ECT 663: Electronic Control Systems Design
Laboratory Exercise #2
Interactive User Controls, Real-time Data Gathering, & Security Design

Name: ____ Due date: March 13th, 2023

SIGNOFF: NOTES:

PAC Project Operates as expected _________________________

Emulator operation correct _________________________

HMI works as expected _________________________

Code Commented & tag database _________________________

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OBJECTIVES: Creating and interacting bits, timers, and counters in Studio5000; along with creating subroutines, & data manipulation operations. Creating multiple displays and navigating between them; creating graphic slider objects to control operations; creating users, user groups, macros, security policies (who can see which displays and objects) and HMI tags for establishing secure login/logout to a project. This is a more extensive project.

OVERVIEW:

Controllers are commonly used to operate electric motors using electromagnetic motor starters in process control systems. Some process systems use two motors in a critical application. This is commonly referred to as a 'Duplex" control system. The two motors (or units if the motor is part of something else, like a pump) can be referred to as a main and a backup, or sometimes they are called a 'lead' and a 'lag.'

ASSIGNMENT: The Produce Warehouse

For the first lab you created an elevator to allow us to move containers between floors. Here we will build on that scenario with a shipping area in our warehouse to store goods awaiting shipping. A fresh produce supplier has a bulk storage area which uses a dual fan ventilation (two fan motors) and an evaporative, or "Swamp," cooler system to maintain stable temperature air flow over fruits and vegetables awaiting loading and shipment to area restaurants and smaller vendors. To prevent excessive temperature from damaging the produce, if area temperature exceeds 70º F then one fan of the two fans comes on to pull cooling air across the produce. The fans automatically alternate between uses as to which is activated (FAN_MTR_1 or FAN_MTR_2). The circuit knows, or remembers, which fan was last used first and will start the other fan on the next use to equally divide the usage across the motors. If the temperature exceeds 80º F then both fans come on to increase air volume. If the temperature exceeds 90 º F an alarm is generated to the operator. The temperature is controlled using a Slider element.

The two fans should be illustrated by a fan blade graphic on the display. There are several in the FTV software. You can make the fan blade appear to spin by using the rotation graphic. Note that for the graphic to look normal you need to set the display update rate to a low number or the graphic will look "jumpy."

Safety Circuits: each of the motors has a normally-closed overload contact to the starter. If too much current is being drawn then the overload will trip (contact will open) and shut down that motor. An indicator will appear to maintenance that the motor was tripped and shutdown. At the moment of shutdown the OTHER motor which is not running will begin to run to keep air moving. Once the OL is reset then the tripped motor will function normally. The OL contacts are represented by input bits on the emulator and are hand operated by you using the mouse.

Also there is a hand operated Normally-Closed Emergency stop, when pressed the fans will not run until reset and an alarm is generated to the user that the E-stop is active.

The system is operated through a PAC using a HMI program. The Controls are created in the HMI as a pushbutton to turn the fan system on or off. The HMI has a three display design:

Main Display: Acts a Login/Logout screen and Menu to the other displays. Allows recognized system users to login & out. Identifies the user by name, shows the current date, and GOTO buttons to displays that logged in user may access
Operation Display: Allows the system to be started or stopped and has a graphic representation of which fan(s) are currently running, and the current temperature reading. Also includes the slider to control the temperature reading. NOTE: The slider is a user input which you will manipulate using your mouse. The slider changes the temperature, so YOU will move the slider button to make the temperature setting go up or down and operate the fans.
Data Display: Shows statistics gathered from the process, and reset.

The displays should have a consistent theme of color and design (the display formats should be consistent, you can use a standard background, you can import an image and use it as a custom background, if you do use an image it should be 'professional' as something you would use in a workplace environment and not expect to get fired, sued, arrested, or all of the above). Navigation buttons should be located in the same place on the displays for consistency of use.

Create three security user groups, Supervisor, Maintenance, & operator. Create at least two users per group. Assign passwords (remember the passwords). Remember that the main display cannot be given a security code (use *) or no one can ever login. Each menu display must have a return GOTO button to get back to the menu, or you will be stuck on a display.

Supervisors & Maintenance users can see both the Operation and Data displays, Operators can only see the Operation display (not the data display).

When the system is turned on in the operation display the fan status is determined by the current temperature. If over 70 then one fan will turn on, which fan turns on will alternate with each start/stop cycle (right, then left, then right, etc). If over 80 then both run until the temperature is below 80. Both fan motors have overload contacts (these are N.C. contacts on the starter) which indicate and over current fault to the motor. The fan motors would be outputs on the emulator, and the overloads would be inputs on the emulator.

The system can be turned off in the Operation display. Indicators inform the users if the system is on or off. Graphics show which fan (or both if called for) is currently running, you can use the rotational animation attached to a fan graphic, which is found in the image library. A readout shows the current temperature. There are graphic objects in FTV that can be animated, or you can create your own, or graphics (.png, .bmp., and .jpg) can be imported.

At the bottom or side of the operations display and the data display put in a slider animation (vertical or horizontal) which we will manipulate to make the temperature go up or down to test the operation as we are running. You can copy the same slider to both pages and control the 'temperature' from either display to watch the system operate or to watch data be displayed.

The data display will have feedback data on the system operation gathered from the Studio5000 program. Only supervisor and maintenance users can access the display, and only supervisors can reset the data values stored there. To gather data for the display create three subroutines in the Studio5000 program.

FAN_MTR_1 (Operational data for Fan Motor #1)
FAN_MTR_2 (Operational data for Fan Motor #2)
SYSTEM_TOTALS (Excessive Temperature in Process)
The subroutines should be called on each scan to update the data gathered.

Using the subroutines for the two fan motors: (A) a counter will be established for each motor which records how many times each fan was activated. (B.) a timer will be set up to record in seconds how long each fan motor has run since last reset. (C) a reset (which only supervisors logged in can access) which resets the counter and timer back to zero (you can use MOV commands here to write 0 to the presets).

Using the totals subroutine for the excess temperate recording: (A). a counter will be established to record how many times the temperature in the warehouse exceeded 90º F; (B) a timer will record in seconds the total amount of how long the temperature remained above 90º F; (C) what was the longest continuous period the temperature was above 90º F. This means you would probably have to use some comparison and mathematics commands as well.

Data gathered from the process will be stored in processor memory as follows where it can be viewed & monitored as needed: To do this you would make tags in PLC memory. As these are “not real” they would be base tags and make them as DINT type. You can use the MOV command to transfer data from a counter ACC or a Timer ACC to these DINTs then have FTV read in these values to a numerical display.

Motor_1_OL	The number of times Fan Motor 1 Tripped out
Motor_2_OL	The number of times Fan Motor 2 Tripped out
Motor_1_ON	The number of times Fan Motor 1 was activated
Motor_1_RunTime	The total amount of time Fan Motor 1 was activated
Motor_2_ON	The number of times Fan Motor 2 was activated
Motor_2_RunTime	The total amount of time Fan Motor 2 was activated
Above_90	The number of times the temperature exceeded 90º F
Above_90_Time	The amount of time the temperature exceeded 90º F
Longest_Run	The longest continuous period either motor was required to run

Resets: If logged in as a supervisor you can see the data and a set of reset buttons
Data from subroutine Fan_Motor_1 is reset (counts and time) to Zero.
Data from subroutine Fan_Motor_2 is reset (counts and time) to Zero.
Data from Totals subroutine (count and time above 90º F, & longest continuous run time for any fan motor) is reset to Zero.

Use the addresses shown below for inputs & outputs which are linked to the PLC emulation software (the fan motor starter coils, the overload contacts for each starter, and the "E_STOP" pushbutton in case of an emergency need to shutdown the system without the HMI).

Logix5000 Emulator Input Description	Address		Logix5000 Emulator Output Description	Address
E_STOP	0		FAN_MTR_1	0
Motor_1_OL (overload)	1		FAN_MTR_2	1
Motor_2_OL (overload)	2			

Many of the details I have purposefully left to you. You should be able to design a working circuit and HMI. Details on designing a "Lead-Lag" motor design circuit are available online. For the HMI development and Studio5000 program you have the manuals, as well as the tutorials at Bryce Automation. My expectation is that you are investing at least six hours per week in actual preparation for our Monday evening class. That when you arrive in class you already have a developed outline in your notebooks of what your ladder logic program will look like, what your tag database will be, your displays in FTV will look like, where objects will be placed on the display, etc.

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How do I make security settings in FTV?
http://bryceautomation.com/index.php/2017/09/19/factorytalk-view-security/

How do I make multiple displays in FTV and move between them?
http://bryceautomation.com/index.php/2017/09/13/factorytalk-view-navigation/

How do I display numbers (data) from my Studio5k in FTV?
http://bryceautomation.com/index.php/2017/09/14/factorytalk-view-numeric-display/

How can I "hide" objects in FTV based on who is logged in?
http://bryceautomation.com/index.php/2017/11/02/hiding-objects-logged/

How can I make a slider and do other graphic animations in FTV?
https://www.youtube.com/watch?v=oH2NHwY8bFY
(Note: There is no talk over with the video just very annoying elevator music, so kill the sound and watch the video full screen. Check out the Rockwell site for additional videos.)

How do I make subroutines in Studio5k (you can right-click and delete the parameters if you don't need them)?
http://bryceautomation.com/index.php/2017/05/28/controllogix-simple-subroutines/

How do I make timers, counters, and resets in Studio5k?
http://bryceautomation.com/index.php/2017/05/30/controllogix-timers/
http://bryceautomation.com/index.php/2017/05/30/controllogix-counters/

How do I get the Time in Studio5k & use it in a program (it is called wallclocktime)?
http://bryceautomation.com/index.php/2017/06/03/controllogix-gsv-command-wallclocktime/

How do I apply rotational animations to my fan blade graphics in FTV?
https://www.solisplc.com/tutorials/hmi-development-factorytalk-view-studio-me-rotation-animation-tutorial-pump-fan-motor-program
If all else fails as a last act of desperation you can also read the manuals I loaded in Canvas.