PROGRAMMABLE LOGIC CONTROLLER

Institute of Technology

(2ICOE51)

AUTOMATED BOTTLE FIILING

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ABSTRACT

- ✓ In this assignment a bottle filling machine is introduced using Programmable Logic Controller (PLC) based controller in automation industry.

- ✓ The foremost aim of this problem is to style and fabricate a little and a straightforward filling system using PLC. This work provides with many advantages like low power consumption, low operational cost, less maintenance, accuracy and many of more.

- ✓ A prototype has been developed as an instance the project. Filling is that the task that's administrated by a machine and this process is widely employed in many industries. During this assignment, the filling of the bottle is controlled by employing a controller cited as PLC which is additionally the main of the entire system. For the conveyor system, a dc motor has been selected for better performance and straightforward operation.

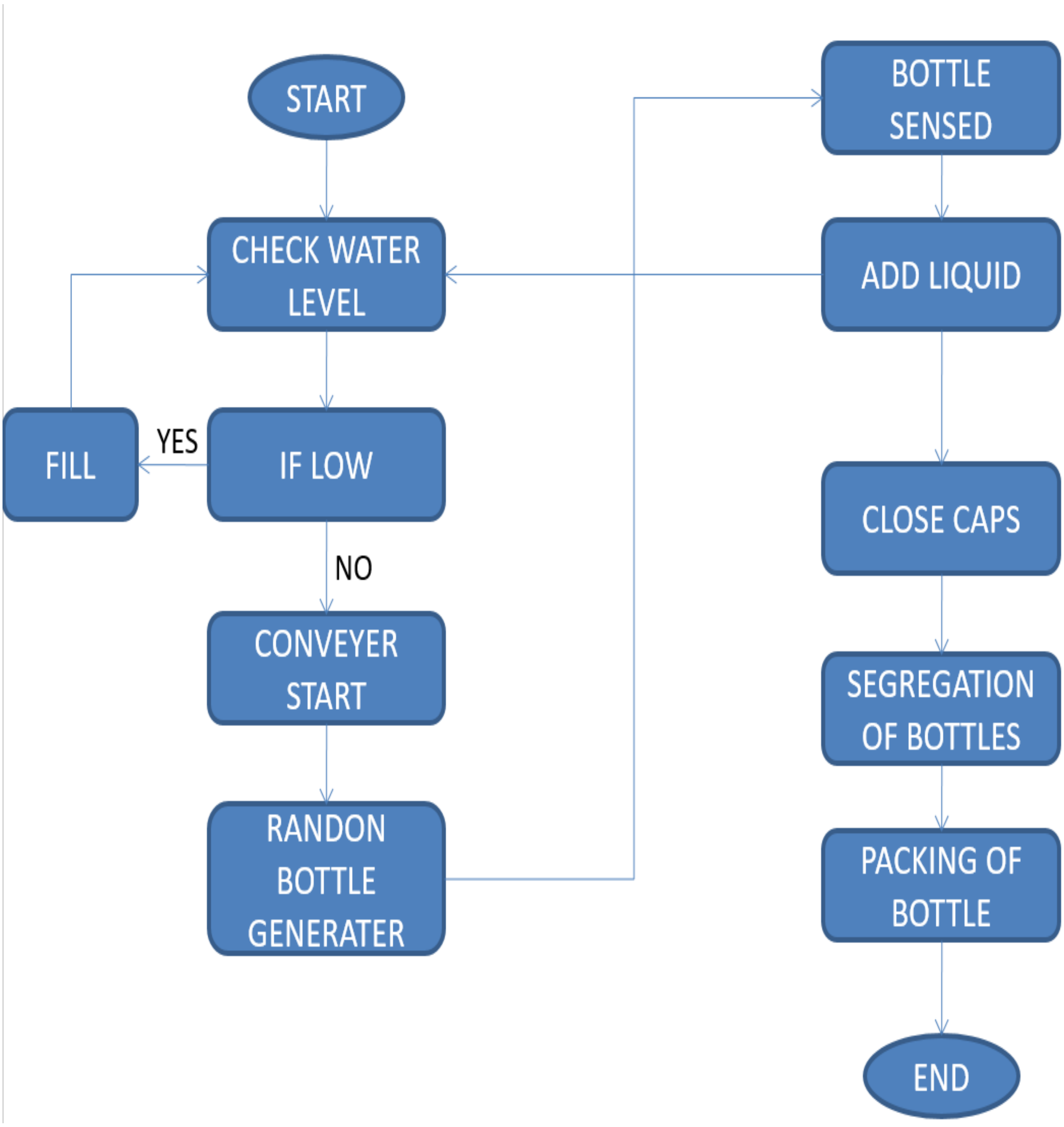
- ✓ A Laser sensor has been accustomed detect the position of the bottle as well as the height of the bottle which will then determine which bottle it is. In our project we have got used less number of system hence the final cost has been reduced to an extent. Ladder logic has been used for the programming of the PLC, which is that the foremost generally used and accepted language for the programming of the PLC.

INTRODUCTION

- ✓ Filling is defined because the method within which liquid is packed into the bottle like water and other beverages. It will be automated by using Programmable Logic Controller (PLC).
- ✓ We used PLC to randomly generate bottles using Fibonacci series and then to enter conveyer belt, fill and close the cap in one go at the same location.

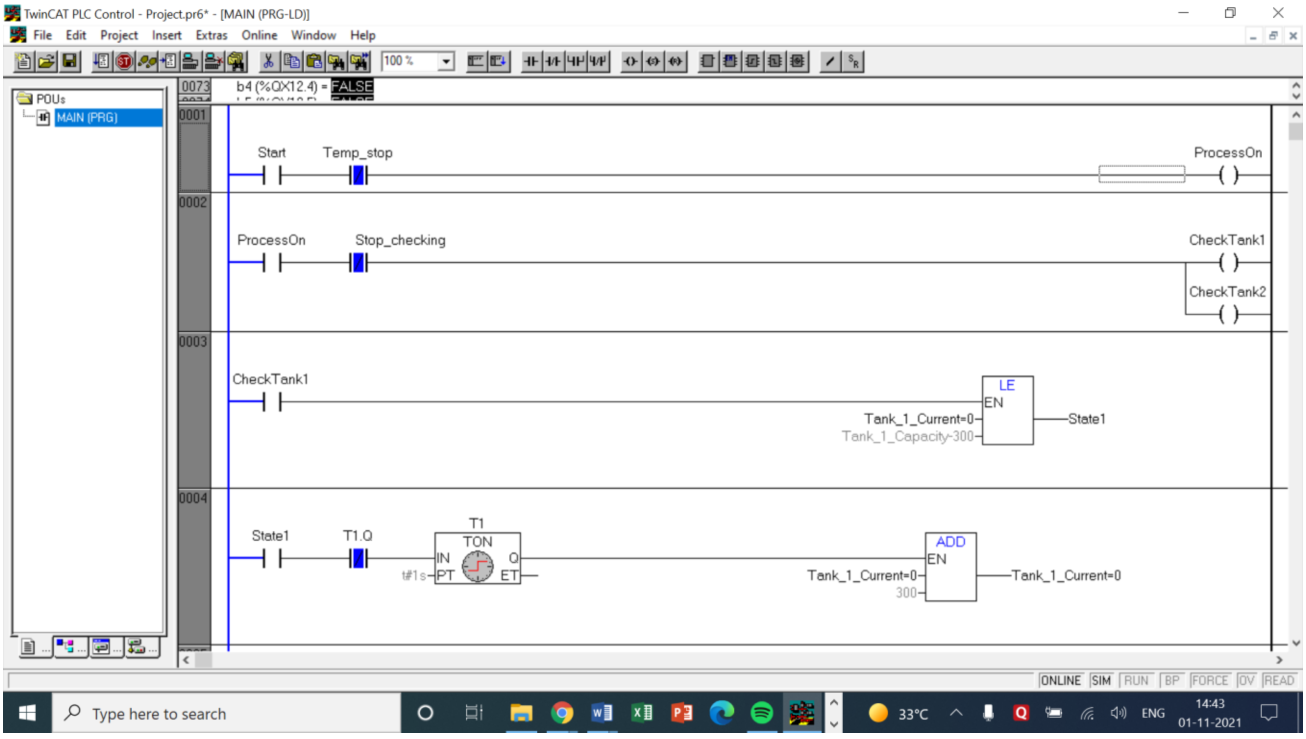
- ✓ This process involves placing bottle on the conveyor and filling the bottle at a time. The aim of this project is to elucidate the method of filling more bottles at a time. For this purpose, various motors can employed effectively to run the conveyor.
- ✓ It requires less number of sensor and it absolutely was cost effective. We need used ladder logic to regulate the full system.

FLOWCHART



RUN THROUGH OF THE LADDER LOGIC

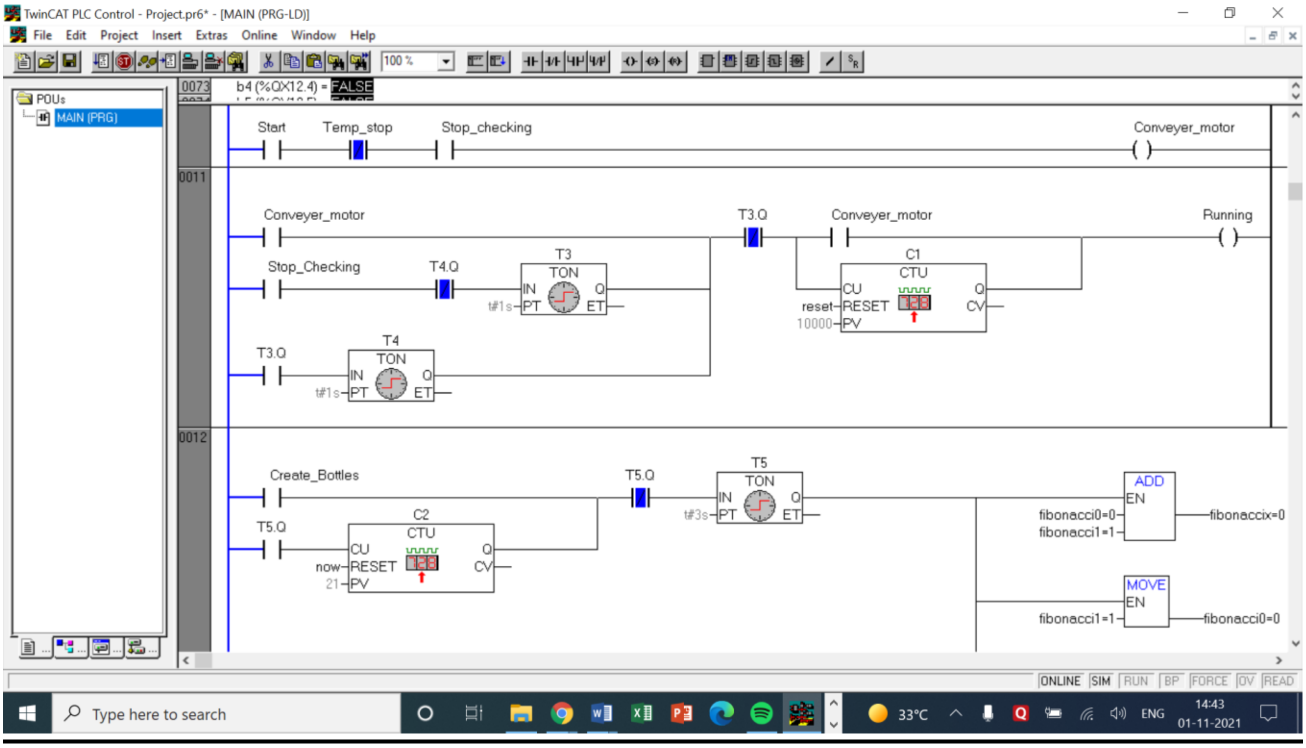
- The entire system starts with a single press of the start switch, since this is an entirely automated system we only require start and stop switch which will shut on and off the system. The operator can casually sit and monitor the process and if required a pause witch is also given to pause urgently
- After the switch is on, the process On output is turned on the following few rungs after that before starting the conveyer belt checks the status of the both tanks.



- The capacity of both the tanks containing Pepsi and Sprite are 3000 and 200 respectively. So the program will check if any of the tanks are less than 2700 and 1800 respectively then it will add 300 and 200 to both the tanks every second until the condition is fulfilled.
- Moving on, after filling initially, the conveyer motor is now started which in turn starts the conveyer belt.
- The output of the conveyer belt is the same as another component named 'Create_Bottles'.
- The version of the TwinCAT being used is very old so a function required known as random number generator isn't present which could have been

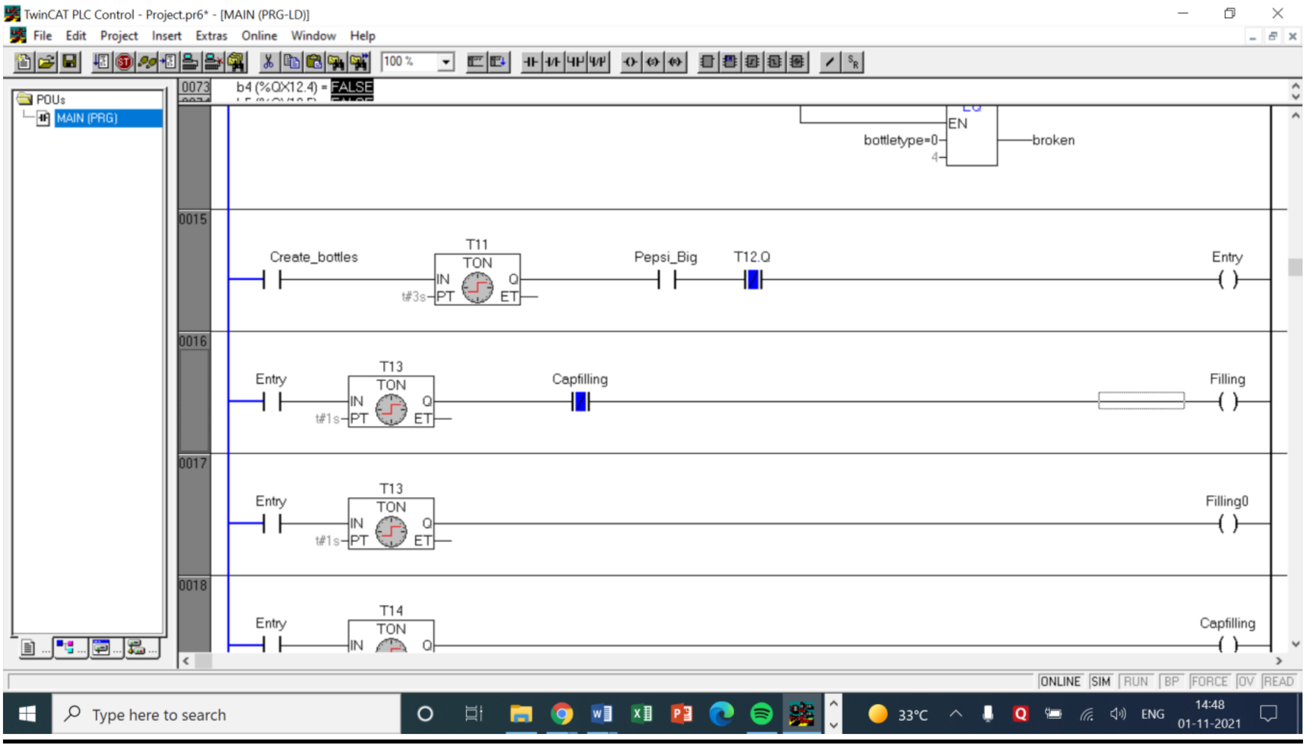
used to randomly create bottle for the program to identify and perform operation accordingly.

- Since the function was not available, We used 2 rungs to create a Fibonacci series in one and then modulo(ed) it with 5 such that we get 5 numbers – 0,1,2,3,4 ; randomly which we can associate with bottles.



- In our case the bottles refer to –
  - 0 – Big Pepsi Bottle
  - 1 – Small Pepsi Bottle
  - 2 – Big Sprite Bottle
  - 3 – Small Sprite Bottle
  - 4 – Broken Bottle

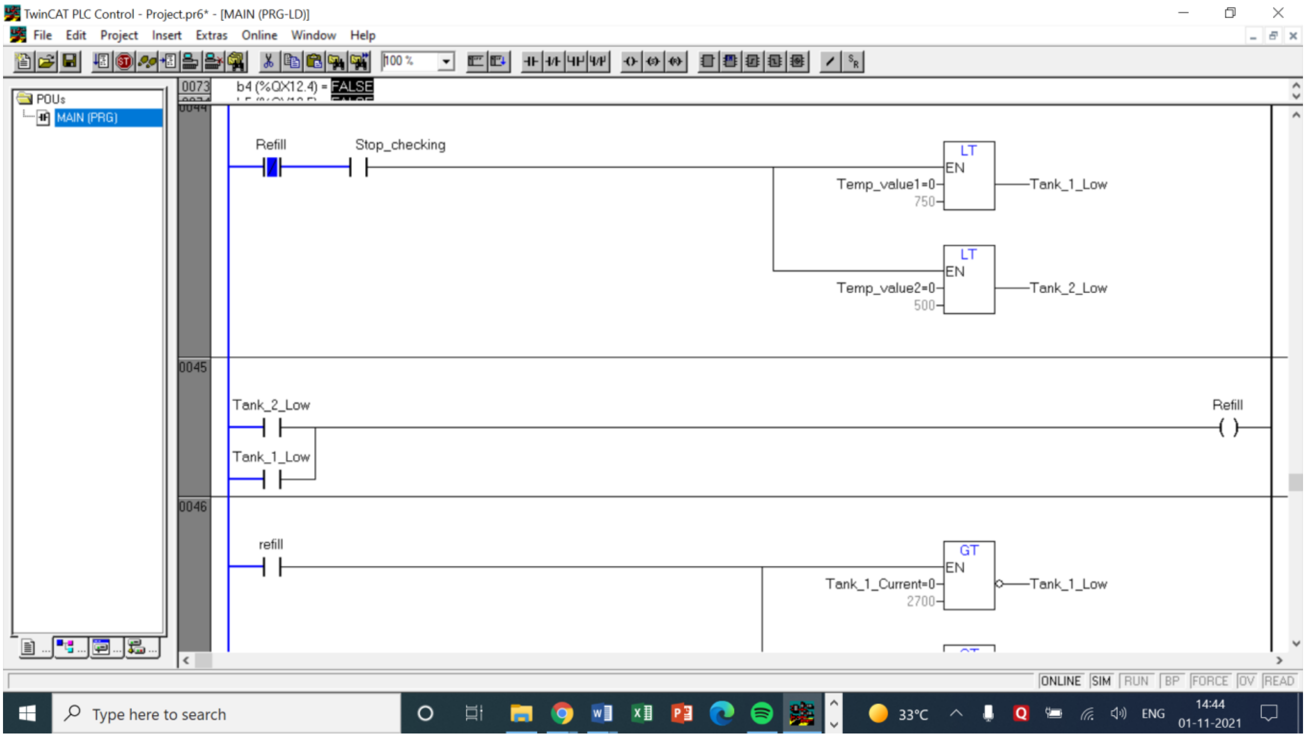
- These 4 bottle are to be sensed by a laser sensor in real time by comparing the height and radius of the bottle but in ladder logic we directly associated the bottle type with these numbers as they come and go due to limitations
- The Bottles are generated every 3 seconds and in these 3 seconds, three steps are needed to be performed – Entry, Filling and Cap closing.



- In the first second the bottle comes and stop below the machine for filling and capping.
- In the 2nd second the bottle is filled with the respective fluid and in the 3rd second the cap is fitted and tightly sealed.
- After these 3 steps the bottles are then further sent for segregation and boxing.
- Important s point to note is that while the bottle is being entered the laser checks the both in real world (and here we have the numbers).
- For that several counters are used. When the conveyer belt start a counter to count the total bottles yet has been used.
- When each of the bottle is recognized 5 different counters are used to count how many bottles of each type is used.
- After counting the function blocks are used to divide by 6 and 4 for small and big bottles respectively and this process continues.

Control Action

- In this sub-section we will explain how the automated action was performed and brought into action by us.
- After the bottles are created and have stopped below the conveyer belt, because of the laser in real time it would know which bottle type it is precisely and in this pseudo-program we know that by the modulo of Fibonacci numbers
- After identifying the type of bottles, since each bottle has different capacity namely –
  - Big Pepsi – 700
  - Small Pepsi – 300
  - Big Sprite – 600
  - Small Sprite – 250
  - Broken bottle – discarded
- In the 2nd second of filling the respective amount of the fluid will be filled and that amount will be decreased from the current capacity of the respective tank it was decreased from.
- This process will continue till the critical capacity is reached which is 750 for Tank1 and 500 for Tank 2.
- Rungs are used for the above step which are checking the condition all time at every interval. When this is reached the circuit breaks and process is temporarily stopped and the refill output is turned on.
- When refill is turned on every process is stopped by the negated refill switch in various rungs. While the refill process is on the loops back to the initial rate of filling 300 and 200 in both tanks respectively.



- A special attention to detail has been made by us that will never overboard the tank capacity i.e. if the current capacity is 2900 then by logic it is not full and will add 300 again in the next step but we also checked this and if further addition is overloading the tank then it will not add.
- Every time one of the tanks is in critical condition the process will stop and both the tanks will start refill using the pump in the reservoir.

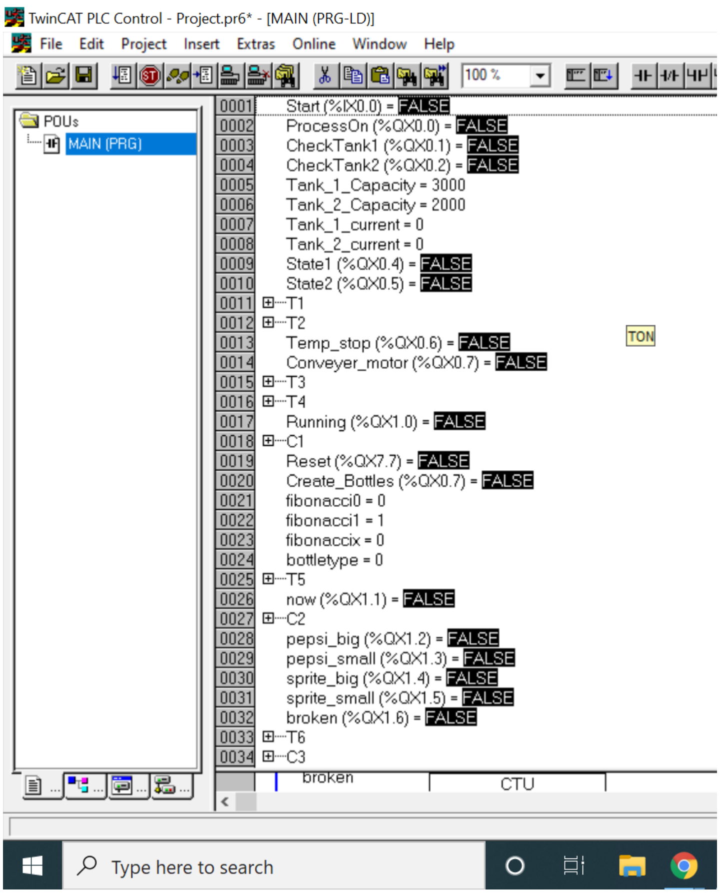
Components Used

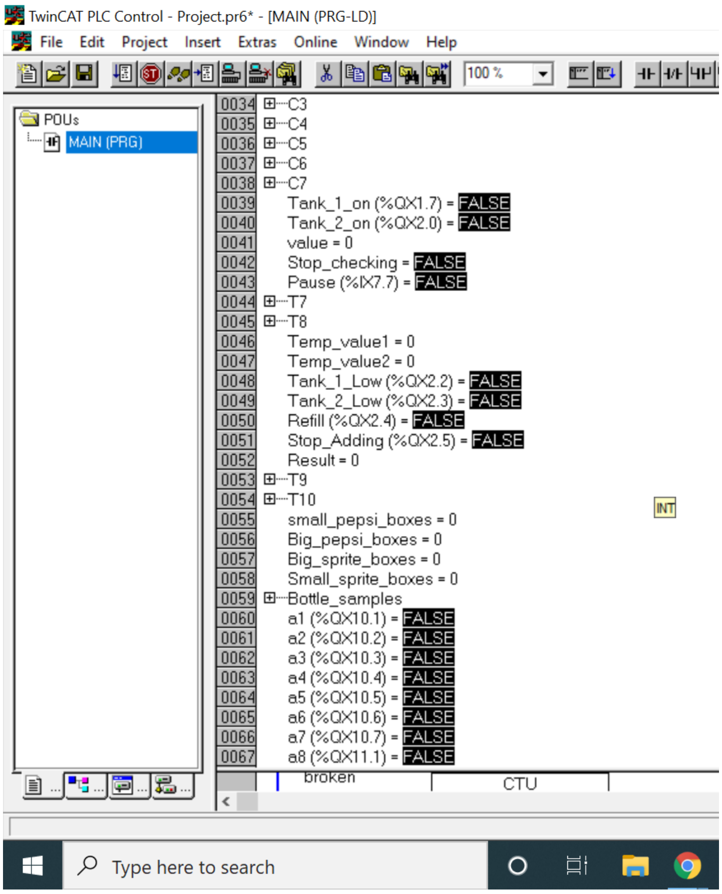
outputs	Address	Tank Level outputs	Address	Counters and Timers	Preset Time and value
ProcessOn	%qx0.0	A1	%qx10.1	C1	PV = 10000
CheckTank1	%qx0.1	A2	%qx10.2	C2	PV = 21
CheckTank2	%qx0.2	A3	%qx10.3	C3	PV = 1000
State1	%qx0.4	A4	%qx10.4	C4	PV = 1000
State2	%qx0.5	A5	%qx10.5	C5	PV = 1000

Temp_stop	%qx0.6	A6	%qx10.6	C6	PV = 1000
Conveyer_motor	%qx0.7	A7	%qx10.7	C7	PV = 1000
Running	%qx1.0	A8	%qx11.1	T1	t#1s
now	%qx1.1	A9	%qx11.2	T2	t#1s
pepsi_big	%qx1.2	A10	%qx11.3	T3	t#1s
pepsi_small	%qx1.3	B1	%qx12.1	T4	t#1s
Sprite_big	%qx1.4	B2	%qx12.2	T5	t#3s
Sprite_small	%qx1.5	B3	%qx12.3	T6	t#3s
broken	%qx1.6	B4	%qx12.4	T7	t#1s
Tank_1_on	%qx1.7	B5	%qx12.5	T8	t#1s
Tank_2_on	%qx2.0	B6	%qx12.6	T9	t#1s
Tank_1_Low	%qx2.2	B7	%qx12.7	T10	t#1s
Tank_2_Low	%qx2.3	B8	%qx13.1	T11	t#3s
Refill	%qx2.4	B9	%qx13.2	T12	t#1s
Stop_Adding	%qx2.5	B10	%qx13.3	T13	t#1s
Reset	%qx7.7	D1	%qx10.0	T14	t#2s
Pause	%qx7.7	D2	%qx11.0	T15	t#1s

Variables	Value stored	Timers Continued	Preset Time and value	Function Blocks Used	
Tank_1_Capacity	3000	T16	t#2s	ADD	-
Tank_2_Capacity	2000	T17	t#1s	MOVE	-

fibonacci0	0	T20	t#1s	MOD	-
Fibonacci1	1	T21	t#1s	GT	-
Tank_1_current	Varies (initial = 0)	T18	t#1s	SUB	-
Tank_2_current	Varies (initial = 0)	T19	t#2s	DIV	-
fibonaccix	Varies (initial = 0)	T22	t#2s	LT	-
Bottletype	Varies (Initial = 0)	T23	t#5s	GE	-
Temp_value1	Varies (initial = 0)	T24	t#3s	LE	-
Temp_value2	Varies (initial = 0)	T25	t#1s	EQ	-
Result	Varies (initial = 0)	T26	t#3s	-	-

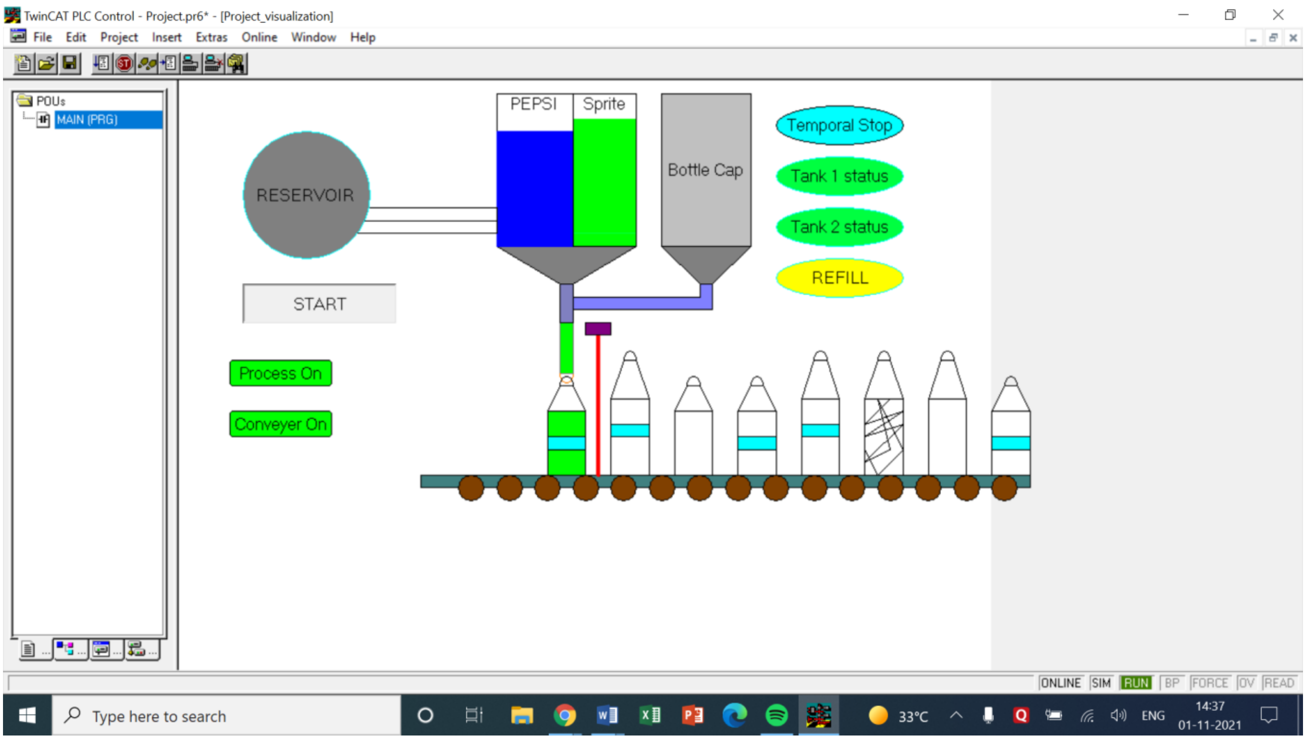




Simulation and its code

- The above actions can be carried out in code entirely but it can't be demonstrated in simulation by itself. Some more function blocks and rungs are needed to be added for this to work in simulation.
- First we design the general drawing of the process in the simulation page such as adding a circle for reservoir, adding the conveyer belt with wheels, adding tanks above the belt and a cap fitting machine beside it.
- Several buttons of Process on, the status of the various tanks was also indicated and added for ease. A toggle switch for start button is added on top left to start and stop the process.
- On the right of the laser is shown how the bottles will be entering and passing the laser sensor.

NOTE – we haven't been taught dynamic simulation and we couldn't find how to no matter how we searched so the right side of the laser is for show only the bottles will appear and get filled and packed below the machine only!!!!



- The animation for the tank was made by some effort we check the capacity of the tank 10 times for each tank and the output was stored in different variables which are constantly being checked.
- So if the 1st tank's level is above 1200 all the output below 1200 will be true and they will change colour in the simulation giving the effect of filling the tank and decreasing the tank.
- The same was don't for the bottle also we added various rungs for each type of bottle and each step (entry, filling and cap fitting) so when Pepsi big is true then the Pepsi small shaped bottle will be visible and the filling step will change colour of bottle and then the capping step will close the bottle with a pink coloured cap then the bottle will go and new bottle will enter.

Component Name	Off state colour	Alarm colour
Pepsi Bog bottle	Invisible	Black visible line
Pepsi Small bottle	Invisible	Black visible line
Sprite Big bottle	Invisible	Black visible line With cyan coloured strip
Sprite Small bottle	Invisible	Black visible line With cyan coloured strip
Pepsi big lower half	Invisible	Dark blue
Pepsi small lower half	Invisible	Dark Blue
Sprite big Lower half	Invisible	Bright Green
Sprite small Lower half	Invisible	Bright green
Pepsi Big Cap	Invisible	Pink outline
Pepsi Small Cap	Invisible	Pink outline
Sprite Big Cap	Invisible	Pink outline
Sprite Small Cap	Invisible	Pink outline
Small filling pipe	Invisible	Green and Blue colour for Pepsi and Sprite big bottles
Big Filling pipe	Invisible	Green and Blue colour for Pepsi and Sprite big bottles
All filling pipe tips	Invisible	Orange
Small cap fitting pipe	Invisible	Cyan Frame (border)
Big cap fitting pipe	Invisible	Cyan Frame (border)
Cap fitting tips	Invisible	Pink
Sprite reservoir pipe	Black Frame	Bright Green colour

Pepsi reservoir pipe	Black Frame	Blue colour
Process ON	Red colour	Bright Green Colour
Conveyer Belt output	Red colour	Bright Green colour
Conveyer Belt shape	Bluish grey colour	Bluish grey colour
Wheels	Brown	Brown
Tank 1 Low	Bright Green colour	Red colour
Tank 2 Low	Bright Green colour	Red colour
Refill	Yellow colour Cyan Frame	Bright Green colour Cyan Frame
Pipes for filling and capping	Light Purple	Light Purple
Laser Line	Bright Red colour	Bright Red colour
Reservoir Tank	Dark Grey colour Cyan Frame	Dark Grey colour Cyan Frame

HARDWARE INSTRUMENTS

Water Float Switch

- It has an input voltage of 250V A.C with an input current of 15A. It's a square shape. It's designed to face high temperature. It's both NO & NC contacts. It's working mechanism is When the tank is filled up with water then the float switch "normally opens" (NO) the circuit and when the tank is empty the float switch "normally closes" (NC) the circuit and energizes the hardware connected with it (mostly pump is connected).
- During this assignment, it's dipped into the tank crammed with water so it floats over the water and on decrease in water level the float switch falls down completely towards the bottom thanks to low level of water which then closes the circuit reference to the water float sensor.
- As a result, the pump that's interfaced with the whole system then gets completely energized and therefore the water from the reservoir is pumped on to the storage tank and it's stuffed with water and gradually the water level starts rising and also the float switch gradually starts to float over water.

- ❖ After the water is filled up to a specific level and therefore the float switch starts floating over water, then the circuit breaks and therefore the pump gets de energized simultaneously

Laser Sensor

- ❖ This sensor should be used when actually actuating the PLC because laser sensors need low power requirements and they are easy to install in the application.
- ❖ This sensor is kept vertically so that when the bottle bass through the laser it can determine the height of bottle by sensing how high the lasers circuit was cut off.
- ❖ The radius or the width of the component can be then calculated by how much time the laser connection was broken off. Using speed of the conveyer belt and time we can get the radius or width of the component.

DC Geared Motor

- ❖ The DC motor used may be a DC geared type motor whose shaft is interconnected with the shaft of the roller. This motor has an input voltage of 12v with an input current of 600mA to 14A.
- ❖ The explanation for choosing this motor is to realize high torque at a continuing speed. It provides sufficient amount of torque for our load. The motor comes with a metal gearbox and cantered shaft.
- ❖ Shaft is loaded with bearing for wear resistance. The explanation for selecting such a high torque has such heavy rollers used on the either side of the hardware which is mounted with a transporter.

Water Pump

- ❖ Its working voltage is 12 V DC and dealing current is 0.1 – 0.5 A. Its lift is 130 cm at 12 V DC and rate is 300L/hr.
- ❖ During this project, the pump is submerged within the reservoir from where the water are pumped up to the most tank if it gets empty.

Water Tank

- The function of the tank is to store the water which is to be filled within the bottle via solenoid valve whenever required.
- The tank contains a float switch which is generally wont to determine the extent of water and whenever the water level within the tank falls it's restored by the water stored into the reservoir with the assistance of the pump through a narrow pipe which is connected with the tank.

Switches

- These manual switches are very troublesome but if required they can be incorporated into this project but for theoretical basis we have decided to keep only one START switch.
- Although other intermediate outputs can be used as switches and can be toggled on and off it not advised by both of us.
- The type of switches we utilized in our project are the toggle switches. Two toggle switches are accustomed change the mode: Manual and Auto.
- Two toggle switches are used for "Auto Start" and "Auto Stop". For manual mode, two toggle switches are used for "Conveyor Start" and "Conveyor Stop" and two toggle switches are used for "Solenoid valve Open" and "Solenoid valve close".
- And lastly, one electrical switch is devoted for the "Emergency Pause" Switch.

Application

- It employed in many industries like milk industries, chemical, food, drinking water and lots of industrial manufacturers.
- This filling machine is cost effective and it may be employed in small scale bottle filling systems like coffee shops, juice shops and other beverage industries.

CONCLUSION

The main objective of this project was to develop a bottle filling system supported certain specifications. The project presents an automatic filling system controlled by PLC as per the filling requirement which has simple operation. The system has the benefits as simple structure and reliable operation. The system is controlled by PLC. By the installation of jet nozzle and powerful solenoid valve can reduce the time to fill bottles and might efficiently increase productivity. A guide way might be utilized in case of vibration. A capping section could even be introduced. The nozzle positioning must tend more care and concentration. The system may be redesigned for increased bottle size and productivity.

Reference and Bibliography

1) *https://rcciit.org/students_projects/projects/ee/2018/GR11.pdf*
2) *https://core.ac.uk/download/pdf/211829785.pdf*
3) *https://ijcsmc.com/docs/papers/March2015/V4I3201599a93.pdf*
4) *https://ijcsmc.com/docs/papers/March2015/V4I3201599a93.pdf*
5) *https://forumautomation.com/t/continuous-bottle-filling-system-using-plc/3937*
6) *https://instrumentationtools.com/top-100-plc-projects-list/*