ECET SENIOR DESIGN PROJECT REPORT

Wet Reagent Profile Sensor Visualization Tool

Submitted to

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by
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Wet Reagent Profile Sensor

ABSTRACT

The Wet Reagent Profile Sensor is a system that Roche Diabetes Care Indy uses in its diabetes test strip manufacturing process. The current system they are using involves a laser sensor that projects onto a wet reagent material after it is coated onto a substrate. The machine that applies the reagent uses averages of 800 measurement points taken by the laser sensor to determine whether or not the reagent is within acceptable limits. If the reagent applied to a given section of the material is not within acceptable limits, then that section is marked for rejection and later taken out of the roll. The current system does not store the data that is collected, display it in an easily accessible manner, nor provide direct access to the 800-point profiles. No variable option currently exists for the data collection rate and the sponsor would prefer a variable option, if possible.

The objective of this project is to store and display all 800 points of data in a profile, change the frequency at which data is collected, and display a 3-D visual of the profiles. These changes and additions should be accomplished while avoiding interference with the normal production process. During the first phase of this project, the student engineers have begun analyzing the system, making design decisions and choosing between different components, planning hardware and software connections, and designing an interface for the system. In the second phase of this process, students began working with Excel, which is the software that was chosen at the end of the first phase, as well as working with the controller in order to communicate serially to a computer. Due to the change of circumstances that occurred in the middle of the second phase, students could no longer test communication options with the controller. The testing and verifying stages of the project were concluded at this point and students were asked to focus on documentation. Students created a new document that discussed all of the decisions that were made throughout the project, if the decision was used, and why or why not. Test plans were revised and updated as well.

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REVISION HISTORY

Version	Date	Revised by	Description
1.0	12/1/2019	Caleb Jackson and Kacie Darrough	Initial version.
2.0	12/3/2019	Caleb Jackson and Kacie Darrough	Added abstract and conclusion. Updated introduction.
3.0	12/12/2019	Caleb Jackson and Kacie Darrough	Software and Interface was updated. Explanations added to System-Wide Design Decisions. User Setup and Operation section added to System Architectural Design.
4.0	12/15/2019	Caleb Jackson and Kacie Darrough	Changed wording and formatting based on feedback. Changed Hardware Design Diagram to reflect feedback.
5.0	2/23/2020	Caleb Jackson and Kacie Darrough	Updated Abstract, changed Introduction and Problem Statement, System Overview, System Wide Decisions, Software Block Diagram, Interface, Concept of Execution, Interface Design, User Setup and Operation, and Conclusion.
6.0	4/13/2020	Kacie Darrough	Updated Abstract, System-Wide Decisions, Conclusions and Recommendations.
7.0	4/16/2020	Caleb Jackson and Kacie Darrough	Updated System Overview section, User Setup, References, System Wide Decisions, Concept of Execution, and Operation section. Added Appendices. Added Document Approval page. Improved formatting in various sections.
Library	4/23/2020	Caleb Jackson and Kacie Darrough	Edited document for library submission based on customer's request.

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1. INTRODUCTION

Roche has a system for preparing blood glucose strips in order to manufacture and sell them to the public. Their current process is that a large roll of material is unwound and is sent to a station where the reagent is put onto the material. While the reagent is still wet, it then goes through several different checking processes to make sure that the reagent is on the strip and that it is within specifications. One of the checking processes involves the Wet Reagent Profile Sensor (WRPS) system. If a section of material is flagged as non-conforming, the system keeps track of this area and it is then marked for reject later in the process. After it goes through these three processes, the reagent gets dried down onto the strip and then is rewound.

1.1 Problem Statement

The Wet Reagent Profile Sensor allows the users and engineers to troubleshoot the reagent on the strip. The WRPS scans blood glucose strips and the reagent that is placed on them. It collects multiple profile data sets of the reagent, performs calculations, and determines if there are non-conforming issues with said reagent. If the sensor measures outside of its established limits, that section of material will be marked for reject and eventually taken out of the production line. The data that is collected is not stored and not displayed in a way that is easily accessible. The system uses averages of parts of the profile points and does not provide direct access to the entire 800-point profile. Data collection rate is not variable and the customer wants a variable option that does not affect the PLC.

The objective of this project is to store and display an entire profile data set (800 points) using the Wet Reagent Profile Sensor.

- Store and display all 800 points of data in a profile
- Store and display multiple profile data sets
- Change the frequency in which the data is received
- Frequency of data being received does not affect 0.7 sec trigger rate from PLC
- Display 3-D visual of the Wet Reagent Profile
- Project cannot interfere with normal production.

Out of Scope

- Provide profiles for other reagents aside from the chemical compound placed on the substrate
- Run the process/collect the data too many times
- Different/new hardware or sensor software

1.2 System Overview

Currently, the entire system unwinds a roll of material. The reagent is placed on this material and then checked in several different checking processes, the WRPS being one of them. Once the reagent is checked, the reagent then gets dried down onto the strip and the material is rewound. If a section was marked for rejection, it is taken out of production at a downstream process. Please see Figure 1 for visual representation.

The new process will be relatively the same as the current system. Multiple profile data sets will be collected. This data will then be sent to a storage system that will keep the data for an extended period of time. The data being stored will be displayed in a list format as well as a 3-D format. The frequency in which the data is collected will also be variable.

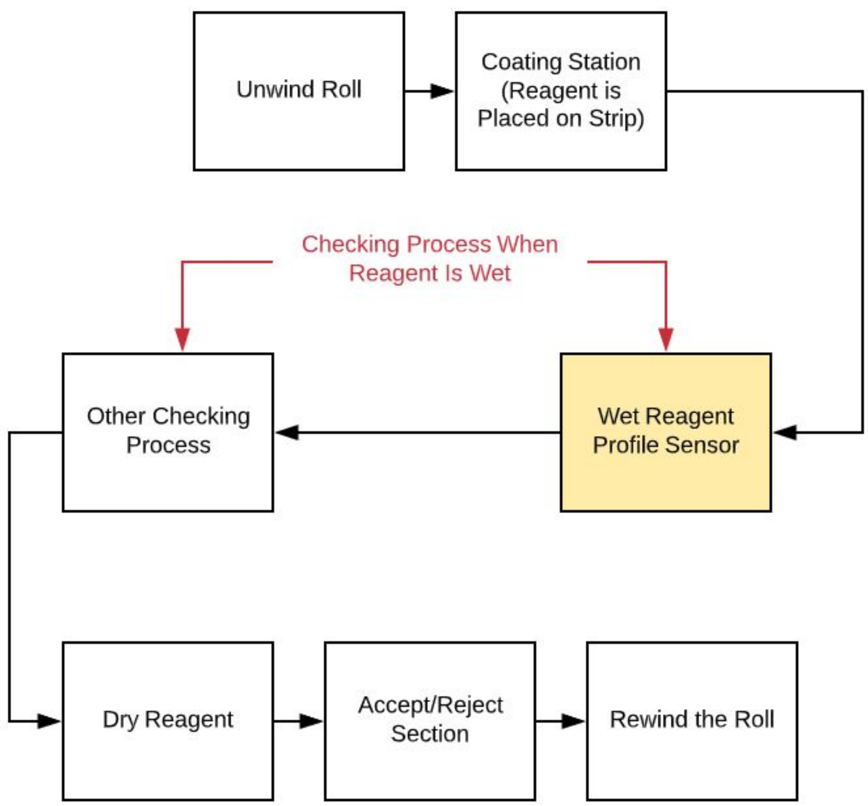

Figure 1: System Overview

2. REFERENCED DOCUMENTS

Table 1: Reference Documents

Title	Source	Comment
WRPS User Manuals	OEM	
Functional Specifications	Student Engineers	We already have the Functional Specs doc completed so we just used information from that document.
High-Level Design Document	Student Engineers	There is information that overlaps between this document and our high-level design document
Low-Level Design Document	Student Engineers	There is information that overlaps between this document and our low-level design document.
IEC 61326 (EN 61326) – Electrical Equipment for Measurement, Control and Laboratory Use – EMC Requirements	https://www.iecee.org/dyn/www/f?p=106:49:0::::FSP_STD_ID:5275	For immunity and emissions regarding electromagnetic compatibility (EMC) for electrical equipment, operating from a supply or battery of less than 1000 V AC or 1500 V DC or from the circuit being measured.
IEEE 802.3u – IEEE Standards for Local and Metropolitan Area Networks	https://standards.ieee.org/standard/802_3u-1995.html	Media Access Control (MAC) parameters, Physical Layer, Medium Attachment Units, and Repeater for 100Mb/s Operation
P3333.2.2 - Standard for Three-Dimensional (3D) Medical Visualization	https://standards.ieee.org/project/3333_2_2.html	For the 3-D display of the profile data
P3333.2.3 - Standard for Three-Dimensional (3D) Medical Data Management	https://standards.ieee.org/project/3333_2_3.html	For the storage and displaying of profile data from the sensor
Confidentiality Disclosure Agreement	Faculty Advisor/Roche	To keep proprietary information confidential unless it's the student engineers or faculty at IUPUI

3. SYSTEM-WIDE DESIGN DECISIONS

Data Collection				
	Already In Use?	**Cost**	**Efficiency**	**Options**
RS-232 to USB	Yes	$0 (already using)	Usually slower than ethernet but has guaranteed speed; slower than USB but good for hardware control	Limited length of cable (up to 50 ft); can be accessed directly by an application
Ethernet to USB	No	$$	Depends on network traffic; Faster than USB; Usually faster than RS-232 but not as guaranteed	Many length of cable (up to 328 ft)
USB to USB	Yes	$0 (already using)	Faster than RS-232; slower than Ethernet	Limited length of cable (up to 16 ft); can have multiple USB connections on one host computer

Table 2: Data Collection

The current system uses both RS-232 to USB and USB to USB methods for data collection. We were told by the sponsor that they would like us to look into the benefits of an Ethernet to USB. In terms of cost, adding the Ethernet option would be more expensive. In terms of efficiency, the Ethernet option would generally be faster than what is already in use, but the stability of the data collection would depend on the amount of network traffic, meaning that it could end up being less reliable. The RS-232 connection is the slowest of the three options, but has a guaranteed speed, and therefore greater stability than Ethernet. It is also better for hardware control than a USB option. One other thing to consider, however, is the maximum length of the cables. The USB cables only go up to 16 ft and the RS-232 cables only go up to 50 ft; whereas, the Ethernet cables can span up to 328 ft, making them better for systems in larger areas. At this point, it makes sense to continue using the existing methods for data collection, but the Ethernet option has not been completely rejected. Further research and testing will need to be done.

Trigger Options		
	Already In Use?	**Frequency**
PLC	Yes	Based on timer
Sensor Software	No	Manual or continuous

Table 3: Trigger Options

The controller that we were given to control the trigger of the sensor laser only has two options for the trigger rate. It can either be triggered manually, at the press of a button, or continuously. The continuous option triggers significantly faster than what the sponsor said their system was triggering the sensor at. As such, we determined that the trigger rate was being controlled in the PLC via RS-232 commands. This was later confirmed by the sponsor.

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GUI Options				
	User Friendly?	**Efficiency**	**Aesthetics**	**Customer Efficiency**
Formatted Excel	Customer is familiar with the program and is comfortable	Multiple profiles with all data points on one Excel file; 1024 profiles is spread across 3 Excel files	Looks like an Excel file but may be able to add headers in Macro	Already familiar with Excel and Visual Basic for Excel. Can go in and make changes themselves when needed
Self-made GUI	Can make it as user friendly as needed	Make it display information for preference of user	Can change aesthetics as needed (simple/professional/etc.)	Not as familiar; would have to call student engineers or outside source if they would want changes

Table 4: GUI Options

Upon looking into the options for displaying the profile data that was being collected and stored, we had initially decided to use a custom-made graphical user interface, rather than the Excel spreadsheet that is currently being used. The thought process was that it would look nicer than an Excel file and that a new user would be able to more quickly access and compare data sets. However, after consulting with faculty and the project sponsor, it was determined that it would be better to pursue the formatted Excel option, as the people working at Roche already use Excel extensively and would be more familiar with that than they would with an entirely new interface.

User Interface Program				
	Student Knowledge	**Ease of Use for Students**	**Support**	**User Interface Elements**
Visual Studio C#	Student engineers have some knowledge of C# programming after 1 semester of object oriented class; it has been 6 semesters since the class but students know how to research and relearn the	Student engineers are more comfortable with this language and know its full capabilities	Faculty advisor teaches classes based on C# and the internet support seems to be superior to the support of Labview	Has many different elements that can be applied to user interface (i.e. buttons, list boxes)
Labview	Student engineers have had some classes that teach different elements of Labivew	Student engineers have a good idea of how to use this program, but don't find it as easy to use as C#	Lacks good support online; hard to find answers to questions or it's difficult to understand how to use something	Has many different elements that can be applied to user interface (i.e. buttons, list boxes)

Table 5: User Interface Program

While we were looking into creating a graphical user interface for the display, we examined both Visual Studio C# and LabVIEW as possible options. We had used both programs extensively and both would be viable options for creating an interface. However, we reached the conclusion that we were both more comfortable with Visual Studio C# and the support that we would have access to for it would be better than the support that we could get for LabVIEW. We will not be using either of these user interface programs because it was decided that Excel would be best for the customer.

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Data Collected

	Chosen?	Why?
Profile Storage	Yes	Using profile storage allows the system to split the correct 800 points into their profiles, and when they are manually exported to a .csv file, each row is a profile.
Data Storage	No	Data storage would just provide data points but without providing information on which profiles the data goes to.
Both	No	The data itself is redundant and the customer does not want too much information or it will slow the controller and the Excel file.

Autosaving

	Chosen?	Why?
Sensor Software	No	After talking with a representative, it was determined that it was not possible to autosave with this software. It was discussed with other software employees at the manufacturer and the final consensus was that autosaving was not an option with this software.
Memory Card	No	Saving data to a memory card via the sensor software only works when the profile data collection is paused, meaning that the controller and sensor are no longer collecting data. To save the data to the memory card, a remote and separate display screen are required. The data is collected by the sensor and software, then you must pause the software and data collection, use the remote on the second display, and download and store the data to the memory card manually. Using RS-232 communication to send commands, the data can be saved to the memory card by simply sending the "SS" command. However, we were not able to test this in a continuous process to see if it would still pause data collection. In addition, extracting the data from the memory card would still require using the remote and stopping the process in order to manually access the stored data. As such, this is not a valid option for the production line.

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Communication

	Chosen?	Why?
USB	No	This option was tested using third party communication software (PuTTY) and there was no communication between the controller and the computer.
Ethernet	No	Could not communicate between the computer and controller using PuTTY.
RS-232	Yes	This was an option that was discussed in the first term of this project, when talking with the manufacturer's representative. It was determined in the second semester, after exploring the autosaving options, that RS-232 communication was the best approach. We were able to get communication working between the controller and the computer using PuTTY, and we sent commands to the controller to trigger the sensor and receive that data in the PuTTY control window. When we were able to successfully retrieve that data, we decided to use the RS-232 for communication.

Graphical User Interface

	Chosen?	Why?
Excel	Yes	The customers are very familiar with Excel, and any changes or fixes needed to be made to the program, they wanted to be able to do that without having to contact us for a fix. They also were comfortable with the layout of the data in Excel and the way the graph was displayed.
Visual Studio C#	No	The customers are not as familiar with C# programming and if there were changes they wanted to make or issues they needed to address, it would be difficult for them to contact someone at the school or one of the student engineers in order to get answers.
LabVIEW	No	The customers do not have a LabVIEW license, and it is very expensive. We did not want to ask them to get a license just for this project, especially because they wouldn't be as familiar with it as they are with Excel.

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Communication Software

	Chosen?	Why?
Excel Macro	No	It appears that it is not possible to communicate directly with the controller using Visual Basic for Applications (VBA) code. VBA is what Excel uses to program macros, and after extensive research and trial and error, it was determined that using VBA code is not a valid way to send commands to the controller and receive data back into the Excel file.
LabVIEW	No	The license for this software is very expensive ($5,000) and Roche does not own a license. Since it would probably only be used for this project, this decision was eliminated.
Advanced Serial Data Logger	No	This software was advertised as working for 64-bit systems, but required 32-bit ActiveX control to send data to a device and the systems that we are working with are 64-bit. The 32-bit ActiveX requirement means this is not a viable option.
TWedge	No	We tried the demo for this software, but the function needed to write commands to the device was not included in the demo package. The license is $117 and we wanted to continue to search for free options before buying a license.
WinWedge	No	No trial for this software is available, so we would have to buy a license to test it. Since we could not test it first, we did not want to purchase the $500 license just to discover the software does not work for our project.
Visual Studio C#	Maybe	This option has not been tested yet, as our ability to continue testing was abruptly halted by the current pandemic. However, research indicates that there is C# code that allows for communication between the controller and Visual Studio. It appears that there is code that allows commands to be sent and data to be received. From there, the plan was to take the data that was sent to the Visual Studio program and send it to an Excel file. The Excel macro would then do the rest of the work.

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3.1 Hardware

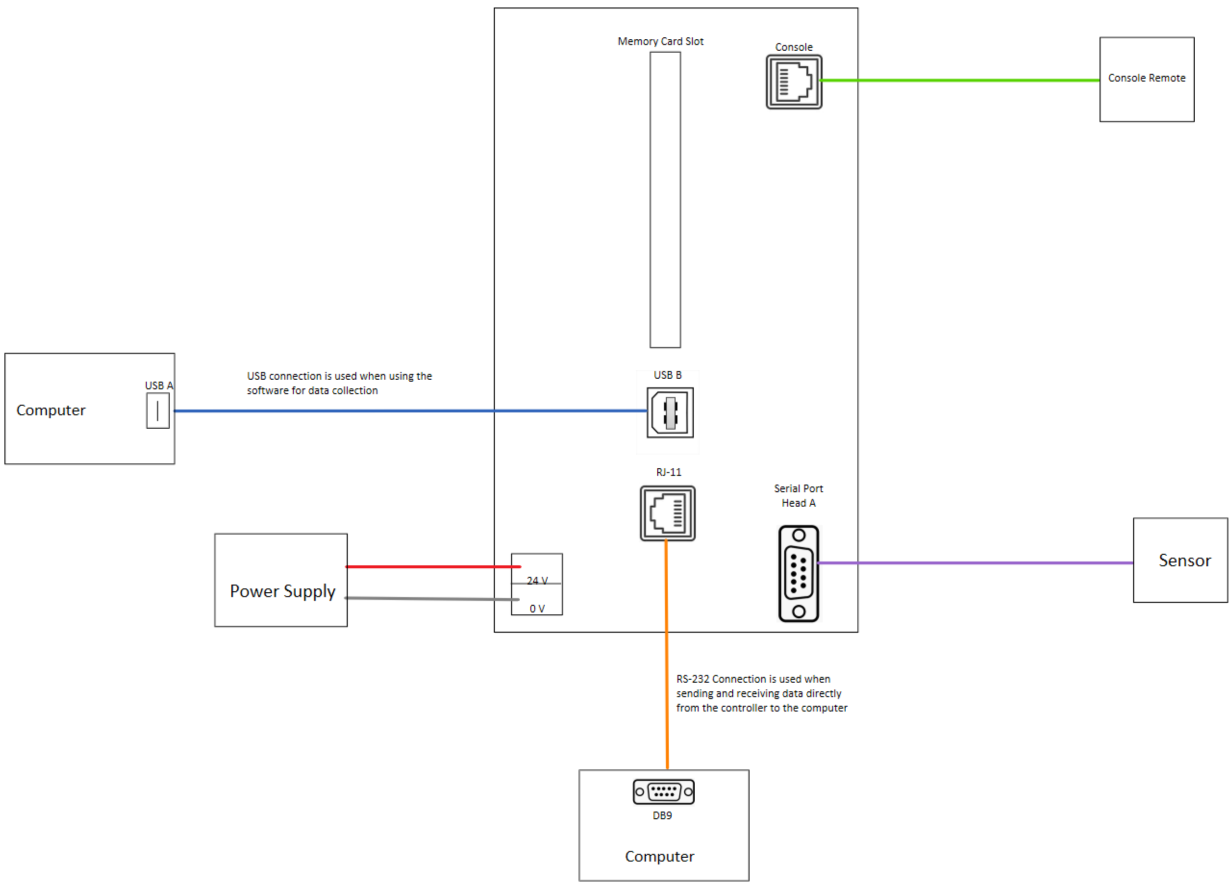

Figure 2: Hardware Diagram of the Sensor Controller and Various Connections

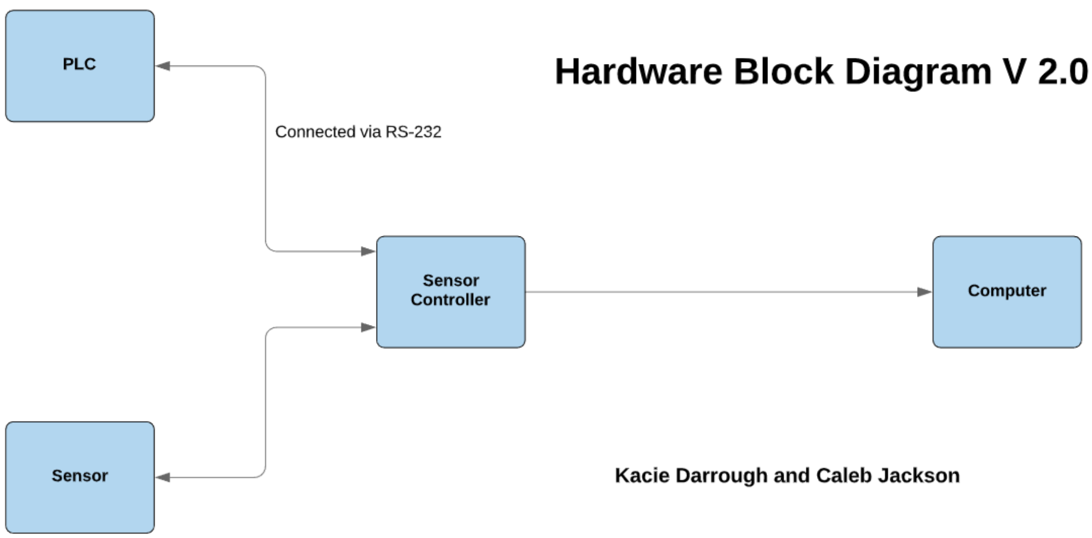

Figure 3: Hardware Block Diagram

3.2 <u>Software</u>

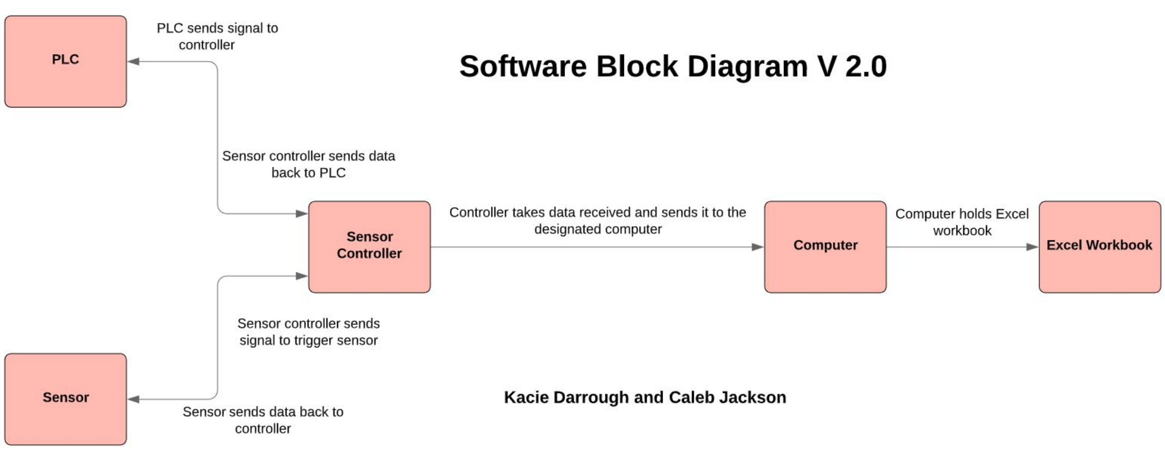

Figure 4: Software Block Diagram

3.3 Interface

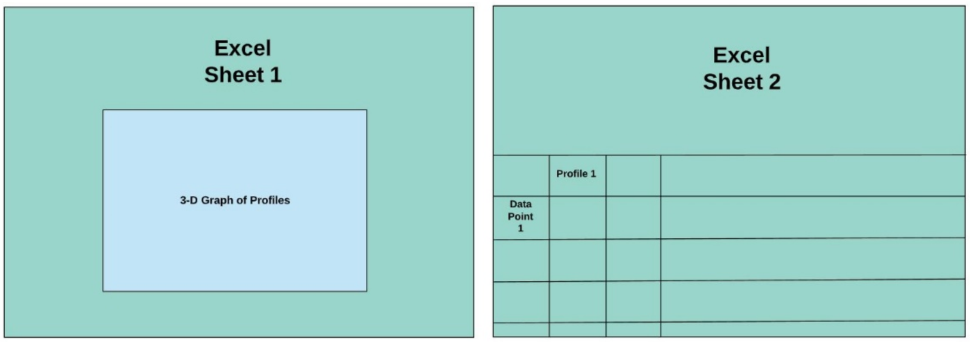

Figure 5: Interface Design

Since the customer is already using Excel, we decided the best option for the interface was to keep it as a formatted Excel sheet. The 3-D graph of the profiles will be on one Excel sheet, continuously updating, while the data is being pulled into a second Excel sheet, being saved and stored. This will keep the screen from being so crowded, hopefully keeping the update time relatively fast.

4. SYSTEM ARCHITECTURAL DESIGN

4.1 System Components

In our hardware block diagram, we have a PLC, the WRPS sensor, a sensor controller, and a computer (any model). The PLC is connected to the sensor controller via an RS-232 cable and the sensor is connected via a serial cable. The sensor controller connects to the computer in a couple of ways, either by USB or RS-232. We were not able to select any of these devices since we are using an already existing set-up.

4.2 Concept of Execution

The PLC sends a trigger signal to the sensor controller. The controller receives the digital input from the PLC and sends the signal to the sensor. The sensor activates the laser, collects the profile data points, and sends this information to the controller. The controller then sends the measurement data received from the sensor back to the PLC. We intend to use RS-232 for our communication. A Visual Studio C# program will send commands to the controller and receive the data that is needed. The C# program will then send that data to an Excel file where a macro will format and store the data, as well as display the data in a 3-D graph.

4.3 Interface Design

For connections between the hardware and the software, an RS-232 cable sends a signal from the PLC to the controller. The controller then uses a serial cable to send that trigger signal to the sensor and the sensor physically emits a light to read the data and then send the data back to the controller. A USB cable is the connection between the controller and the computer, and the USB cable sends multiple types of data to the computer. If the user were to change settings in the controller software, the USB cable is used to send that changed data to the controller. In terms of outputs, the client wants as many profile sets as possible per roll (1024 profiles is the maximum that can be stored) with 800 data points in each. They want it displayed in both an easily accessible list format as well as a 3-D rendering of the data.

4.3.1 User Setup and Operation

Requirements

The following table provides a reference to the requirements that need to be electronically tested. The test cases that are used to check compliance to the requirements are cross-referenced in the table below.

Test Case #	Requirement Description
Test Case #1	Determine that the Sensor Controller is properly acquiring, storing, and saving reagent profile data.
Test Case #2	Determine that RS-232 communication with the controller is functioning properly.
Test Case #3	Determine that profile data is being properly saved to the memory card via RS-232 commands.
Test Case #4	Determine that the profile data is being properly extracted from the controller via Visual Studio C# code.
Test Case #5	Determine that the graph on a separate Excel file is continuously updating with new profile data.

Test Components

The table below provides the details of all the components required to execute this test procedure. Based on the different test cases, different components may be required to execute different test cases. See Appendix for pictures of the different components.

#	Component	Component Details
1	Removed by Customer	Sensor Controller
2	Removed by Customer	Sensor to read profile data
3	Removed by Customer	Controller – Sensor communication cable
4	USB B-to-A	Controller – Computer connection for sensor software
5	RS-232	Controller – PC connection for serial communication (OP-26487 cable with OP-26486 DB9-Pin head)
6	Power Supply	Power supply to provide 24 V AC to the controller
7	PuTTY	Terminal emulation software used to send RS-232 commands and verify communication
8	Compact Flash (CF) Memory Card	CF Memory Card used to save and export profile data. We used the HuaDaWei 1GB CF Memory Card.

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Test Cases

This section discusses the various test cases that are needed to test the Wet Reagent Profile Sensor Visualization Tool.

Test Case 1: Acquiring and Storing Profile Data with the Sensor Controller

Purpose

The purpose of this test is to verify whether the Sensor Controller is able to properly acquire, store, and save reagent profile data.

Test Setup

Equipment:	The following components are necessary for executing this test case:
	☐ Sensor, Sensor Controller, Communication Cable, Power Supply, USB B-to-A
Preparation:	☐ Ensure that all components are present

Test Process

Test Steps:	1. Connect the Sensor to the Sensor controller via the Communication Cable. 2. Connect the Sensor Controller to the power supply. Turn on the power to the controller. It requires 24 V AC. 3. Load up the Sensor software. 4. Select “Read the settings of the connected controller” and click “Ok.” 5. Select “View Profile.” 6. When the new window appears, select “Profile acquisition start.” 7. Return to the main screen. 8. Select “Profile storage.” 9. When the new window appears, select “Start storage.” 10. Once you have collected some profiles, select “Read storage data.”

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	11. To save information to an Excel sheet, select “Save to file.”
Expected Result(s):	1. The system should display and store profiles detected by the Sensor. Reading the storage data will allow the user to examine individual profiles. Saving the information to a file will send all the profile data to a formatted Excel sheet and display the numerical data in the cells. Depending on how many profiles are stored, it may create more than one Excel file.
Fault Condition(s):	1. Fault: The Sensor Controller does not turn on. Fix: Check that the controller is properly connected to the power supply and is receiving 24 V AC to its voltage input pins.
	2. Fault: The application does not store profile data Fix: Make sure that the controller’s storage is not full. It can only hold a maximum of 1024 profiles. Once it reaches this limit, storage will stop and must be cleared before it can be started again.
	3. Fault: Failed to communicate error message when attempting to read the settings from the controller. Fix: This is typically caused by a change in the communication settings. Bypass the error message by selecting “Startup with default values.” Select a config file. It doesn’t matter which one. Then go to “Comm settings” > “PC communication settings” and select “Communication via USB.” Then click “Ok.” You should now be able to return to the main screen and receive the settings from the controller.

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Test Case 2: Verifying RS-232 Communication with PuTTY

Purpose

The purpose of this test is to verify that RS-232 communication with the controller is functioning properly via the PuTTY terminal emulation software.

Test Setup

Equipment:	The following components are necessary for executing this test case:
	☐ Sensor, Sensor Controller, Communication Cable, RS-232, Power Supply, PuTTY
Preparation:	☐ Ensure that all components are present

Test Process

Test Steps:	1. Connect the Sensor to the Sensor controller via the Communication Cable.
	2. Connect the Sensor controller to the PC via RS-232.
	3. Make sure the controller is connected to the power supply. Turn on the power to the controller.
	4. Load up the PuTTY software.
	5. Select the “Serial” connection type.
	6. Set the serial line to the corresponding COM port.
	7. Set the speed to 19200. This is the value that the controller is using.
	8. Under the Terminal tab, select “Implicit CR in every LF,” “Implicit LF in every CR,” and then under Local echo, select “Force on.”
	9. Under the Serial tab, set the Flow control to “None.”
	10. Press “Open.” A command prompt window should come up.
	11. Type “S1” and then press the Enter key. This command will cause the sensor to trigger.
	12. Type “S2” and then press the Enter key. This command will display the data points of the collected profile on the screen.

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Expected Result(s):	1. Sending these simple commands should be enough to establish that the RS-232 communication between the PC and the controller is functioning properly. (See PuTTY Data Collection Example in Appendix for reference)
Fault Condition(s):	1. Fault: Error message popup – Unable to open COM port. Fix: This typically indicates that the COM port is in use by another application. Make sure that the COM port selected is the correct one. Close any other application that may be making use of the corresponding COM port and try again.
	2. Fault: Noise appearing in text after each character input. Fix: This is caused by the baud rate in PuTTY not matching the baud rate in the controller. Make sure that the speed setting in PuTTY matches the baud rate of the controller and then try again.
	3. Fault: Nothing being returned after a valid command is entered. Fix: This indicates that there is no communication between the PC and the controller, despite the COM port being opened successfully. Make sure that the RS-232 cable is the correct one listed in the Test Components section and that it has not been damaged or disconnected. If it is not the listed cable, there may be a difference in the pinout or cable protocol causing the communication issue. Replace with a proper cable.
	4. Fault: Command returns error message ending in 00. Fix: This indicates that the error was in the command itself. Make sure that the command is input correctly and try it again. (See PuTTY RS-232 Error Response Command Format in Appendix for reference)
	5. Fault: Command returns error message ending in 01. Fix: This indicates a status error. Make sure that the PuTTY settings are correct and the controller is ready to receive commands. Then input the command again. (See PuTTY Settings and PuTTY RS-232 Error Response Command Format in Appendix for reference)

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Test Case 3: Using the Sensor Controller Memory Card

Purpose

The purpose of this test is to verify whether the Sensor Controller's Compact Flash Memory Card can be easily accessed and used to save profile data.

Test Setup

Equipment:	The following components are necessary for executing this test case:
	Sensor, Sensor Controller, Communication Cable, Power Supply, RS-232, Compact Flash Memory Card, Sensor Remote Control Console
Preparation:	Ensure that all components are present

Test Process

Test Steps:	1. Make sure the Sensor Controller is connected to the power supply and turned on.
	2. Make sure that the memory card is inserted into the Sensor Controller and that the memory card light is on.
	3. Connect the Sensor Remote Control Console to the controller.
	4. Follow the steps listed in Test Case #2 to send RS-232 commands through PuTTY.
	5. When you get to the command prompt screen, start by sending the "AS" command to begin profile storage.
	6. Send the "S1" command a few times to trigger the sensor and store some profiles.
	7. After storing some profiles, send the "SS" command to save the stored profiles to the memory card.
	8. Press the Prog/Run switch on the side of the console. The switch will bring up the menu screen on the connected HMI.
	9. Use the arrow keys on the console to move up to the top of the screen and select "Memory Card."

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	10. Select "Profile Storage" from the Load menu. 11. From here, you can access the saved profile data, load, and display it on the connected HMI to make sure that it is being saved properly. 12. Once you have verified that the data is being saved properly, press the Escape key on the console to finish.
Expected Result(s):	1. The memory card screen should be accessible through the use of the Sensor Remote Control Console. Once it has been accessed, the user should be able to set it up to access the memory card from an external application and export the saved data when necessary.
Fault Condition(s):	1. Fault: (Additional testing required) Fix:

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Test Case 4: Sending Profile Data from the Sensor Controller to Excel via RS-232 Commands in Visual Studio C#

Purpose

The purpose of this test is to verify that the storage process via RS-232 commands in C# is functioning and the data is being properly sent to Excel for display.

Test Setup

Equipment:	The following components are necessary for executing this test case:
	☐ Sensor, Sensor Controller, Communication Cable, Power Supply, USB B-to-A, RS-232
Preparation:	☐ Ensure that all components are present

Test Process

Test Steps:	1. Make sure the Sensor Controller is connected to the power supply and turned on. 2. Make sure the Sensor is connected to the Sensor Controller. 3. Make sure the Sensor Controller is connected to the PC. 4. Load up Visual Studio C# on the PC. 5. Select the WRPS control program. 6. Compile the program. 7. Execute the program. 8. Check Excel to make sure the data is being sent properly.
Expected Result(s):	1. The Visual Studio C# code should send RS-232 commands to the controller to begin profile storage, trigger the sensor, clear storage, etc., as well as send the collected data to Excel for display.
Fault Condition(s):	1. Fault: (Additional testing required) Fix:

Test Case 5: Graphical User Interface (Excel Macro)

Purpose

The purpose of this test is to verify whether the Graphical User Interface for the WRPS is functioning properly.

Test Setup

Equipment:	The following components are necessary for executing this test case:
	☐ Sensor, Sensor Controller, Communication Cable, Power Supply, USB B-to-A, RS-232
Preparation:	☐ Ensure that all components are present

Test Process

Test Steps:	1. Make sure the controller is connected to the power supply and turned on. 2. Follow the steps in Test Case #4 to send data to an Excel file. Alternatively, use the Sensor software to collect and store profile data and save it to a .CSV file for testing. 3. Check data file to make sure that profile data is being saved. 4. Open graph Excel sheet. 5. Run the Excel macro. 6. A 3-D graph of the profile data should appear. 7. The graph should automatically update as new data comes in. However, depending on how much data is coming in at once, the graph update may take up to a minute to complete.
Expected Result(s):	1. The GUI should display the profile data from the Sensor Controller in a neat list format that can be easily accessed and read by the user, as well as a 3-D graph of multiple profiles. The graph should update automatically as new data is sent to the file.
Fault Condition(s):	1. Fault: Running the Excel macro returns an error message. Fix: (Additional testing required)
	2. Fault: The graph does not update as new data is sent to the file. Fix: (Additional testing required)

5. CONCLUSIONS AND RECOMMENDATIONS

During the first phase of the Wet Reagent Profile Sensor project, the student engineers have learned the sensor system, researched the data management and storage options, as well as made design decisions based on the existing process. They are to store all 800 points in a profile, store multiple profiles, display the data in list format, as well as display the points in a 3-D format. Based on this information, students are continuing to get an understanding of how to store the data automatically but are prepared to make a graphical user interface for the data once it is successful. The student engineers have determined which mode of collection is best, as well as which graphical user interface program to use.

In the second phase of this project, students have made progress with serial communication between the controller and a computer, as well as making progress with creating an Excel workbook macro that will take data and store it in an Excel sheet, as well as update a graph with the information. From this point forward, it is suggested to try Visual Studio C# as a way of pulling data from the controller and bringing it to the computer. From there, the C# program should send the data to an Excel file, where a macro will create a display of the data.

Wet Reagent Profile Sensor

NOTES

Terms and Definitions:

Term	Definition
Sensor	2-D display system for user that shows small slice of reagent on strip
Points	Individual height measurement points across the width of the sensor
Profile	All points of data
Reagent	Chemical compound that reacts with blood
Roll	Strip material for test strips. Detailed information removed by customer.
Strips	Strips that the reagent is coated on

REFERENCES

- Roche Diabetes Care Indy
- Sensor User Manual – Detailed information removed by customer.
- **Excel VBA code:** created by Sumit Bansal from https://trumpexcel.com, Microsoft, Chris Newman from TheSpreadsheetGuru and modified for this project

APPENDICES

Section removed at customer's request.

Wet Reagent Profile Sensor

Document Approval

This section includes signatures of those that have written, reviewed or approved this Final Report deliverable for the Wet Reagent Profile Sensor.

Author's Signature:

Your signature indicates that this document describes the Requirements of the Wet Reagent Profile Sensor and that this deliverable meets Roche standards for documentation.

Name	Signature	Title/Department	Date
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Approvers' Signatures:

Your signature signifies that you agree with the low-level design presented in this document, and that it has been reviewed by appropriate personnel to ensure compliance with company and/or regulatory policies.

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