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# Remote Control and Monitoring System for rural Pump stations using PLC

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## Article Informations

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## ABSTRACT

Several water systems are mechanized to minimize human labor, optimize water utilization, and mitigate water wastage. The researchers suggested implementing remote administration and control for an automated water system. On a remote agricultural property, a pump will utilize a well to replenish a water tank with water. Because of the expensive nature of wired control, it is necessary to activate and deactivate this pump using wireless means in accordance with the water tank's filling level. The system's operator needs have constant access to a cell phone in order to monitor the water level in the tank. In order to accomplish the aforementioned objectives, this article utilizes a LOGO!® Programmable Logic Controller (PLC) and a LOGO!® Communication Module Radio (CMR) manufactured by SIEMENS. SIEMENS utilizes SoftComfort V8.3 as the software for programming and controlling the system.

## Introduction

Modern technology makes remote control and monitoring systems increasingly popular. Success depends largely on mission ease and cost. Remote areas have enormous prices, thus the only realistic answer is the mobile network. Use of existing cellular networks to manage and monitor devices via text message is the simplest and most costly method, compared to utilizing a smartphone or the internet [1]. In figure (1), the suggested system to be modified has these components:

i. The water level in an irrigation tank is monitored by four float devices (S1-S4).
ii. A good region that is considered a water source.
iii. A pump provides water to the tank via conduits, controlled by 4 sensors on the tank.
iv. D1=The distance between the tank and the hole horizontally.
v.D2=The distance from the base of the tank to the level of the well.

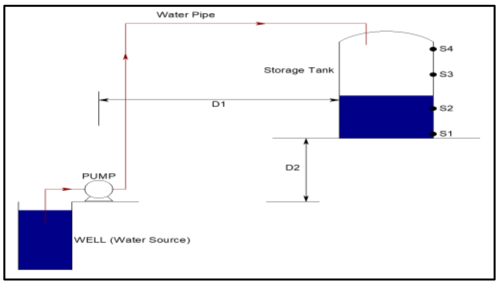


**Figure 1. The proposed system.**

## Hardware-Design

The computing hardware for this activity has three parts:

### 1. Sensory

Figure 2 shows that all sensors are a buoyant device linked to a traversing lever revolving with tank water volume. The sensors feature a permanent magnet on the end and a normally open (NO) reed valve in the front of figure 2(a). The lever rises with the water level until it's horizontal. As seen in figure 2(b), the permanent magnet deactivates the reed valve and the specifies this type of sensor [2]:

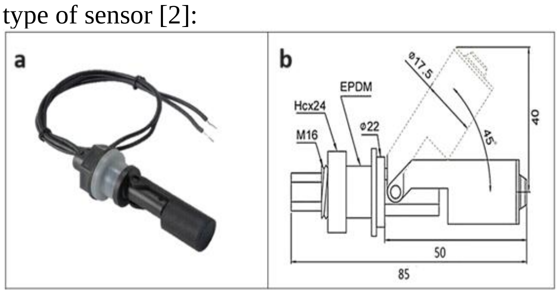


**Figure 2. (a) Floating Device. (b) Floating Sensor operations.[2]**

### 2. Pump

Pump ratings depend on D1&D2 [3].

### 3. Control & Communication

Figure 3 depicts the communication-control system components:

Section1. The two P.L.Cs, controllers, and C.M.Rs will communicate using their antennas. Section2. In stage(1), which is associated with the storage-tank, the P.L.C receives digital inputs from 4 sensors and outputs an indication light. Section3. The P.L.C's digital output contactor coil operates the pump at stage(2) and is connected to the well and pump. Section4. (P.L.C) & (C.M.R) link via Ethernet in. Section5. phone.

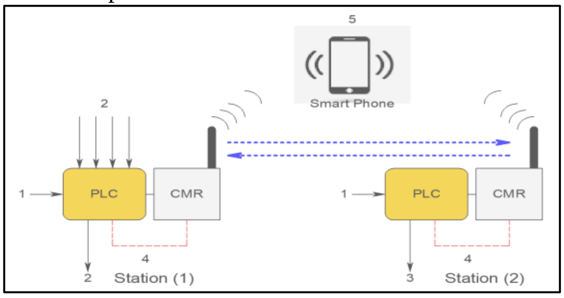


**Figure 3. Communication & Control System schematic.**

### 3.1 P.L.C controller

The P.L.CLOGOV8 controller was chosen for its simplicity, efficiency, and versatility [4]. FIGURE (4) shows this. Table 1 lists the Programmable Logic Controller (P.L.C) parameters used in this research [4]:

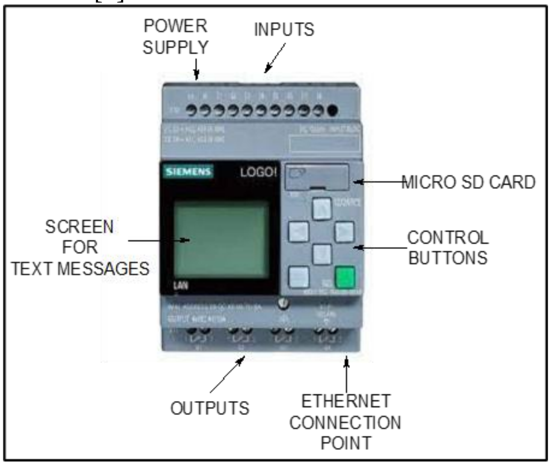


**Figure 4. P.L.C controller.[4]**

**Table 1. P.L.C-LOGO-V8 features [4].**

| Type | LOGO!-RCE 12/24 |
|---|---|
| Power Supply | 12/24 DC-voltage |
| Inputs | 8-Digital Inputs (I1-I8)<br>4-High Speed Digital Inputs (I3-I6)<br>4-Analog Inputs (I1-I2=AI3- |
| Outputs | 4-RelayOutputs (Q1-Q4)<br>EthernetAccessPoint |

*Source of this table from datasheet https://docs.rs-online.com/d0ed/A700000007202415.pdf

### 3.2 The 2020 LOGO-C.M.R

The LOGOC.M.R2020/2040 module connects LOGO8 to GSM/GPRS. LOGOC.M.R2020 and

P.L.CLOGOV8 constitute a cost-effective SMS-based communication system that handles remote areas in a specified GSM network. A GPS device may operate autonomously. Table 2 outlines and describes the C.M.R (Cognitive Mapping & Reasoning) used in this research [5].

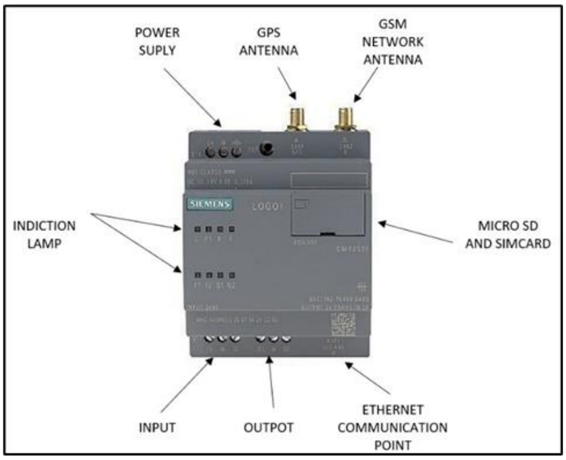


**Figure 5.LOGOC.M.R2020.**

**Table 2. LOGOC.M.R2020 features[5].**

| | |
|---|---|
| **Type** | LOGO!-CMR 2020 |
| **Power Supply** | 12/24DC-voltage |
| **Inputs** | 2Digital inputs (I1-I2) |
| **Outputs** | -2-Digital outputs (Q1-Q2)<br>-Ethernet Access Point (RJ-45)<br>-GSM, GPRS Networks<br>2G-Antenna MobileWirelessRod Omni-directional, SMA Connector, Weatherproof for indoors and outdoors<br>-GPS-Antenna, SMA Connector, Weatherproof for indoors and outdoors. |

*Source of this table from https://support.industry.siemens.com/cs/pd/478004?pdti=td&dl=en&lc=en-DE

## Software-Design

Two steps were used to describe the system's basic operations:

**1. Stage (1) Storage-Tank:**

Figure 6 shows a storage-tank with four floating sensors (S1 - S4) that monitor the water-level.

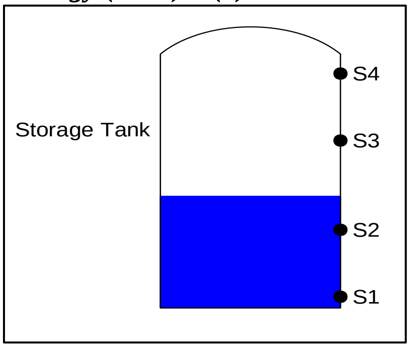


**Figure 6.Container for holding drugs and measuring instruments.**

Stage (1) sends to stage (2) an SMS [6] to request water, when S1 is Disabled (The reed valve has been activated) and level of water is low. Stage (2) receives SMS, engages the pump via its contactor, and pumps water to stage (1). If stage (2) does not acknowledge within a certain interval, stage (1) will send another SMS. If the second SMS is ignored, an alarm will sound and an SMS will be sent to the operator's phone to report a fault. Stage (1) sends stage (2) a text message to stop the pump when S4 turned on (The reed valve is closed), indicating a full storage-tank. SMS verifies receipt in Stage (2). Stage (1) will send another SMS if stage (2) does not acknowledge within a certain interval. If the second SMS is not answered, an alarm will be turned on and the operator phone will get an SMS to notify them of a problem, as seen in figure 7.

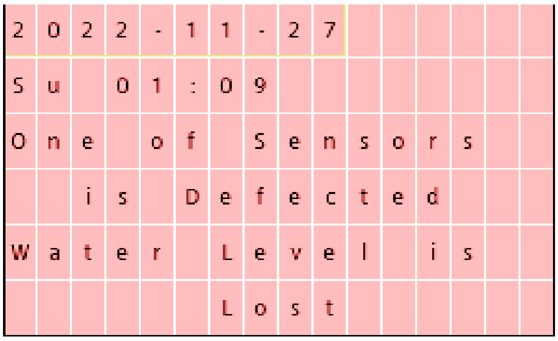


**Figure 7. Operator Alert from stage (1).**

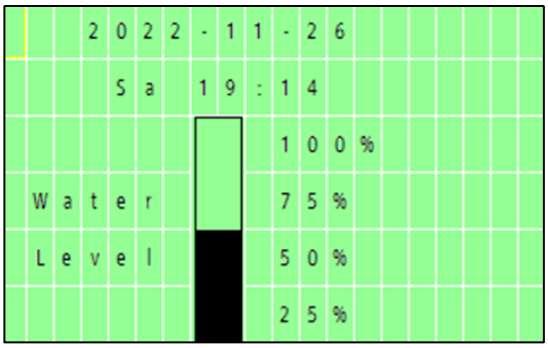


**Figure 8. Stage (1) sent the operator a message.**

A mobile phone SMS to stage (1) can tell the operator the storage-tank water level shows in Figure (8). Text message transmitted using SMS

[7]. Figure 9 shows the stage (1) programme flowchart. The programme will assess float valve sensors S1 and S4 using the flowchart in figure 9. If S1 is open, it will text stage 2 to trigger the pump and start a countdown. The timer is stopped and reset if stage (1) receives a conformation SMS from stage (2) During the designated timeframe, and the programme returns to original state. If stage (1) does not get a confirmation SMS from stage (2) inside the timer, the timer resets and stage (2) receives another SMS. If stage (2) does not acknowledge within the timer, a warning alert and SMS will be sent to the operator's phone. Unless stage (2) acknowledges within the specified time, the timer is paused, reset, and the programme resets. S4 closing repeats the same procedure, including sending an SMS to stage (2) to disable the pump.

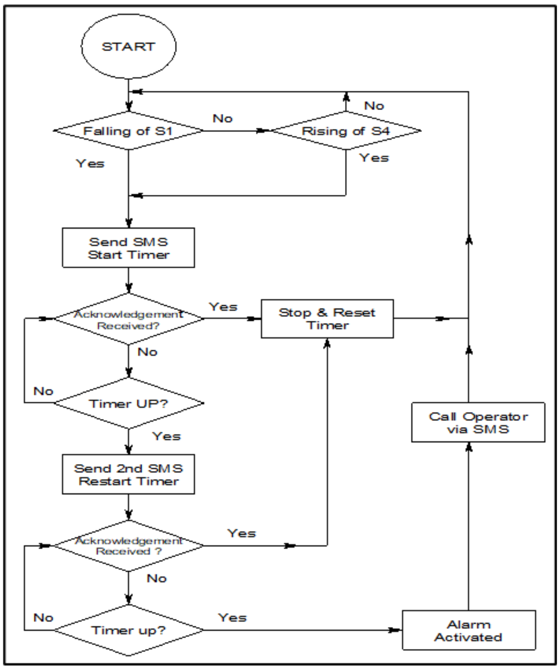


**Figure 9. Stage (1) flowchart.**

## 2. Stage (1) tank water-level measurement method

The tank has four float sensors to monitor water levels in five increments (0–4): empty, 25% capacity, 50% capacity, 75% capacity, and 100% capacity. The approach uses two identical analogue multiplexers and one adder. Figure (10 shows the basic schematic layout. The multiplexer circuit uses digital signals (0, 1) from the float sensors as selectors and integrates analogue data with the values (D1=0, D2=1, D3=3, D4=2). Figure (10) and table (3) illustrate that the two multiplexers' outputs are combined to produce the tank's water level [7] [8].

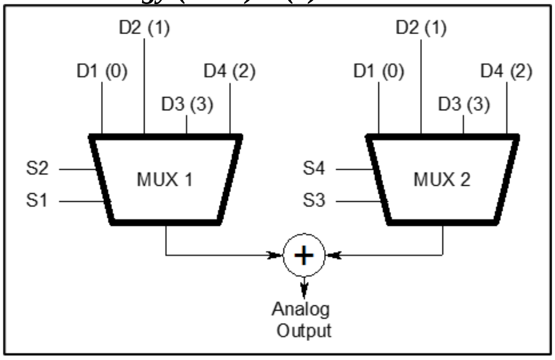


**Figure 10. MUX-circuit diagram.**

Figure (7) shows that P.L.C1 will display a warning message on its screen and send it to the operator's mobile device when the two multiplexers' analogue output value surpasses 4. that alerts the operator about malfunctioning sensors. A screen warning will appear if the float sensors do not match any of the combinations in table (4). If there is noerror, the mobile device will get the message, as indicated in figure (8), and P.L.C1 will display it.

**Table 3. Detecting water level.**

| S4 | S3 | S2 | S1 | MUX1 output | MUX2 output | Analog output | Tank Status |
|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | Empty “Pump ON” |
| 0 | 0 | 0 | 1 | 0 | 1 | 1 | 25% filled |
| 0 | 0 | 1 | 1 | 0 | 2 | 2 | 50% filled |
| 0 | 1 | 1 | 1 | 1 | 2 | 3 | 75% filled |
| 1 | 1 | 1 | 1 | 2 | 2 | 4 | full “Pump OFF” |

## 3. Stage (2) Pump controller

The machine receives stage commands via an analogue network input. Unit activities are flowcharted in Figure 11. Both programmable logic controllers' variable memory (VM) stores numerical codes for each comm&. Operators can request these comm&s via SMS. [7]. Logo! The C.M.R oversees this action and helps the two P.L.Cs communicate. Figure (12) shows the pump's power circuit architecture. Due to its simplicity, the authors suggested the Direct onLine starting approach for small induction motors, where pump size depends on D1, D2, and other factors. [3].[9].[10].

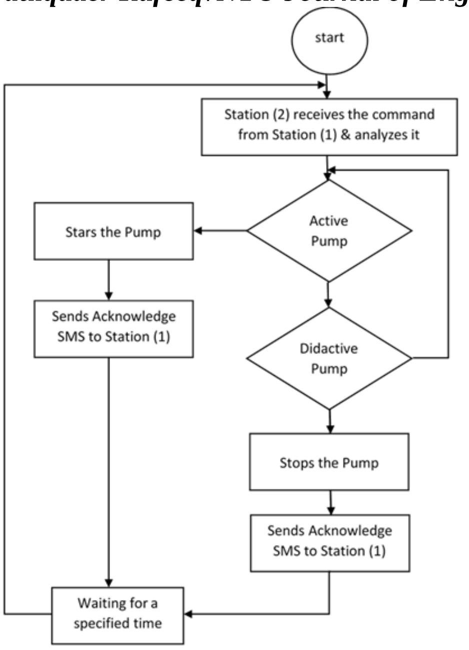


**Figure 11. Stage (2) flowchart.**

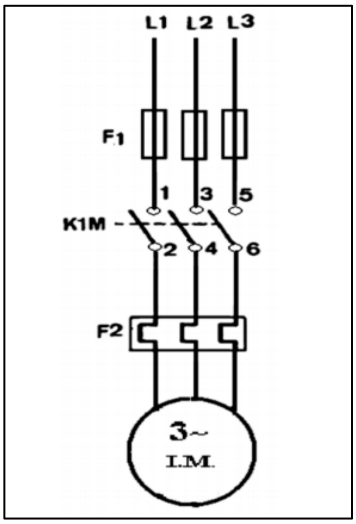


**Figure 12. Pump Power Circuit.**

## 4. Datalog

This study [11] used SIEMENS Soft Comfort V8.3's datalog method. The function stores data in the P.L.C internal EEPROM in this situation. The operator's PC and P.L.C micro-SD card may receive data [12]. The operator uses CSV to review data acquired over lengthy periods of time while monitoring [4] [13]. Figure (13). The datalog block is connected to stage (2) contactor digital output block and stage (1) P.L.C error digital output block (indication bulb).

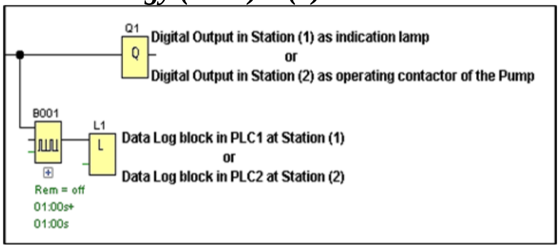


**Figure 13. Both P.L.C datalogs.**

## 5. Stage-1 indicator board

The local farmer uses this board to get accurate tank water level readings. The gadget displays tank water level with six LEDs. These LEDs show six states: 0%–100% and overflow. See Figure 14. If there is an overflow, the red LED should not be lit until stage (1) confirms that stage (2) has engaged the pump. Figure 15 shows the indicator board programming [14][15].

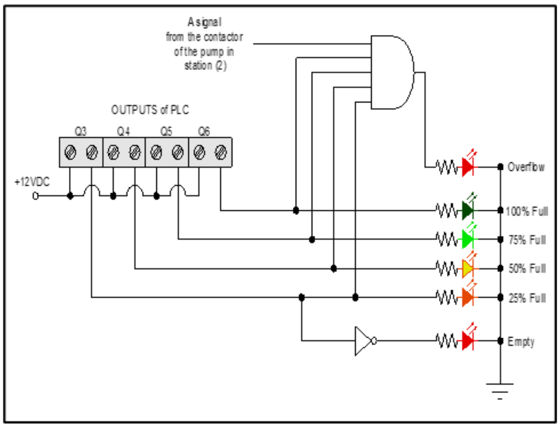


**Figure 14. Indication Board Circuit Diagram.**

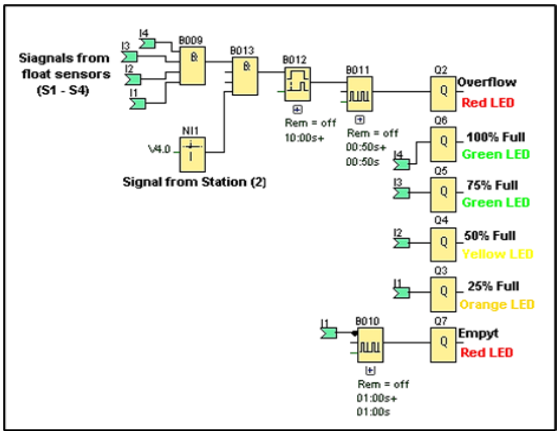


**Figure 15. Indicator board programme portion.**

## CONCLUSIONS

This study aims to create a remote water-carrying system that overcomes cost, flexibility, and usability. Our solution uses smartphones and mobile networks to allow users to easily monitor and control storage reservoir water levels and waterpump performance. This study detailed the design and modelling of a P.L.C-centered autonomous wireless control and monitoring system with cutting-edge sensors. Considering the study progress, we can safely list some main benefits of the technology provided in this article: Full automation, efficiency, ease of implementation, error prevention, and fingertip interactivity. This research aims to rethink water management by giving people remote control and monitoring power. Our system embodies efficiency, simplicity, and resilience, advancing sustainable water resource use. This study illuminates the road to intelligent, responsive, and user-centric water management technologies, leading to a more sustainable and interconnected future as we face the challenges of an evolving world. The most important limitation facing these types of systems is the connectivity issues in extremely remote areas where there is no communication network coverage. For future researches, the authors suggest the following ideas:

1- The implementation of solar system in supplying electrical power to system.

2- By combining and implementing the Global Positioning System (GPS) and geographic information systems (GIS), the users of these types of systems will get a high precision control and communication in rural and remote areas.

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