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Study and Deployment of an Automatic Water Consumption Recording System in The Democratic Republic of Congo/Kananga

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Abstract: *This article aims to present the different steps required to deploy and configure the proposed solution to monitor and control water consumption in the city of Kananga.Based on the analysis of needs and the constraints of mutual control of water consumption, we will discuss the configuration of the Arduino card and the mechanisms for transmitting data by SMS that we will use to allow REGIDESO subscribers to receive information on their water consumption.*
Keywords: study, Arduino, consumption, water, automatic

INTRODUCTION

This scientific production addresses the issue relating to water management. This problem is acute in the town of Kananga. Water is life, they say. This is why we want the residents of the town of Kananga to be served at the appropriate time and that the bill they pay does not reflect actual consumption.

With this in mind, we are carrying out the study and deployment of an automatic water consumption reading system. Thanks to this device, the company that supplies water and the inhabitants of the town of Kananga will have effective solutions to monitor and control the use of this vital commodity.

Often, people complain that pricing is flat rate. It uses little water and pays a lot of money. For its part, the REGIDESO company complains that the population is wasting water and does not want to pay their bills. Which makes, we believe, water supply a real difficulty in a city as important as that of Kananga. The only aspect of the question that we are addressing is, as we mentioned above, the deployment of an automatic water consumption device.

It is important to emphasize that this device offers many advantages. The automatic counter, because this is the device that it is, allows the transmission of data by SMS with emphasis on its potential benefits and the steps necessary to implement this solution.

Related work:

Much other scientific work has been carried out in this area. We quote :

1) Miss INGUEL MALHA from Mouloud Mammeri University. His DEA dissertation is entitled: "Design and creation of a GSM home automation system". In this work, she develops the possibility of monitoring and controlling systems remotely using the GSM network.
2) BEIDI ADAMA Alain, from the Ecole Normale Supérieure d'Enseignement Technique d'EBOLOWA. His DEA dissertation subject is: "Design and production of an intelligent water meter in Prepaid mode". In his Memoir, he makes an assessment of the drinking water supply in Cameroon. He then proposes improving this service with a smart meter. Our distinction lies at the level where we make it easier for the consumer. Instead of purchasing water in advance, he easily manages his consumption by receiving consumption alerts in real time.
3) Hélène OMOY KOMBE, from the Institut Supérieur Polytechnique Informatique, is writing her DEA dissertation on "The Design and Creation of the Remote Control of a Smart Home Using Arduino". In her Memory, she fights against the abusive consumption of electrical energy. On our part, we want rational water management.

In our humble opinion, we believe that we have provided a solution to the problem of drinking water supply in the town of Kananga. This study was carried out at REGIDESO/KANANGA and its effects are lasting.

Apart from the summary, the introduction and the conclusion, our study is subdivided into eight main parts:

The first part concerns the analysis of the needs and constraints of mutual control of water consumption.

The second part concerns the choice of the solution based on the implementation of the Arduino board.

The third part concerns the configuration of the Arduino board for controlling the water meter;

The fifth part concerns the deployment of the solution in the town of Kananga;

The sixth part concerns the data transmission mechanism by SMS;

The seventh part concerns the configuration and installation of the Arduino board on the water meter;

And the last will address the testing and validation of the implemented solution.

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RESEARCH METHODOLOGY

We conducted our study using the following approach:

a) **Needs analysis:** Understand project requirements, user needs and technical constraints.
b) **Design:** Design the software architecture, user interfaces and databases.
c) **Testing:** Verify that the software functions correctly and meets specifications.
d) **Integration:** Integrate the different modules of the software to form a complete application.
e) **Deployment:** Put the software into production in the target environment.

ANALYSIS OF THE NEEDS AND CONSTRAINTS OF MUTUAL CONTROL OF WATER CONSUMPTION

Needs and constraints analysis consists of identifying and understanding the requirements as well as the limitations of a system-solution during its implementation. This Identification involves the collection and analysis of the needs of users and stakeholders involved, which makes it possible to understand the technical, financial, regulatory and other constraints that may influence the design and implementation of the system-solution. The objective of this analysis is to ensure that the system-solution will meet the specific needs of users while respecting the constraints and requirements of the context in which it will be deployed.

This solution includes the following elements:

Functional needs:

- Collection of water consumption data from the REGIDESO meter in Kananga.
- Periodic sending of water consumption statements to billing and regular users.
- Sending alerts if predefined consumption thresholds are exceeded.
- Receiving complaints or inquiries from users.

Operational needs:

- Availability of an SMS sending and receiving network for data transmission.
- Capacity for storing water consumption readings in the Arduino board.
- Capacity for processing data collected on the Arduino board.
- Secure access and authorization for programming and configuring the Arduino board.

Technical constraints:

- Compatibility and interoperability of the Arduino card with the Kananga REGIDESO meter.
- Availability of a stable and regular power supply for the meters and the Arduino board.

- ❖ SMS transmission capability to send consumption reports and receive user requests.
- ❖ Ability to store and process data on the Arduino board.

Organizational and regulatory constraints:

- ❖ Compliance with rules and regulations regarding the protection of personal data when collecting and transmitting water consumption data.
- ❖ Collaboration and coordination with REGIDESO officials to ensure the feasibility and acceptability of the proposed solution.
- ❖ Raising awareness and training users in the use of the mutual water consumption control system.

The analysis of the needs and constraints of mutual control of water consumption as part of this solution will therefore highlight the functional, operational, technical and organizational requirements that the system must meet to ensure successful implementation of the water consumption system. mutual control of water consumption.

CHOICE OF THE SOLUTION BASED ON THE IMPLEMENTATION OF THE ARDUINO BOARD

Choosing the solution requires an in-depth analysis of the needs, technical constraints, available resources, advantages and disadvantages of the different options. This analysis also involves comparing different solutions, consulting experts or carrying out tests and prototypes, especially since “the Arduino implementation offers a wide range of pre-existing libraries, making the programming of projects even easier and fast ". (Michael McRoberts, Beginning Arduino, 2007. p. 43.)

The solution based on the implementation of the Arduino card is therefore a suitable option for the mutual control of water consumption within the Kananga Water Distribution Authority.

To implement this system, it would be necessary to set up a device consisting of a meter equipped with a flow meter, a GSM module and an Arduino card to connect to the water distribution network. This device will be used to measure and record customers' water consumption accurately and regularly.

Once the data has been collected, the GSM module can transmit it by SMS. This transmission would enable easy and quick communication with customers regarding their water consumption levels, billings, leak alerts and other relevant information.

The use of SMS as a means of communication is very popular in the DRC. And most REGIDESO users have mobile phones. By sending information via SMS, it is possible to reach a large number of customers without requiring a permanent Internet connection.

By using the Arduino card to connect the REGIDESO Kananga customer meters, and transmitting the data by SMS, this solution would therefore offer an efficient and practical

method for mutual monitoring of water consumption. It would allow customers to be informed in real time of their consumption levels and facilitate communication between REGIDESO and its customers.

SETTING UP THE ARDUINO BOARD FOR WATER METER CONTROL

Configuring the Arduino board allows the Arduino software to correctly compile and upload the code to the board, ensuring that the correct settings are used for proper communication between the computer and the Arduino board.

In the context of our study, we adopted the following configuration for the Arduino card:

- Board type: Arduino UNO or Arduino Mega (depending on number of connections and I/O requirements)
- Communication port: Using the Serial port for SMS communication
- Communication speed: 9600 baud (or other, depending on the GSM module used for SMS communication)
- Processor type: ATMega328P (for Arduino UNO) or ATMega2560 (for Arduino Mega)
- Other parameters specific to the GSM module used: for example, configuration of the GSM module for communication with SMS (type of SIM card, telephone numbers to use)

Figure 1:Source : https://www.arrow.com/fr-fr/research-and-events/articles/arduino-uno-vs-mega-vs-micro

DEPLOYMENT OF THE SOLUTION IN THE CITY OF KANANGA

Deployment of Arduino board setup for water meter control in Kananga town is of utmost importance.

The implementation of the Arduino card will make it possible to connect the customer meters of the REGIDESO of Kananga, in central Kasai in the DRC, in an efficient and innovative manner. Using this solution, water consumption data can be transmitted via SMS, providing an agile and convenient method of mutual monitoring.

Furthermore, the implementation of this solution has numerous advantages. First of all, it will make it possible to collect water meter readings in real time, thus facilitating the monitoring and management of consumption. Users will be able to regularly receive SMS messages containing information on their water consumption, thus helping them to better manage their expenses and become aware of their consumption.

On the one hand, this solution will help reduce errors and fraud linked to the manual manipulation of meter readings. Automating the process will ensure data accuracy, minimizing the risk of error and improving the integrity of the information collected.

On the other hand, its deployment will promote more rational and responsible use of drinking water. Thanks to the availability of information in real time, users will be encouraged to adopt eco-responsible consumption practices, which will contribute to significant water savings in the city of Kananga.

All in all, its implementation will improve the operational efficiency of REGIDESO. Automated meter readings and data transmission via SMS will reduce costs and time spent on manual tasks associated with collecting readings, enabling better use of the company's human and financial resources.

DATA TRANSMISSION MECHANISMS BY SMS

For the deployment of the Arduino board configuration for water meter control in the town of Kananga, we offer these data transmission mechanisms via SMS:

- GSM Modem: Use a GSM modem connected to the Arduino board to send and receive SMS. The GSM modem must be compatible with the mobile communication networks available in the city of Kananga.
- SMS Protocol: Program the Arduino board to use the SMS protocol to transmit data. The send data can be formatted into SMS messages and sent to the appropriate phone numbers. Received SMS messages can also be analyzed by the Arduino board to retrieve the necessary commands or information.
- SIM card: Insert a SIM card into the GSM modem to enable communication via the mobile network. The SIM card must be activated and configured with a data plan and a phone number for sending and receiving SMS messages.
- Arduino Programming: Use the Arduino programming language to write the code needed to transmit data via SMS. The code should include instructions to initialize the GSM modem, connect to the mobile network, send SMS with the appropriate data and receive SMS to perform the necessary actions.

- ❖ Integration with the REGIDESO system: Ensure the integration of the system based on the Arduino card with the existing REGIDESO system. This requires close collaboration with REGIDESO-Kananga technical teams to ensure that data is correctly transmitted and used in their system.
- ❖ Integrate a power supply device into the purchase of the electric meter to compensate for the lack of electricity in the town of Kananga. So a 30w solar panel and a 20A lithium battery to operate the card and the meter.

CONFIGURATION AND INSTALLATION OF THE ARDUINO BOARD ON THE WATER METER

The configuration and installation of the Arduino board for controlling the water meter in the town of Kananga is carried out by following the following steps:

Necessary material :

- An Arduino card (preferably a model compatible with GSM/GPRS modules for sending SMS).
- A GSM/GPRS module for SMS communication.
- Connection wires.
- A compatible water meter that can be connected to the Arduino board.

Installing Arduino software:

- Download and install the Arduino IDE software from the official Arduino website (https://www.arduino.cc/en/Main/Software).
- Connect the Arduino board to your computer using a USB cable.

GSM/GPRS module configuration:

- Check if the GSM/GPRS module is compatible with the Arduino board used. If necessary, consult the module documentation for specific instructions.
- Connect the GSM/GPRS module to the Arduino board using jumper wires. Make sure to connect the RX and TX pins correctly between the two modules.
- Power the GSM/GPRS module following the manufacturer's recommendations.

Programming the Arduino board:

- Launch the Arduino IDE software on your computer.
- Set the communication parameters of the GSM/GPRS module in Arduino code. This may include initializing the module, assigning the correct pins, setting the phone numbers to send the SMS to.

- Write Arduino code to read water meter data, store or process it as needed, and then send it via SMS to relevant users.
- Upload the code to the Arduino board by pressing the "Upload" button in the Arduino IDE.

Water meter connection:

- Identify the appropriate pins on the Arduino board to connect to the water meter. This may vary depending on the specifications of the water meter and the Arduino board used.
- Use jumper wires to connect the water meter pins to the corresponding pins on the Arduino board.

System test:

- Make sure all connections are correct.
- Power on the Arduino board and the GSM/GPRS module.
- Check if the system is working by sending SMS messages from the Arduino board with water meter data to the affected users.

All these steps completed, the system is ready to transmit the water meter data by SMS to the concerned REGIDESO users. It is therefore operational.

TESTING AND VALIDATION OF THE IMPLEMENTED SOLUTION

To test and validate the solution implemented during the configuration and installation of the Arduino board on the water meter, the following steps were followed:

1. Hardware check: Make sure the Arduino board is correctly connected to the water meter and any other necessary components, such as a GSM module for sending SMS. Also check the electrical connections to ensure they are correct.
2. Configuring the Arduino Board: Make sure the Arduino board is properly programmed with the necessary instructions to collect water meter data and transmit it via SMS. Also check that the SMS communication settings are configured correctly.
3. Data collection test: Perform a test using a REGIDESO customer account. Check if the Arduino board is able to collect water consumption data from the meter and store it properly.
4. SMS Sending Test: Make sure the Arduino board is capable of sending the collected data via SMS. Check if the recipient receives the SMS with the correct data.
5. Checking Data Accuracy: Compare the data collected by the Arduino board with the manual water meter readings to check their accuracy. Perform several tests to ensure the consistency of the data collected.

6. Verifying system reliability: Perform testing over a longer period of time to verify system stability and reliability. Make sure the Arduino board is working properly and that data is transmitted smoothly and reliably.
7. Validation on several customer meters: Deploy the configuration of the Arduino card on several REGIDESO customer meters in the city of Kananga. Perform testing on each meter to ensure the solution works properly and reliably at scale.
8. Supervision and maintenance: Set up a supervision system to continuously monitor the operation of the system. Also have a maintenance plan to resolve any technical issues that may arise.

By following these steps, we tested and validated the implemented solution for water meter control using the Arduino board in Kananga city.

CONCLUSION

The deployment and configuration study of the proposed solution for the mutual control of water consumption through the use of the Arduino card made it possible to analyze the needs and constraints of the mutual control of water consumption. It also made it possible to choose the solution based on the implementation of the Arduino card, to configure the Arduino card for controlling the water meter, to deploy the solution in the town of Kananga, to set up the transmission mechanisms data by SMS, configure and install the Arduino card on the water meters, as well as test and validate the implemented solution.

It proved possible to effectively connect the customer meters of the water distribution authority (REGIDESO) of the town of Kananga to central Kasai. The collected data is transmitted via SMS, providing a simple and convenient method to track and control water consumption. This solution will allow REGIDESO to better manage water resources, improve billing and detect possible leaks or abuse of consumption.

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