Industrial Washers: Remote Monitoring

Project plan

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1 Introduction

1.1 PROJECT STATEMENT

Industrial parts washers manufactured by PMW use PLC's for control units that allow customers to control and modify wash cycle parameters such as water temperature, pressure, high and low reservoir fill levels, in addition to cycle times for the washing rinsing and drying of the parts. Washer PLC's are used to control the speed of transport belts or carousels that deliver the parts to the wash cycles. Washer PLC's often need to share cycle time data with robots designed to load and unload parts going through the washer enclosure. PLC's can monitor pressure drop through system filters to notify operators when filter media should be cleaned or changed. Access to operating data from customer sites would be very useful to PMW engineers when customers have equipment field inquiries and are not able to troubleshoot problems locally. It is not infrequent that the customer's wire pump motors in a configuration that has them rotating backwards and still operating at a significantly reduced pressure and flow rate. This could be diagnosed by the PMW engineers using PLC data.

1.2 PURPOSE

PMW would analyze field data collected by this system to allow future designs to have improved performance and reliability. PMW engineers could provide a level of support for customers they have not experienced from other cleaning equipment manufacturers. This would provide a competitive advantage for PMW.

1.3 GOALS

Goals for this project include:

1. Recommendations for two approaches with a proof of concept for the recommended system that might include embedded software for collecting data from the washer PLCs.

2. Provide a communication protocol that results in the key data being collected in a PMW database that the engineers can access in real time.

3. Provide step by step instructions on how to set up these communication protocols so that it can be repeated across a broad spectrum of products and systems.

4. Develop a user interface that can access this data remotely be usable by PMW engineers, service techs and sales representatives.

2 Deliverables

Documentation and proof of concept demonstration of one or more alternative systems communicating over a simulated distance to illustrate the feasibility of the recommended approach.
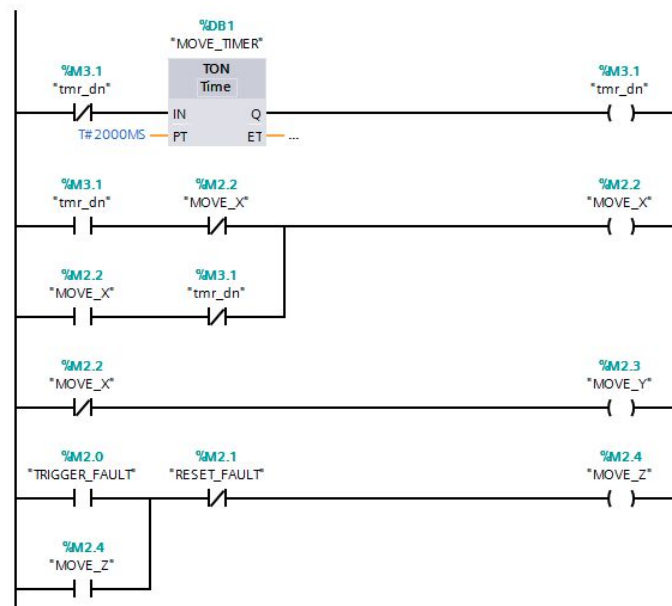
3 Design

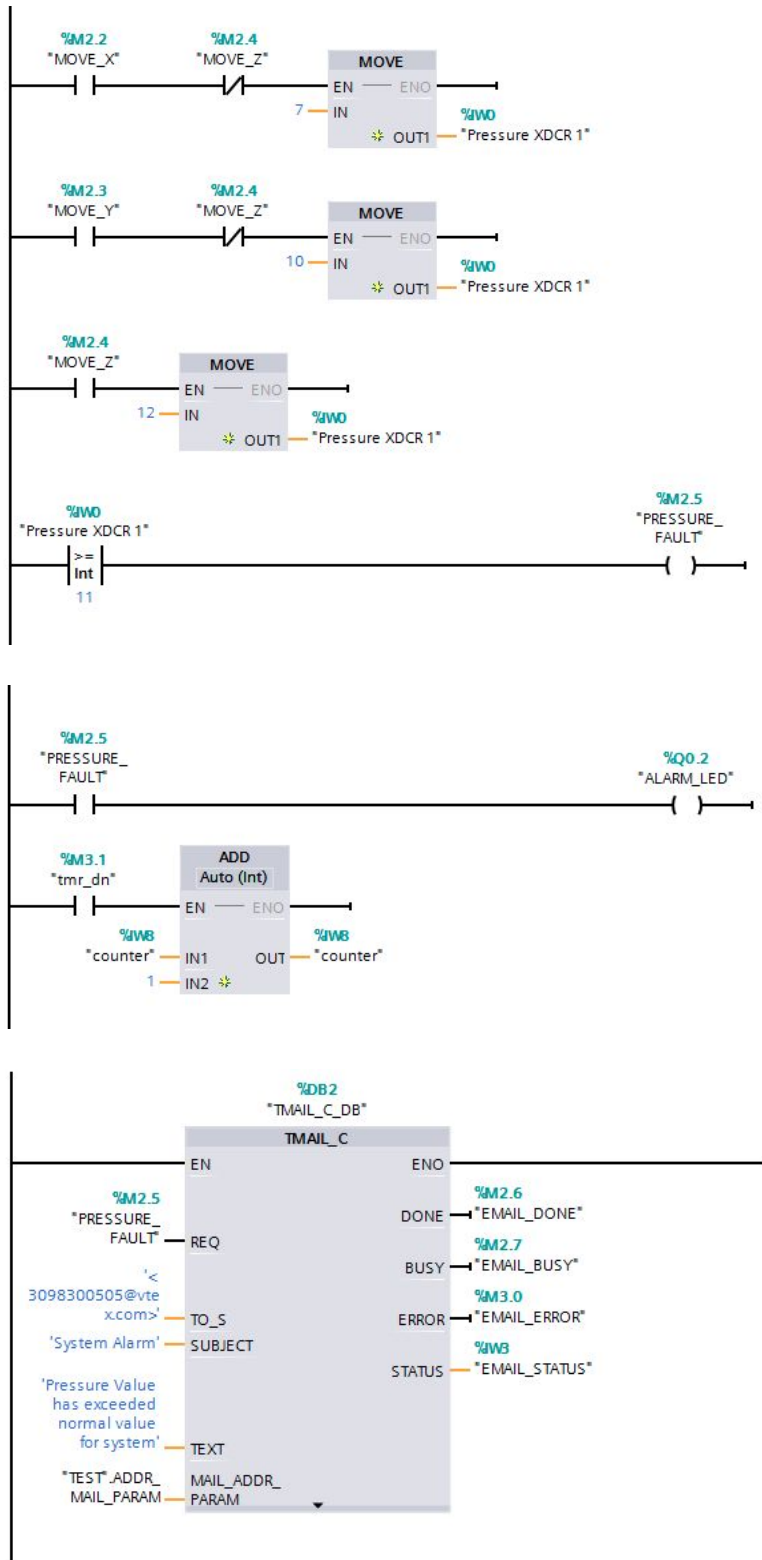The goal is to use the existing hardware as well as adding a few pieces that already exist.
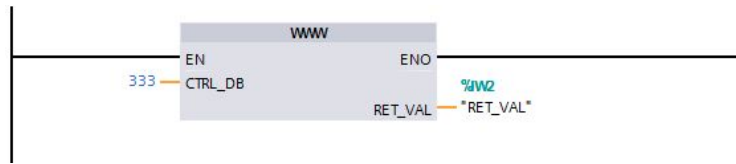
3.1 PREVIOUS WORK/LITERATURE

There are products that are available through both Siemens and Rockwell that are set up to work with PLCs. No specific examples of this exact procedure have been placed. Similar jobs have been done but with different working conditions.

3.2 DESIGN

The programming design for this project was completed in the TIA portal, software which is provided with the PLC. This is basic ladder logic which is based on normally open and normally closed contacts. Any person who has had experience with ladder logic in the past will not have any problems understanding the basic program or functions within the code below.

%M2.2
"MOVE_X"
─┤ ├─

%M2.4
"MOVE_Z"
─┤/├─

```
     MOVE
  EN ──── ENO
7 ─ IN
        OUT1 ─ %IW0
               "Pressure XDCR 1"
```

%M2.3
"MOVE_Y"
─┤ ├─

%M2.4
"MOVE_Z"
─┤/├─

```
      MOVE
   EN ──── ENO
10 ─ IN
         OUT1 ─ %IW0
                "Pressure XDCR 1"
```

%M2.4
"MOVE_Z"
─┤ ├─

```
      MOVE
   EN ──── ENO
12 ─ IN
         OUT1 ─ %IW0
                "Pressure XDCR 1"
```

%IW0
"Pressure XDCR 1"
```
 >=
 Int
 11
```

%M2.5
"PRESSURE_
FAULT"
─( )─

%M2.5
"PRESSURE_
FAULT"
─┤ ├─

%Q0.2
"ALARM_LED"
─( )─

%M3.1
"tmr_dn"
─┤ ├─

```
        ADD
      Auto (Int)
   EN ──── ENO
%IW8
"counter" ─ IN1   OUT ─ %IW8
                         "counter"
        1 ─ IN2
```

```
              %DB2
            "TMAIL_C_DB"
            TMAIL_C
   EN                    ENO
                                    %M2.6
                         DONE ─ "EMAIL_DONE"
%M2.5                               %M2.7
"PRESSURE_               BUSY ─ "EMAIL_BUSY"
FAULT" ─ REQ
                                    %M3.0
'<                      ERROR ─ "EMAIL_ERROR"
3098300505@vte
x.com> ─ TO_S                       %IW3
'System Alarm' ─ SUBJECT STATUS ─ "EMAIL_STATUS"

'Pressure Value
has exceeded
normal value
for system' ─ TEXT

"TEST".ADDR_   MAIL_ADDR_
MAIL_PARAM ─ PARAM
                        ▼
```

This program simulates pressure transducer data that would normally be obtained by the PLC from the sensor in the piece of equipment. The program is set up on a timer of 2 seconds which means that it checks for new values from the sensor every 2 seconds. This will then trigger the Pressure XDCR 1 value to change based on what the simulated value is portraying. When a "bad value" is presented (in our case it is in the form of a push button) the program will transfer the value to PRESSURE_FAUL and that variable will trigger an LED to show that there is an alarm in the system.

Alarms can also be set up to be seen via text message/email. The program above shows how a function block can be used to set up emails being sent directly from the PLC. This requires access to a server but would not be difficult for a customer to set up.

All of the variables can be accessed from a siemens defined webpage as well as a user defined webpage that was set up specifically for this project. User defined web pages are written in html and can be as simple or complex as the user chooses to make them. These pages can be accessed by anyone who has access to the network, or additional user security can be put in place. In our case, we used ethernet as it is not easy to access the school's network. However, in industry as long as the customer allows for network access, remote access will be quite simple using a wireless access point.

4 Challenges

PLC work is not something that is taught in either the electrical, computer, or software engineering course work. Because of this, a main challenge was working with the coding of the PLC and connecting all members to the project. Being able to test our solution may also be a challenge. Testing will have to be on a machine that the customer has available but not already connected to a PLC. This second challenge was overcome when we created simulated data that would be transferred from a sensor on the washer.

Another major difficulty came in the form of communication. Through this obstacle, we realized as a group how important communication is in an effective work environment. This aspect of a project can make or break a successful outcome. This is something we call became aware of at the end of this project.

Many of the customers that our client works with require different product lines to be used. Because of this, we had to focus on a few types to start with and let the client decide which one will be most beneficial to them. Each product line has different features and different coding processes so completing all of the options is a goal, but it may not be obtainable based on time constraints.
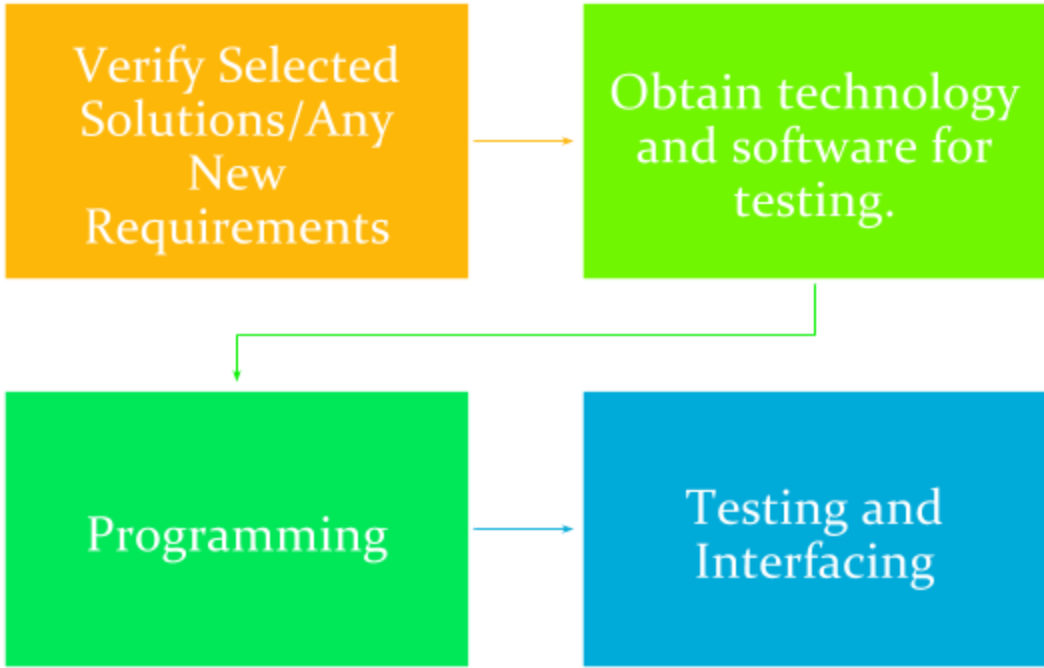
5 Timeline

5.1 FIRST SEMESTER

In our first semester, we focused on researching to learn more about PLCs. We came into this project with a few of us having a very basic understanding of the inner workings of PLCs, so it was important to get some more background information on the device. We also focused on narrowing down to three PLCs that we felt that the client could use with their products. By narrowing down, we were able to give much more detail on the options that we have selected based on what needs the customer had given. With the information for each PLC collected, we created a proposal for each of the options, including the pros, cons, costs and features for the client. We wanted them to select the best option for us to move forward and pursue into the next semester.
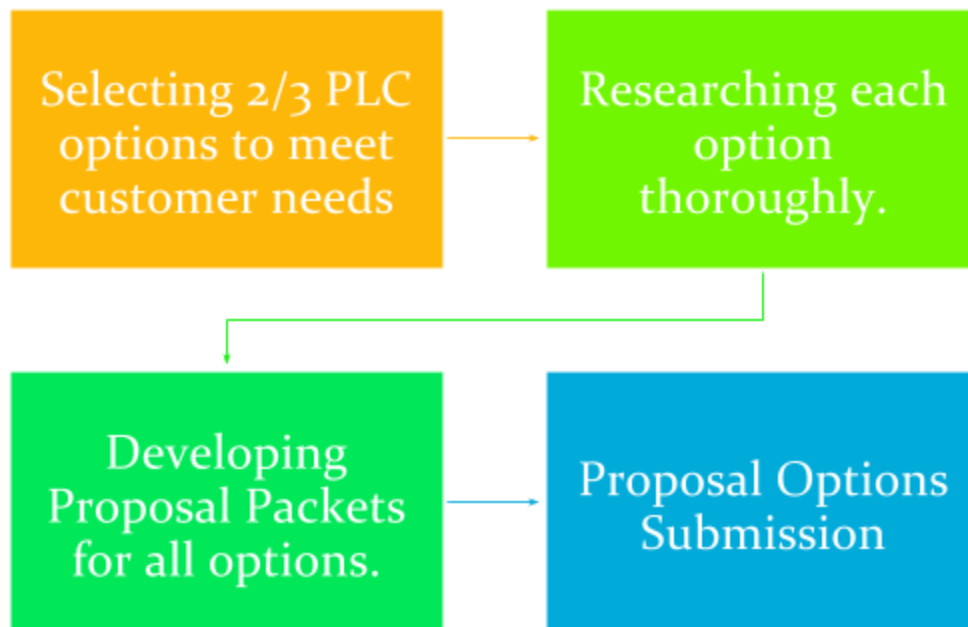
5.2 SECOND SEMESTER

The group decided to move forward with the Siemens S7-1200 PLC to implement remote access capabilities. After some quick initial research, we realized that the best way for us to do this was to have access to the PLC and its software. At this point, we found a vendor and bought the PLC using university funds. While we waited for the PLC to arrive, we continue to do research on viable design solutions to remote access. Once it arrived, we were able to get a better understanding of the system that we were working with and moved forward with implementing our ideas. We were able to program and test the PLC using simulated data which proved that our program and user interfaces were a viable solution to the problem given.

```
┌─────────────────────────┐          ┌─────────────────────────┐
│  Verify Selected        │          │  Obtain technology      │
│  Solutions/Any          │ ───────► │  and software for       │
│  New                    │          │  testing.               │
│  Requirements           │          │                         │
└─────────────────────────┘          └─────────────────────────┘

┌─────────────────────────┐          ┌─────────────────────────┐
│                         │          │                         │
│  Programming            │ ───────► │  Testing and            │
│                         │          │  Interfacing            │
└─────────────────────────┘          └─────────────────────────┘
```

6 Conclusions

Our plan is to implement a system that will allow our customer to successfully troubleshoot from a remote location by logging data and being able to see real time work that is happening on the washer. Using different platforms is an ideal solution for the client because it would allow them to be more diverse when marketing this service to their clients.

7 References

https://www.youtube.com/watch?v=NgZ5V3ruGAU

http://w3.siemens.com/mcms/programmable-logic-controller/en/logic-module-logo/pages/new-product.aspx

http://w3.siemens.com/mcms/programmable-logic-controller/en/basic-controller/s7-1200/pages/default.aspx

8 Appendices

8.1 Appendix I: Operation MAnual

Basic understanding of PLC functions and operation is necessary to adequately run the system. However, usage of the user defined webpage requires no additional knowledge other than basic web browser usage. Any instructional materials needed to program or maintain the PLC can be found on the manufacturers technical support webpages. Because our group didn't create these instructions, we did not add them to the appendices.

8.2 Appendix II: Initial Ideas

In the begining, on top of the remote access, we were working on a way to push the data to push the data given by the PLC via remote access to a user defined webpage. We also were looking for ways to analysis that data to the benefit of our client and their customers. This included the addition of alerts and optimal running conditions to maximize the efficiency of the PLC and the washers it controlled. However, after meeting with our client to fully define the project, we found that they only wanted remote monitoring of the PLCs, so the original additions would be considered out of scope.

The client also told us that they had used several different PLCs in the past from different companies. We took this into consideration and drew up proposals for several different PLCs, including the Allen Bradley Micrologix 1400, Siemens Logo!8, and the Siemens s7-1200. These proposals included the capabilities of these PLCs as well as ways to externally monitor We decided to continue designing the set up for the S7-1200 due to its ability to handle a wide array of projects as well as cost considerations.

8.3 Appendix III: Code

Tag table_1

	Name	Data type	Address	Retain	Visibl...	Acces...	Comment
	Pressure XDCR 1	Int	%IW0	☐	☑	☑	Simulated Pressure Value: PSI
	TRIGGER_FAULT	Bool	%M2.0	☐	☑	☑	
	RESET_FAULT	Bool	%M2.1	☐	☑	☑	
	MOVE_X	Bool	%M2.2	☐	☑	☑	
	MOVE_Y	Bool	%M2.3	☐	☑	☑	
	MOVE_Z	Bool	%M2.4	☐	☑	☑	
	PRESSURE_FAULT	Bool	%M2.5	☐	☑	☑	
	EMAIL_DONE	Bool	%M2.6	☐	☑	☑	
	EMAIL_BUSY	Bool	%M2.7	☐	☑	☑	
	EMAIL_ERROR	Bool	%M3.0	☐	☑	☑	
	EMAIL_STATUS	Word	%IW3	☐	☑	☑	
	tmr_dn	Bool	%M3.1	☐	☑	☑	
	ALARM_LED	Bool	%Q0.2	☐	☑	☑	
	RET_VAL	Int	%IW2	☐	☑	☑	
	counter	Int	%IW8	☐	☑	☑	
	\<Add new\>			☐	☑	☑	

```
<!DOCTYPE html>


 <html>

  <head>

   <meta charset="utf-8">

   <title>Washer Remote Monitoring</title>

        <style>

table, th, td {

  border: 1px solid black;

}

</style>

  </head>

 <body>

  <table style="width:100%">

 <tr>

  <th>Variable</th>
```

```html
    <th>Status</th>

    <th>Monitor Value</th>

   </tr>

   <tr>

    <td>Pressure XDCR</td>

    <td>On</td>

    <td>:="Pressure XDCR 1":</td>

   </tr>

   <tr>

    <td>Alarm LED</td>

    <td>Off</td>

    <td>:="ALARM_LED":</td>

   </tr>

    <tr>

    <td>Pressure Fault</td>

    <td>Off</td>

    <td>:="PRESSURE_FAULT":</td>



</table>


  </body>

</html>
```