Design and Implementation of a System for Monitoring and Remote Control of a Greenhouse Climate Parameters

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***Abstract*—This paper explains the design and implementation of electronic system based on GSM (Global System for Mobile communication) for controlling the climate parameters by SMS (Short message Service) in greenhouse. The main purpose of this system conception is the remote control of the climatic parameters that influences the production in greenhouse (Temperature, relative humidity of air and soil moisture). Several sensors and actuators are installed and connected to a management and acquisition card. These sensors provide relevant information that are used to control ventilation, heating and pump by SMS. The procedure used in our system provides the owner with a remote control avoiding the need to perform the control actions on site. The developed system in this paper is ideally suited for agricultural greenhouses in Morocco. It is simple to be installed and easy to use by farmers who do not have knowledge in computer skills. Besides, most people use their cell phones to communicate and send messages. Thus, in our system, with a simple message, all farmers can control their greenhouses from a distance. They can know the status of their greenhouse climate at any time (temperature, humidity...) and can control actuators to adjust these parameters (fan, heater, vent, drip irrigation...). Thus, we have developed a supervision interface using visual basic integrating algorithms dedicated to analogue controls.**

***Index Terms*—Remote control, greenhouse climate control, microcontroller, GSM**

I. Introduction

Greenhouse Automatic control is necessary for properly growing plants, in a controlled manner. This paper mainly reviews the present Greenhouse Monitoring and control systems by GSM [1] and [2]. It suggests a generic architecture which can be applied for many other automation applications. It also suggests the usage of an intelligence system which integrates analog and digital peripherals. The kit senses the climate parameter of the greenhouse and checks it with the defined limit, so if the settings are not in the range, the actuator will analogically correct them. By sending an SMS with an order, this system allows the user to receive a report message that informs him about the recent state of the system, as well as, read the state of the system (temperature, humidity, CO_2) with opening roof and irrigation of the soil with a defined percentage.

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II. Description of the System

A. Schematic of the System

The Fig. 1, illustrate the descriptive schema of the developed system:

Figure 1. Descriptive diagramof the system

Our system consists on an acquisition card based on a PIC 18F4550 microcontroller connected to the PC via USB. And a management interface developed in Visual basic algorithms dedicated to integrating analog controls (when opening / closing roof or irrigation control valve analog by an analog control signal (4-20 mA)) [3].

The implementation of such a strategy must take into account the economics of water, nutrients and power while enabling farmers to increase their production both in quality and quantity.

B. Description of System

The developed system is composed of:

- A mobile phone
- Another mobile to order and read the state of the system.
- A computer with a USB port.
- An electronic card for the control and data acquisition based on a microcontroller (PIC 18F4550).

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- Sensor:
  Temperature (LM 35).
  Humidity (capacitive sensor) for irrigation.
  Light (LDR).
- Actuator:
  A fan
  A heater
  A modulating valve analog control
  An opening roof
- Partsy software
  MicroC To program the microcontroller
  Proteuse Isis to simulate the application
  Visual Basic (VB6) to develop a setup that can install it in any computer to control and monitor the system status.

III. Description the Principle of Control

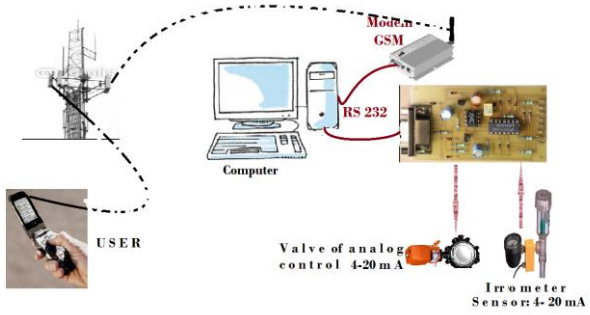

Figure 2. Principle of control

The Fig. illustrates the principle of control

A. The Operation Principle

Reading probes are generally transmitted as a signal 0-5VDC, 0-10 VDC or 4-20 milliamps (mA). To control equipment, two modes are used in greenhouses: Either digital mode (voltage type "on/off") subject to Article [4] or the analog (4-20 mA current type, for example).The control mode of a device is directly connected to its design as well as its mechanical interface permitting current (v) or variations amperage (mA) of current to perform desired control equipment;

B. The Operation

Through AT commands all GSM service can be controlled. Every new message received from the user side, is checked through the shipped number if it is an allowed number or not. If it is, then after about 20 seconds the red rectangle starts flashing five times to inform us that there is a new received message, otherwise the message will be automatically rejected.

Through AT commands can control all GSM service [5]. Each received a new message from the user side, we check if from shipper number allowed, if yes, then after about 20 seconds the red rectangle starts flashing five times to inform us that there is a new received message, otherwise the message will be automatically rejected.

After reading the received message from the authorized shipper number, it will be broken down as follows: the contents of the message, the sender number and the date and time of receipt, everything will be stored in a data base, and as a result will be displayed separately.

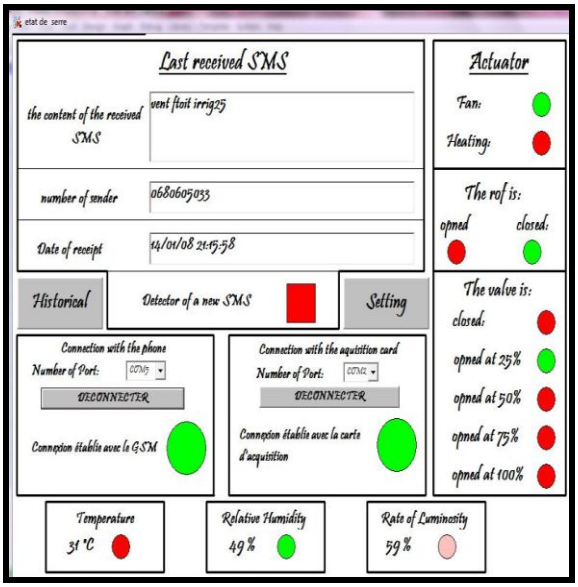

Figure 3. The interface of supervision

Fig. 3, illustrated the interface of supervision developed under Visual Basic, the user can locally control the climate plants in a very friendly manner where details are presented in a dynamic graphical interface as it can display the message history sent / received and possibly previous sensor measurements using the history button.

The essential functionality of the control system achieved allows performing the following functions:

- Greenhouse climate management by performing three basic operations:
  Acquisition of various climate parameters; Data processing;
  Control actuators.
- Irrigation management (manual and automatic);
- Real time monitoring of the evolution of the parameters;
- Data storage.
- Adjusting the set points of climate parameters,
- Configuring connections
- The choice of control mode (manual or automatic).
- The display of error messages,

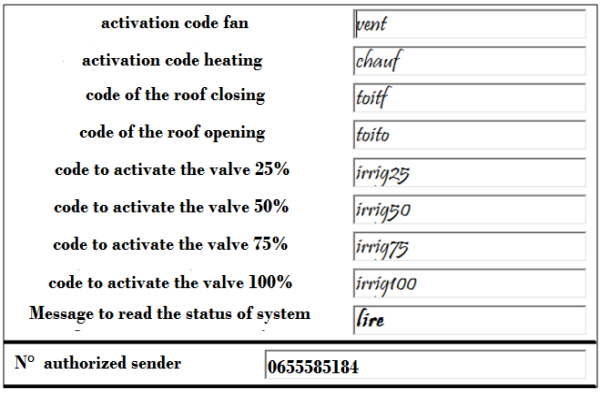

Figure 4. Interface configuration

From this interface the user can manually set the codes and the actions of commands (number of authorized consignor, code to open the valve to a defined percentage, monitored in real time the physical parameters of the system ...)to control the system.

Fig. 4 shows the interface that will appear when you press the button of historical settings.

Fig. 5, shows the interface that will appear when you press the button of historical command, this button can help the user to view the history of sent messages and possibly past sensor readings.

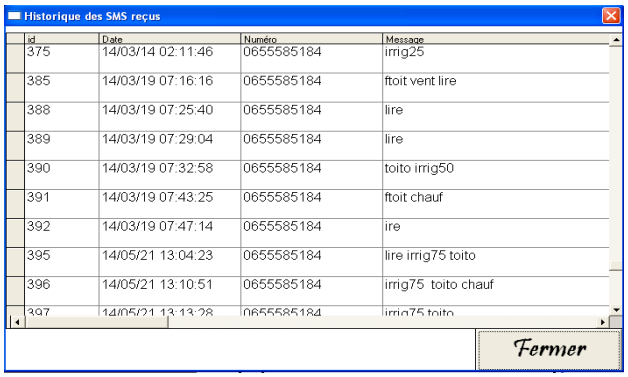

Figure 5. Interface of historical command SMS

On our application we used four digital outputs for controlling the modulating valve (analog control), then there is possibility of going from 0000 to 1111 in binary (16 levels). The following table shows the manner used to control the valve.

TABLE I. SMS CODE FOR CONTROLLING THE VALVE

Code SMS	Binary Signification	Correspondence decimal	Valve Status
Irrig0	0000	0	Close
Irrig25	0100	4	Open 25%
Irrig50	1000	8	Open 50%
Irrig75	1100	12	Open 75%
Irrig100	1111	15	open 100%

IV. CONCLUSION

This card based microcontroller PIC18F4550 with our management interface developed in Visual Basic is designed for controlling and monitoring any remote equipment in an greenhouse by a simple SMS from anywhere in the world via the GSM network. The developed system can be a very profitable investment because it will make possible to optimize the usage of greenhouse resources. The GSM network operating in the design of this system has allowed us to make our greenhouse more autonomous and, thus, to adapt it to the constraints and Moroccan socio-economical realities that do not necessarily match the technological and economic development of Western countries that are real consumer societies. Our work has consisted mainly of optimizing simple ways (using SMS) to realize real tools for remote monitoring of climate parameters and of drip irrigation in greenhouses in Morocco by strengthening the capacity and coverage action of farmers who are often uneducated. Using this system and with a simple SMS, we can start and stop different actuators as well as know the climate under greenhouse via the GSM network from anywhere.

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