronic system are described as: 3G cell interface, RS-232 data interface, RJ45 interface and /or TCP-IP, 01 output commanded remotely, 05 signals and feed inputs 110/220 V, or converter to battery system.

05 – Control and Command Center - This is the central point that receives the data transmitted by the sensors. Here the data obtained by the system are analyzed, and all decisions are taken to solve possible problems. Below is shown the login screen and password, figure 08, of the access page to the acquisition and monitoring platform of remote data received via 3G network, which the operator will have to access to manage the parameters to be verified on the main screen shown next in figure 09.

8 EXPERIMENTAL BENCH

Wind turbine are usually installed close to homes, but they may be far from town, which makes it difficult to transmit data to a central unit. The Wind turbine built for bench tests has sensors that must be monitored [15],[16], figure 10. The data of each sensor are collected directly from the Wind turbine by simulations and sent to a remote computer through the 3G network. Note: For situations in which the 3G network is not available, the GSM-GPRS network may be used.
9 DATA ACQUISITION AND MONITORING VIA 3G CELL NETWORK

The wind turbine is now constantly monitored by the remote acquisition and monitoring platform, figure 11.

All sensors measure and generate operational data. These data are collected continuously, managed by the stored software, and can be transferred via 3G network to the equipment manager. Wind turbine control and regulation are automated and if an event or an operational failure occurs, the data are automatically transmitted and received by the monitoring system which makes the decision to send an SMS (short message service), figure 12a and 12b, or refers this information to the registered social media, in order for the relationship network to receive the information and treat it so as to improve the quality of the monitored process, figure 13.

All the wind turbine control components and operational data continuously monitored and controlled remotely are now organized so that information can be extracted for technical improvements and/or to organize maintenance and repair of the equipment for damage prevention.

10 VALIDATION OF RESULTS

The remote monitoring systems controlled are the main sources of information available to the operators of the monitoring and control center. They enable online diagnosis before the stage of system restoration. The data are only those obtained by the sensors and transmitted to a computer by means of the 3G Cell Phone Network. Several tests for transmission and reception of variables were simulated for the study. Below is the description of two bench tests performed and described as shown in figures 14, 15, 16, 17 and 18.

Transmission and reception of data on brake pad wear of the first set of pads option LEVEL GOOD.
Transmission and reception of data on brake pad wear of the first set of pads LEVEL ATTENTION.

Transmission and reception of wear data of the brake pad of the first set of pads, option LEVEL STOP

11 Conclusion

The future prospects of existing technologies are to unify the different communication media. In a not so remote past, those who had the media had power, but things have changed and now everybody can produce and receive information through the largest communications network of the planet: the Internet and the cell phone networks.

Not only the fixed public cell phone networks will be integrated, the large area networks (WANs) will also be interconnected, enabling the connection of laptops and other devices to an endless number of new wireless service providers, practically anywhere in the world.

The article shows how easy it is to interact remotely with equipment, using the existing communication networks. It provides a broad overview of possible applications in many fields of activity.
Using the existing communications networks, it is possible to interact with devices remotely, and to obtain information that is part of the variables which allow it to function. This information is obtained by means of the ensemble of data acquisition (sensors + signal conditioners).

This study also shows that in remote places which are difficult to reach, or where there are no physical lines, and communication is impossible, this can be done by wireless or cell system, using frequencies and operating in the ranges authorized by regulating agencies in the telecommunications industry. This technology is currently a safe, reliable, adequate solution for data communication. It is known that most wind turbine equipment is installed at sites where a cable transmission system would be very difficult, due to the need for authorizations to pass them through, implementation and maintenance costs, and others.

As to the model of impact of prices per solution, the most crucial aspect is the monthly fixed cost of the connection. Even if some providers offer a solution with a composition of fixed and variable costs, a simplified model is suggested at only a fixed cost per point connected. This suggestion is due to the tendency of data transmissions to be predictable and sporadic, so that simplified price models have been more widely accepted in the market. There are exceptions, as in applications where there is greater complexity and a larger volume of information exchanged. In such cases, the fixed variable model still makes more sense.

The benefits provided by most remote monitoring projects on the market are clear and significant. However, because of the current price of solutions the cost/benefit ratio for most sectors is not feasible. But it should be emphasized that, depending on the industry, the cost/benefit ratio may vary according to the number of points connected. In other words, it is essential to analyze each industry individually. Thus, the companies that manage to diminish the cost of applications and terminals will be able to encourage the adoption of the solutions and increase their participation in the market.

1. REFERENCES


Juarez Bento da Silva. Graduated in Business Administration from Pontificia Universidade Catolica do Rio Grande do Sul (1991), specialization in Networks and Telecommunications from the University of Southern Santa Catarina (1999), Masters in Computer Science from Universidade Federal de Santa Catarina (2002), Ph.D. in Engineering and Knowledge Management from Universidade Federal de Santa Catarina (2007). He is currently a professor researcher at the Universidade Federal de Santa Catarina (UFSC) develops research projects and coordinates the Laboratory of Remote Experimentation (RExLab) and the draft Recycling Computers UFSC. He has experience in Computer Science with emphasis in Computer Systems acting on the following topics: Embedded Systems, digital systems, Remote Experimentation, Accessibility and Technology, Computer Systems and Digital Inclusion. It is also reviewer of the journal IEEE Transactions on Learning Technologies - TLT and Journal of Healthcare Engineering and so far had 21 publications in journals and scientific events.

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