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Literature Survey of Water Control System by P.L.C. Control and Its Cost Analysis

Reshmi Banerjee

Assistant Professor, Department of EE, Guru Nanak Institute of Technology, Panihati, Kolkata, W.B., India.

ABSTRACT: On the basis of the constant-pressure principle and variable-frequency principle applied to traditional water supply system, this paper presented the operation performed in an Amusement Park. These are logically designed using PLC (Programmable Logic Controller) as main controller. The logic used is ladder logic. The amusement park water ride is associated with a tank of water and splash a tour group. In this process there is no need of labour so there is no human error. Without human error, the quality of product is better and the cost of production would definitely decrease with no error in quantity required. Water level sensing can be implemented in industrial plants, commercial use and even at home.

KEYWORDS: Detector, Ladder logic, Limit switch, PLC, Sensor, Water control system.

I. INTRODUCTION

Available water on the earth is being less and less, while peoples demand of water supply is increasingly rising. As a result, water supply has drawn many experts and scholars' attention in recent years.
Drinking water supply in India continue to be inadequate, despite longstanding efforts by the various levels of government and communities at improving coverage. The share of Indians with access to improved sources of water has increased significantly from 72 % in 1990 to 88 % in 2008.

A PLC is a digital computer used to automate electromechanical processes. It is used to automate respective processes. PLCs are used in many industries and machines. PLCs are designed for multiple analogue and digital inputs and output arrangements, extended temperature ranges, immunity to electrical noise, and resistance to vibration and impact. A PLC is an example of a "hard" real-time system since output results must be produced in response to input conditions within a limited time, otherwise unintended operation will result.
Early PLCs were designed to replace relay logic systems. These PLCs were programmed in "ladder logic", which strongly resembles a schematic diagram of relay logic. This program notation was chosen to reduce training demands for the existing technicians. Other early PLCs used a form of instruction list programming, based on a stack-based logic solver.

SCADA has traditionally meant a window into the process of a plant and/or a method of gathering of data from devices in the field. Today, the focus is on integrating this process data into the actual business, and using it in real time. In addition to this, today's emphasis is on using Open Standards, such as communication protocols (eg IEC 60870, DNP3 and TCP/IP) and 'off-the-shelf' hardware and software, as well as focusing on keeping the costs down. PLCs continue to gain in popularity. In fact, many SCADA applications use PLCs as the RTU of choice, when communicating with field devices.
In electrical engineering a limit switch is a switch operated by the motion of a machine part or presence of an object. They are used for control of a machine, as safety interlocks, or to count objects passing a point.
A limit switch with a roller-lever operator; this is installed on a gate on a canal lock, and indicates the position of a gate to a control system.

Standardized limit switches are industrial control components manufactured with a variety of operator types, including lever, roller plunger, and whisker type. Limit switches may be directly mechanically operated by the motion of the operating lever. A reed switch may be used to indicate proximity of a magnet mounted on some moving part. The class

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of proximity switches operates by the disturbances of an electromagnetic field, by capacitance or by sensing a magnetic field.
Rarely, a final operating device will be directly controlled by the contacts of an industrial limit switch, but more typically the limit switch will be wired through a control relay, a motor contactor control circuit, or as an input to a programmable logic controller.

Miniature snap-action switch may be used for example as components of such devices as photocopies or computer printers, to ensure internal components are in the correct position for operation and to prevent operation when access doors are opened. A set of adjustable limit switches are installed on a Garage door opener to shut off the motor when the door has reached the fully raised or fully lowered position. A numerical control machine such as a lathe will have limit switches to identify maximum limits for machine parts or to provide a known reference point for incremental motions.
A sensor is a device to detect changes in the environment such as energy, heat, light, magnet, supersonic etc and convert them to electric signals.

Control Sensor: Control sensor as a control component is to capture correctly and speedy data of an environment where a machine is installed and data of products that are being processed, and then convert those data to controllable electric signals or information that human can easily confirm.
Ladder logic was originally a written method to document the design and construction of relay racks as used in manufacturing and process control. Each device in the relay rack would be represented by a symbol on the ladder diagram with connections between devices .
Ladder logic has evolved into a programming language that represents a program by a graphical diagram based on the circuit diagrams of relay logic hardware. Ladder logic is used to develop software for programmable logic controllers used in industrial control applications.

Windows XP Service Pack 3 (SP3) was released to manufacturing on April 21,2008, and to the public via both the Microsoft Download Center and Windows Update on May 6, 2008.
It began being automatically pushed out to Automatic Updates users on July 10, 2008. A feature set overview which details new features available separately as stand-alone updates to Windows XP, as well as back parted features from Windows Vista, has been posted by Microsoft. A total of 1,174 fixes have been included in SP3. Service Pack 3 can be installed on systems with Internet Explorer versions 6,7, or 8. Internet Explorer 7 and 8 are not included as part of SP3. Service Pack 3 is not available for the 64-bit version of Windows XP, which is based on Windows Server 2003 kernel.
Special features in Service Pack 3:

- NX APIs for application developers to enable Data Execution Prevention for their code, independent of system-wide compatibility enforcement settings.
- Turns black hole router detection on by default.
- Support for SHA-2 signatures in X.509 certificates.
- Network Access Protection client.
- Credential Security Support Provider.
- Descriptive Security options in Group Policy/Local Security Policy user interface.
- An updated version of the Microsoft Enhanced Cryptographic Provider Module (RSAENH) that is FIPS 140-2 certified.
- Installing without requiring a product key during setup for retail and OEM version

II.METHODOLOGY & SYSTEM MODEL

Water Control System:
Input: (i) Cart Detector, (ii) Full Level Sensor, (iii) Empty Level Sensor.
Output: (i) Idle Mode, (ii) Filling Valve, (iii) Outlet Valve, (iv) Water Jet.

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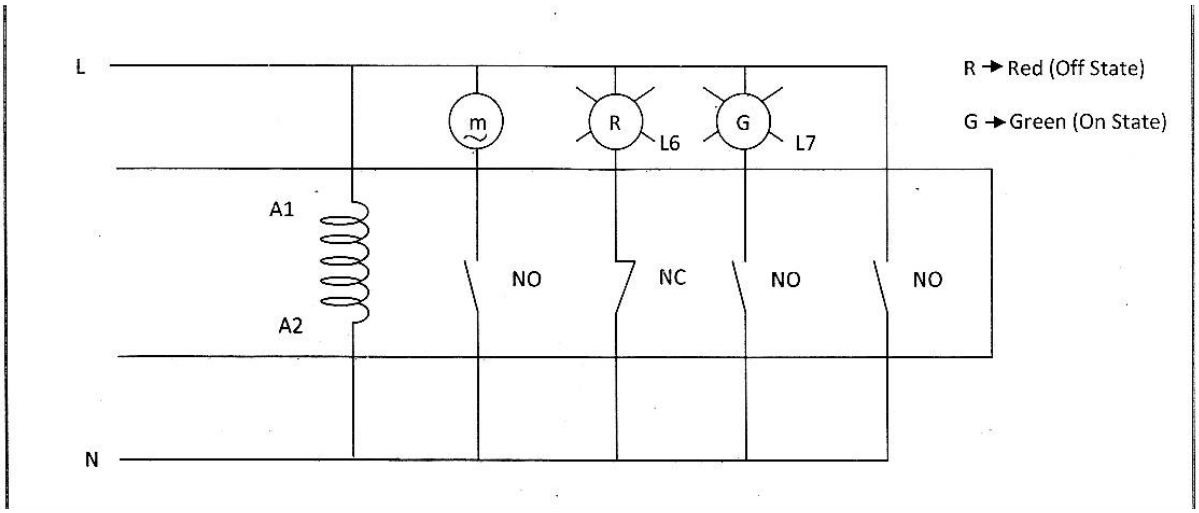

Fig. 1 : Water Jet A.C. Contact

- Step 1: The process starts in idle mode.
- Step 2: The cart detector limits the switch opens the filling valve.
- Step 3: After a delay of 30 seconds from the opening of the filling valve, the outlet valve opens.
- Step 4: When the tank is full (level full sensor: healthy) the filling valve closes.
- Step 5: When the tank is empty (level empty sensor: healthy) the outlet valve closes.
- Step 6: After a delay of 10 seconds from the opening of the outlet valve, water jet opens.
- Step 7: After a delay of 2 seconds the water jet closes and the process returns to the idle state.

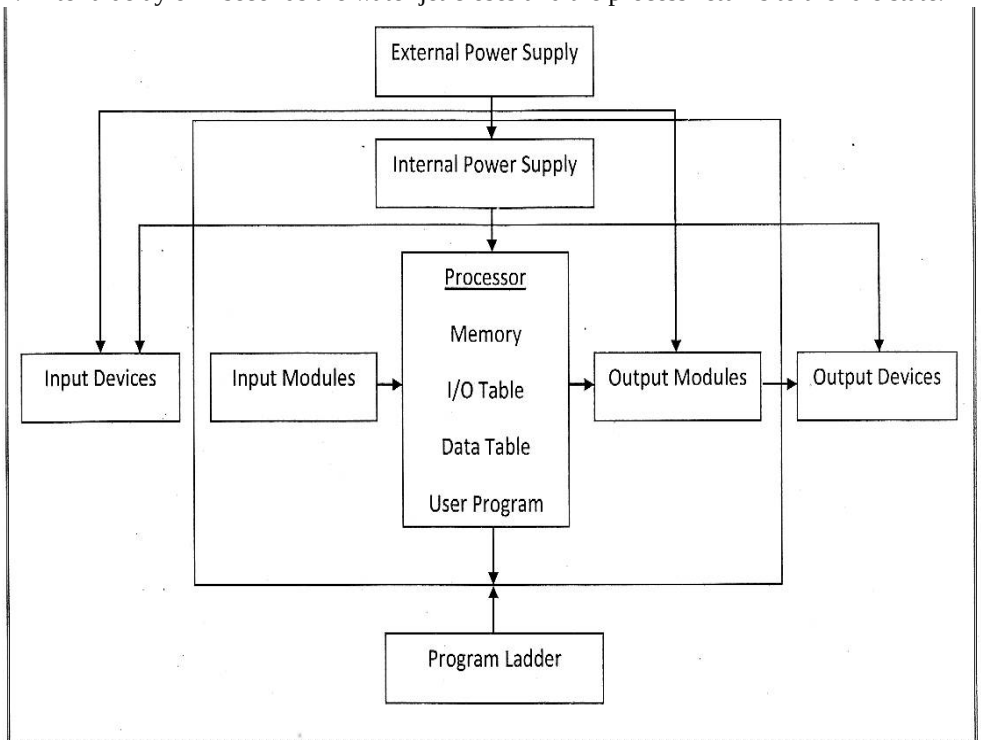

Fig. 2 : System Map

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- At first the system is in idle mode. So we use an output coil to shoe the idle mode (0:0.0/3).
- When we force on the cart detector, the idle mode is automatically force off and then we force off the cart detector. Due latching branch the whole rung will get signal although the cart detector is turn into force off condition. In ladder program we take an input of a no contact, named as cart detect (I:O.O/O). For latching circuit use an extra branch with a NO contact and address it with the memory bit address (B3:0/1).
- At the time when cart detector force on it will force on the filling valve. So filling level sensor senses the water level when the tank is full. Therefore filling valve will sense off. In case of input use a NC contact, named as level full (I:0.0/1). In ladder circuit we use extra memory bit (B3:0/1) instead of using extra output. Use an output coil and termed as filling valve (O:0.0/0).
- Again with the force on condition of cart detector a TON timer (T4:0) will start counting for 30 seconds. After 30 seconds the Done bit (T4:0/DN) will go high. Which helps the outlet valve in ON condition. Taking a coil, named as outlet valve (O:0.0/1).
- When outlet valve goes high, the empty level sensor sense the water level is empty, taking a NC contact termed as level empty (I:0.0/2). At glance the outlet valve will force off. So take an output coil, named as outlet valve (O:0.0/1).
- Again at the time outlet valve goes high, a TON timer (T4:1) will start counting for 10 seconds. After 10 seconds the Done bit (T4:1/DN) will go high. Which helps the water jet in ON condition. Taking a coil, named as water jet (O:0.0/2).
- On condition of water jet will again help to start a TON timer (T4:2) for 5 seconds. After that water jet will automatically force off.
- After forcing off condition of the water jet coil will remain the idle mode back in on condition. A protection would be taken that, when cart detector is in on condition the idle mode should not be forced on. So we use several NC contacts for several and certain input and memory bit.

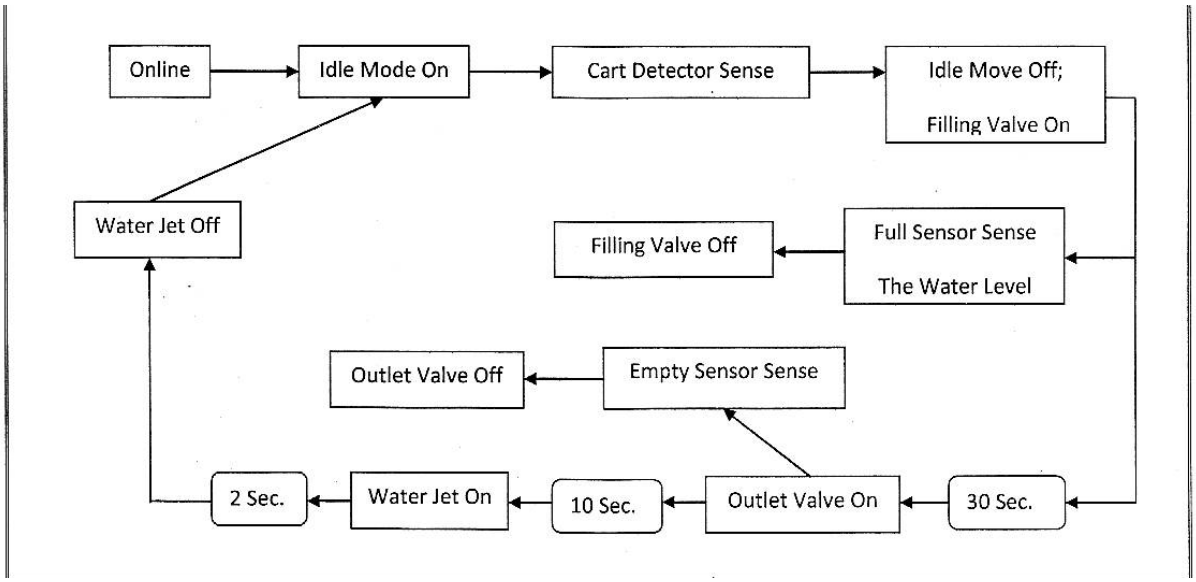

Fig. 3 : Process

Here the following software and hardware are used:
Software:
Operating System: Microsoft Windows XP Professional Version 2002 Service Pack 3
PLC Programming: RSLogix 500 English 7.00.00 (CPR 7)
SCADA Designing: RSView 32 Works 7.20.00 (CPR 7)
Emulator: RSLogix Emulate 500

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Communication Software: RSLinx Classic 2.51.00 (CPR 7)
Communication Protocol: DH-485; [DH-Data High Way]
Communication Driver (with PLC): AB_DF1-1
Communication Driver (without PLC): EMU-500
Others: Rockwell Automation USB CIP Driver Package

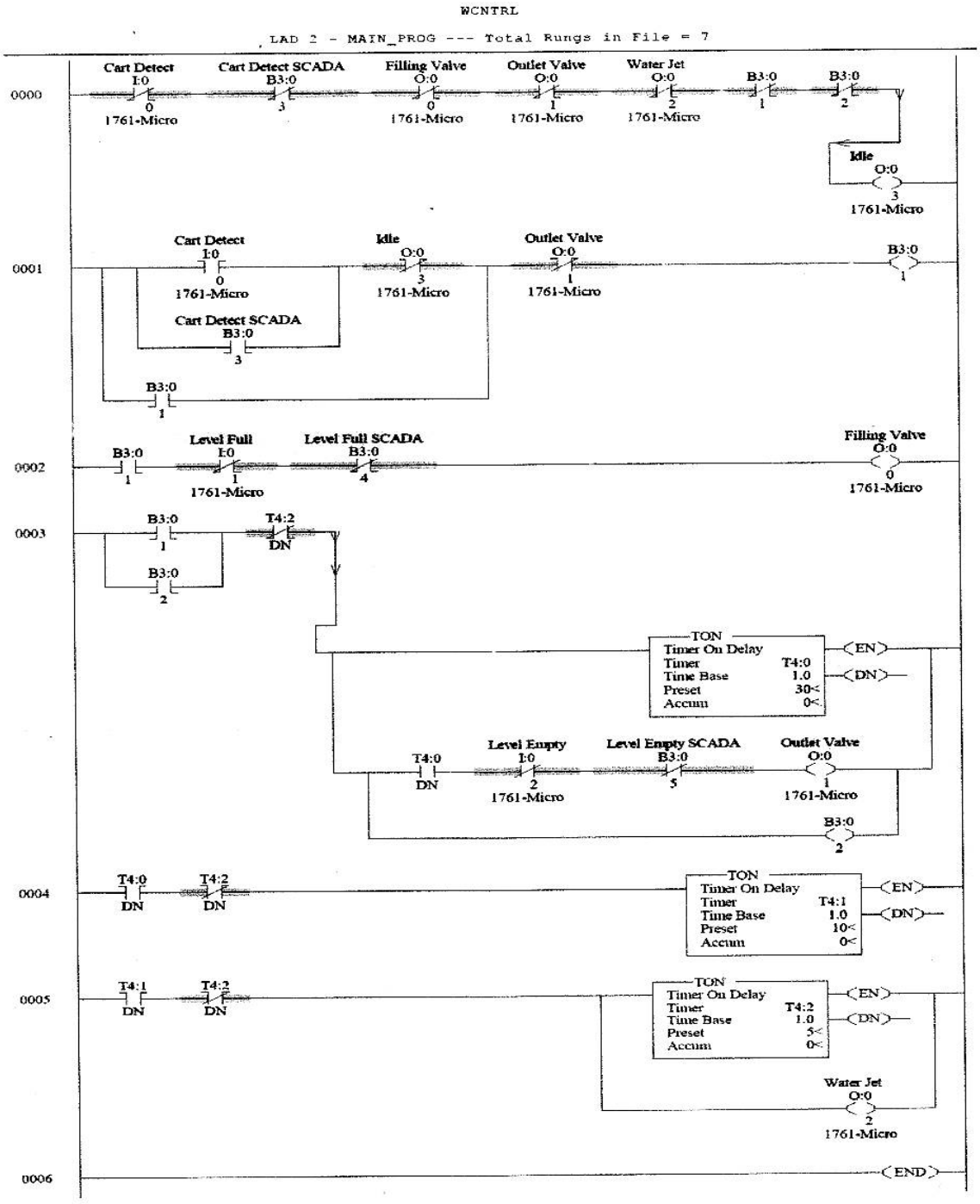

Fig. 4 : Ladder Diagram of Water Control System

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Hardware:
PC: Intel Core 2 Duo CPU 3.06 GHz , Intel Original Motherboard, 2 GB DDR2 RAM, 320 GB SATA HDD 14" Colour TFT Monitor.
PLC: MicroLogix 1000, 1761-L16BWA 220V AC/24V DC, 10 point input/6 point output, Bus current draw- 5V DC 0.04A 24V DC 0.105A,Input range-4-20, 0-10V DC,Class2, Output range-4-20,0-10V DC.
PLC Communication Port: 1761-CBL-PM02,Series C

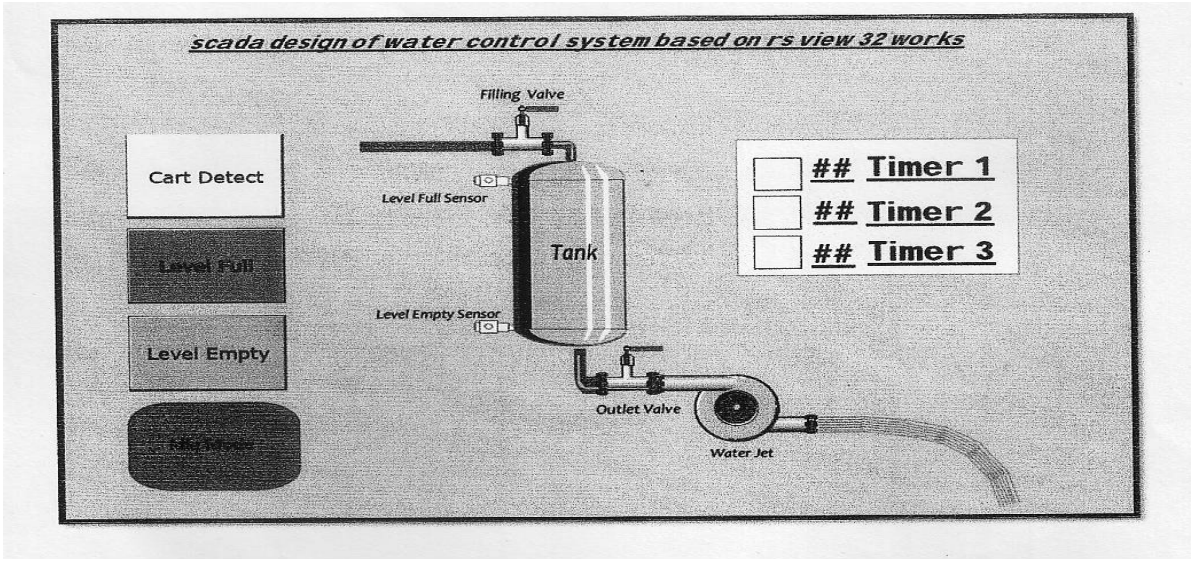

Fig. 5 : SCADA Design of Water Control System

Micro Logix 1000 Controllers are the most compact of the Micro Logix family. This controller fits a wide variety of applications up to 32 I/O points, while using a fraction of the space of a full –size controller. It contains embedded analog I/O, providing compact and cost effective.

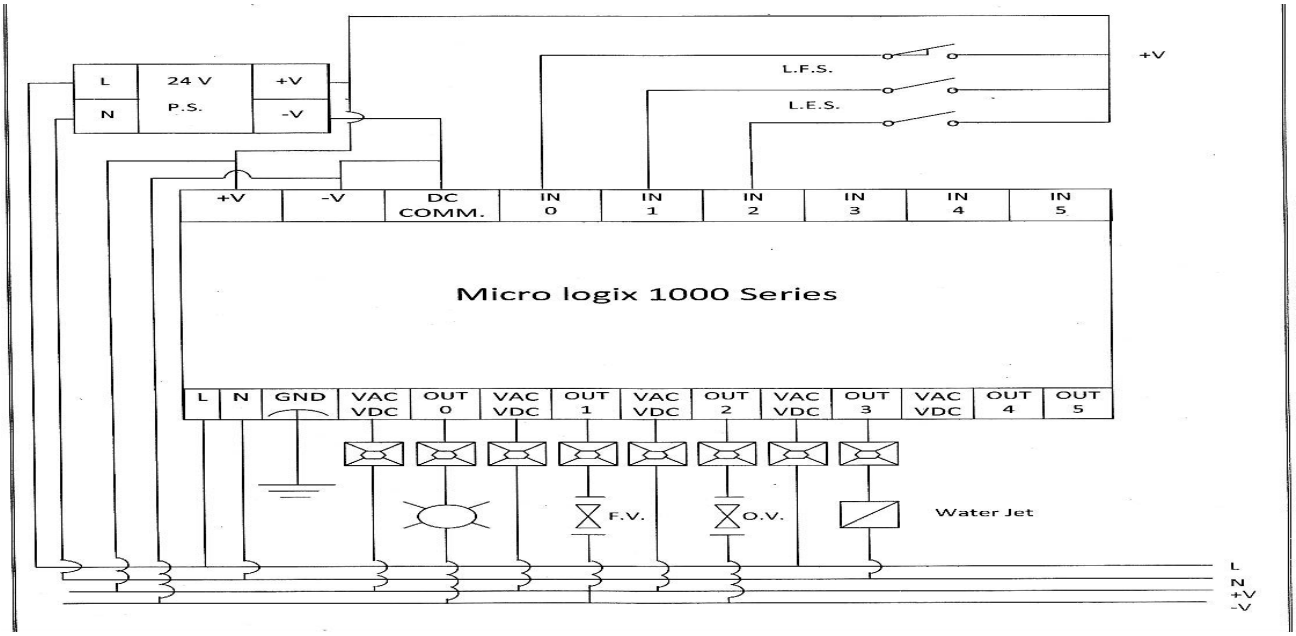

Fig. 6 : PLC Control Circuit

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Features:

- Available in 10-point, 16-point or 32-point digital I/O versions.
- Analog versions available with 20 digital I/O points, 4 analog inputs (two voltage and two current) and 1 analog output (configurable for either voltage or current).
- Provides a compact form factor, with footprints as small as 120 mm*80 mm*40 mm.
- Offers fast processing with typical throughput time of 1.5 ms for a 500-instruction program.
- Preconfigured 1 KB program and data memory to ease configuration.
- Includes built-in EEPROM memory; no need for battery back-up or separate memory module.
- Provides peer-to-peer messaging (up to 32 controllers on a DH-485 network) through a 1761-NET-AIC communication interface.
- Communicates via Device Net and Ether Net/IP through 1761-NET-DNI and 1761-NET-ENI communication interfaces.
- Includes a built-in high-speed counter (only on controllers with 24V DC inputs).
- Lets you customize input response time and noise rejection using adjustable DC input filters.
- Supports simple connectivity through RS-232 communication channel to a PC for program upload, download and monitoring.

Benefits:

- Compact design-Lets the MicroLogix 1000 controller thrive in limited panel space.
- Choice of communication networks-An RS-232-C communication port is configurable for: DF1 protocol for direct connection to a programming device or operator interface; DH-485 networking through a 1761-NET-AIC converter; Device Net networking through a 1761-NET-DNI interface; Ether Net/IP networking through a 1761-NET-ENI interface;or for half-duplex slave protocol in SCADA applications.
- Simple programming with your choice of programming device-You can program these controllers in familiar ladder logic with Micro Logix 1000 A.I. Series Software, PLC 500 A.I. Series Programming Software, RSLogix 500 Windows Programming Software, or the MicroLogix Hand-Held Programmer (1761-HHP-B30).
- Comprehensive instruction set-Over 65 instructions including simple bit, timer, and counter instructions, as well as instructions for powerful applications like sequencers, high-speed counter, and shift registers. Fast execution time for a typical 500 instruction program is only 1.56 ms.

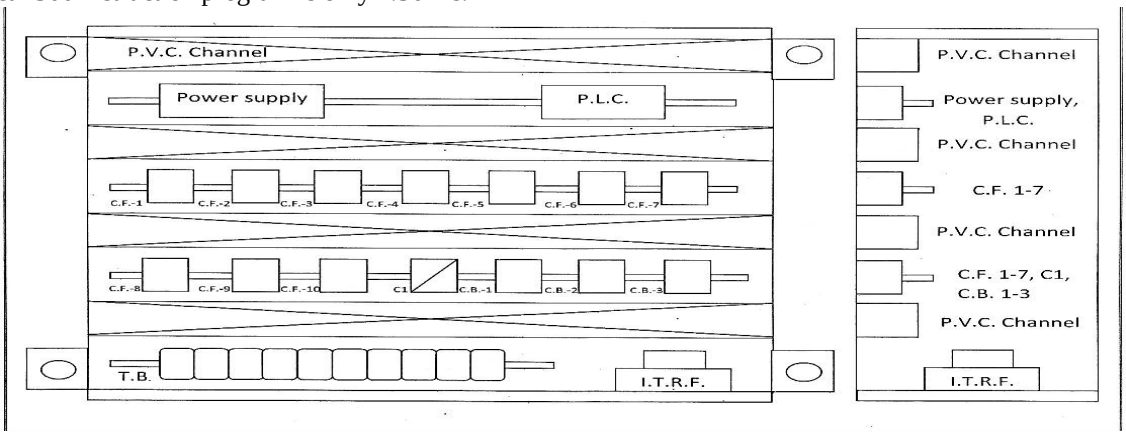

Fig. 7 : General Arrangement of Panel

Anaolog Input Specifications:
Voltage Range: +/ – 10.5V-1LSB
Current Range: 0.20 mA-1LSB
Data Format: Natural binary 16-bit signed integer
Voltage Input Impedance: 210 k?
Current Input Impedance: 160 k?
Resolution: 16 bits

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Overall Accuracy 0....55º C +/–0.7 % of full scale
?, is also a function of the input filter selection.

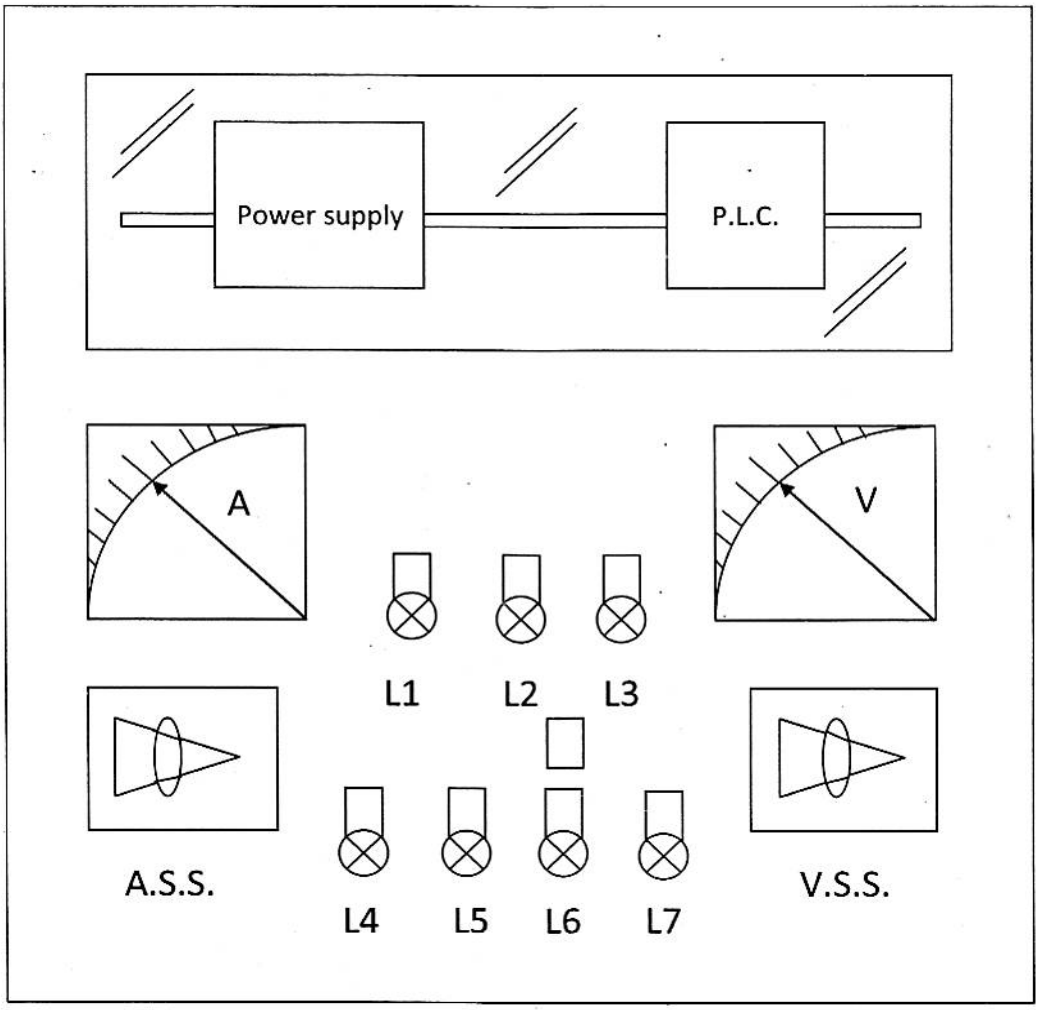

Fig. 8 : Front View

Analog Output Specifications:
Voltage Range: 0...10V-1LSB
Current Range: 4...20mA-1LSB
Data Format: Natural binary 16-bit signed integer
Step Response: 2.5 ms at 95 % +/–10.5V -1LSB
Load Range: 0...500?
Output Coding: 0...32, 767
(4...20mA-1LSB, 0...10V-1LSB)
Resolution: 15 bits
Overall Accuracy 0... 55º C: +/–1.0 % of full scale

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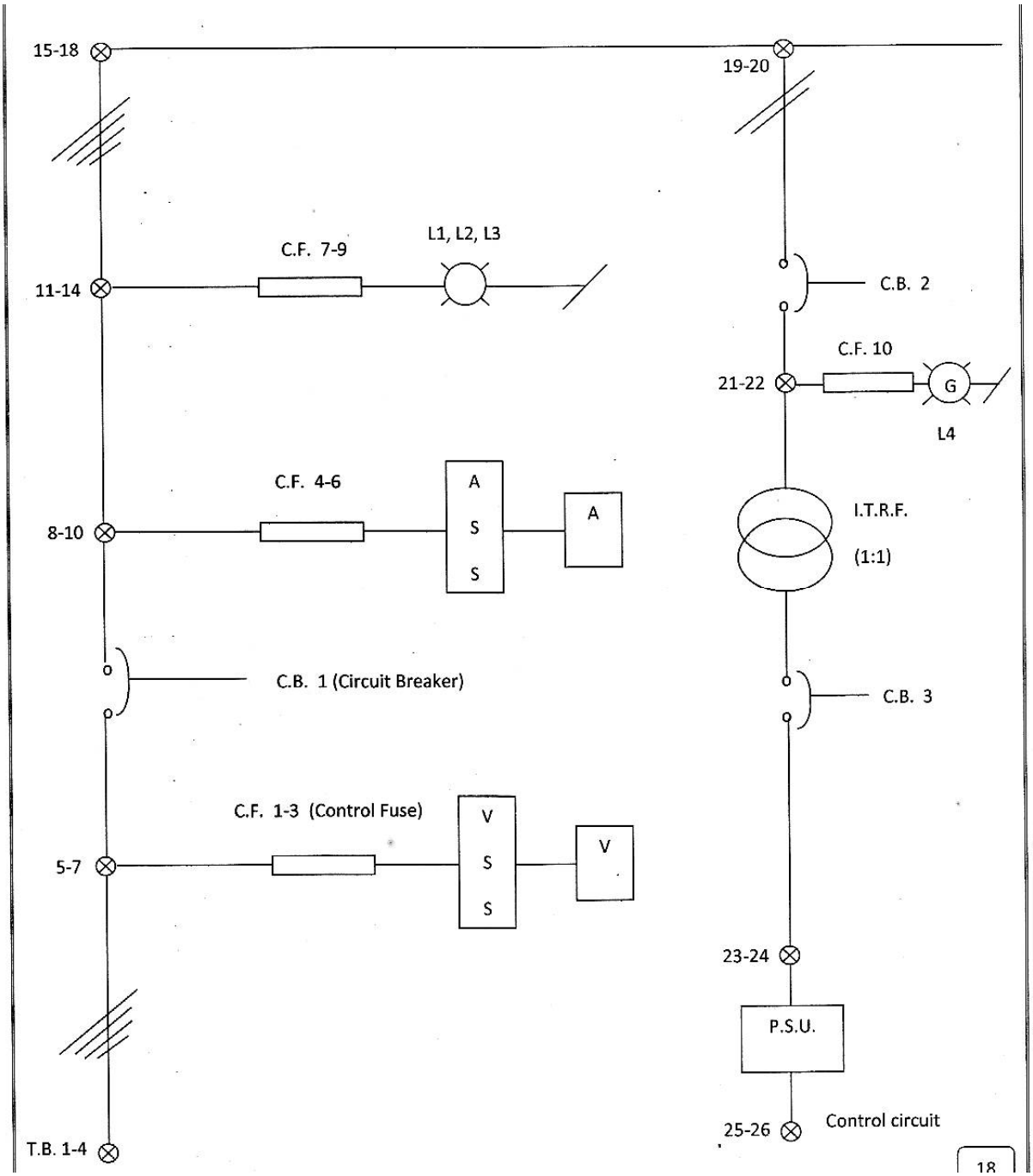

Fig. 9: Single Line Diagram

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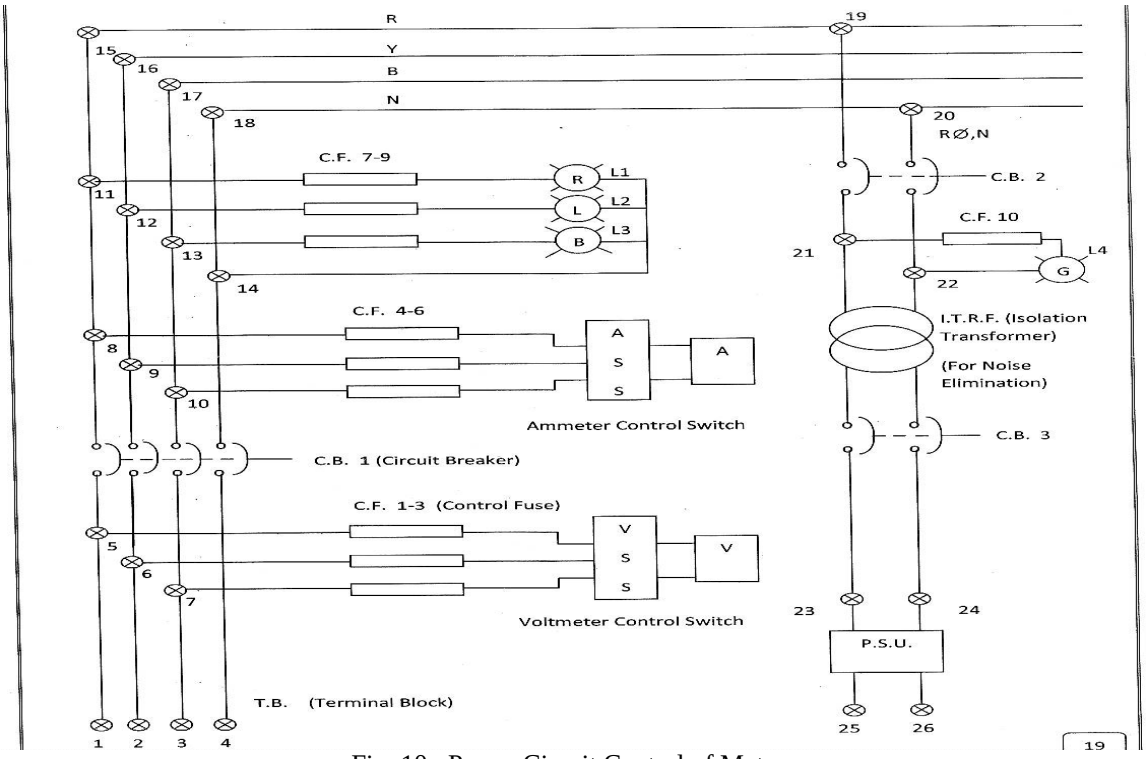

Fig. 10 : Power Circuit Control of Motor

II. FINDINGS

Bill of Material

LEGEND DETAILS

Sl. No.	Tag	Material Description	Range/Rating	Type	Make	Qty.
1	PLC	Programmable Logic Controller (CPU)	I/P:- 10 nos. 24V DC O/P:- 6 nos. Relay type; 1440 VA	MicroLogix-1000; 1761-L16BWA Series E FRN 1.0	Allen-Bradley	1
2		PC -> PLC Communication Port	RS-232; 9 pin connector	1761-CBL-PM02, Series C	Allen-Bradley	1
3	PSU	Power Supply Unit	5A	I/P: 120/230V AC; O/P: 24V DC	Meanwell	1
4	ITRF	Isolation Transformer	5VA; CTR-1:1	I/P: 120/230V AC; O/P: 120/230V AC	Gupta Engg.	1
5	CB1	TPN / FP	63A, Breaking Capacity: 6kA	C Curve; Isolator type	L&T	1
6	CB2, CB3	DP	10A, Breaking Capacity: 6kA	C Curve; Isolator type	L&T	2
7	C1	Contactor	10A, 230V AC	with (3NO+1NC) Aux. contact	Telemecanique	1
8	A	Ammeter	0 - 100A	Analog, Direct reading; Size: 72 mm²	Meco	1
9	ASS	Ammeter Selector Switch	6A	4 position (with Off)	Kaycee	1
10	V	Voltmeter	0 - 500V	Analog; Size: 72 mm²	Meco	1
11	VSS	Voltmeter Selector Switch	6A	4 position (with Off)	Kaycee	1
12	CF1 - CF10	Control Fuse	2A, 140W	with Base mtg.	GEC	10
13	L1 - L9	Panel Indicating Lamp; Red, Green -2 nos. each & Orange, Yellow, Blue -1 no. each	230V AC,24V DC	Filament type	Siemens	9
14	LVR	Louver	Size: 150 mm²	Mesh type	Keyman	1
15	EXHF	Exhaust fan	Size: 4"; 230V AC	Ventilation type	Rexnord	1
16	CFL	Compact Fluroscent Lamp	12W / 230V AC	Colour: White	Philips	1
17	DLS	Door Limit Switch	6A		Essen	1
18	TB	Terminal Block	Size: 2.5 mm²	Clip-on type	Elmex	Bulk
19		Cu. Wires	1100V/660V, 2.5 mm²	PVC Insulated, Multistranded FRP Flexible	Finolex	1 coil
20		Transparent Perspex Sheet	200 mm.(H) × 200 mm.(W)	1.2mm.Thk; Scratch proof	Siant-Gobain	1
21		Hardwares (PVC Channel, DIN Rail, Nut, Bolt, Screw, Washer, Cable Tie, Lugs, Rubber Gasket, Ferrules, Groomet, Earthing Stud, Door Knob, Nameplate, Terminal Endplate etc.)	Various size	Various type	Reputed	Bulk
22		Control Box	[H×W×D]: 500 mm.×500 mm.×300 mm.	Wall Mounting; IP-54;	Fabcon Technology	1

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Cost Analysis

COST ANALYSIS							
Sl. No.	Material Description	Range/Rating	Type	Make	Qty.	Unit Price (in Rs.)	Total Price (in Rs.)
1	Programmable Logic Controller (CPU)	I/P:- 10 nos. 24V DC O/P:- 6 nos. Relay type; 1440 VA	MicroLogix-1000; 1761-L16BWA Series E FRN 1.0	Allen-Bradley	1	18,000.00	18,000.00
2	PC -> PLC Communication Port	RS-232; 9 pin connector	1761-CBL-PM02, Series C	Allen-Bradley	1		
3	Power Supply Unit	5A	I/P: 120/230V AC; O/P: 24V DC	Meanwell	1	1,250.00	1,250.00
4	Isolation Transformer	5VA; CTR-1:1	I/P: 120/230V AC; O/P: 120/230V AC	Gupta Engg.	1	1,400.00	1,400.00
5	TPN / FP	63A, Breaking Capacity: 6kA	C Curve; Isolator type	L&T	1	2,500.00	2,500.00
6	DP	10A, Breaking Capacity: 6kA	C Curve; Isolator type	L&T	2	450.00	900.00
7	Contactor	10A, 230V AC	with (3NO+1NC) Aux. contact	Telemecanique	1	500.00	500.00
8	Ammeter	0 - 100A	Analog, Direct reading; Size: 72 mm^2	Meco	1	650.00	650.00
9	Ammeter Selector Switch	6A	4 position (with Off)	Kaycee	1	150.00	150.00
10	Voltmeter	0 - 500V	Analog; Size: 72 mm^2	Meco	1	650.00	650.00
11	Voltmeter Selector Switch	6A	4 position (with Off)	Kaycee	1	150.00	150.00
12	Control Fuse	2A, 140W	with Base mtg.	GEC	10	25.00	250.00
13	Panel Indicating Lamp; Red, Green -2 nos. each & Orange, Yellow, Blue -1 no. each	230V AC,24V DC	Filament type	Siemens	9	155.00	1,395.00
14	Louver	Size: 150 mm²	Mesh type	Keyman	1	150.00	150.00
15	Exhaust fan	Size: 4"; 230V AC	Ventilation type	Rexnord	1	350.00	350.00
16	Compact Fluroscent Lamp	12W / 230V AC	Colour: White	Philips	1	150.00	150.00
17	Door Limit Switch	6A		Essen	1	150.00	150.00
18	Terminal Block	Size: 2.5 mm²	Clip-on type	Elmex	Bulk	500.00	500.00
19	Cu. Wires	1100V/660V, 2.5 mm²	PVC Insulated, Multistranded FRP Flexible	Finolex	1 coil	2,500.00	2,500.00
20	Transparent Perspex Sheet	200 mm.(H) × 200 mm.(W)	1.2mm.Thk; Scratch proof	Siant-Gobain	1	500.00	500.00
21	Hardwares (PVC Channel, DIN Rail, Nut, Bolt, Screw, Washer, Cable Tie, Lugs, Rubber Gasket, Ferrules, Groomet, Earthing Stud, Door Knob, Nameplate, Terminal Endplate etc.)	Various size	Various type	Reputed	Bulk	2,500.00	2,500.00
22	Control Box	[H×W×D]: 500 mm.×500 mm.×300 mm.	Wall Mounting; IP-54;	Fabcon Technology	1	5,000.00	5,000.00
						TOTAL COST:	39,595.00
						(Rupees Thirty Nine Thousand Five Hundred & Nintyfive Only.)	

III. CONCLUSION

An efficient water control system is prime necessary to meet every demand for water supply. In this paper a method of water control system by automization using PLC and SCADA is explained with its cost analysis. The automation implemented in water control system ensures to avoid wastage of water and reduces time. The entire system can be operated by person who apparently has no knowledge over PLC and SCADA.

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