

1910605

by Karla Wilson

Submission date: 26-Apr-2022 05:27PM (UTC+0100)

Submission ID: 177377284

File name: 17779_Karla_Wilson_1910605_179606_335872921.pdf (2.21M)

Word count: 3017

Character count: 17943

Course: HNC Electrical and Electronic Engineering

Module: SGEE4005 Instrumentation and Integrated Automation Systems

Assignment: 2. Integrated Automation System

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University number: 1910605

Date submitted: 26/04/2022

Word count: 2206

Contents

1. Research.....	3
2. System Overview and Operation	5
Overview:.....	5
Pneumatic station:.....	6
Vision station:	7
Master PLC – PLC 101:	8
Hydraulic Station:.....	9
Assembly robot and slider:	10
Process station.....	11
Water recirculation	12
Process:	13
System:.....	15
3. Health and Safety, Maintenance and Reliability Requirements	16
4. Team Working.....	17
5. Citation List	18
6. figures	19

1. Research

Industry 4.0 refers to the fourth industrial revolution that is currently being installed within industry today. This term refers to the use of smart factories, smart manufacture and artificial intelligence.

Industry 4.0 is demonstrated in industry through the use of offline programming and adaptive control, this allows for a more effective and efficient business model for companies, allowing in turn for a higher quality and profit.

Machine to machine (M2M) communications is the act of allowing data to be transferred from one machine to the other. The main purpose of this technology is to allow sensor data to be transmitted to the network through means such as Ethernet, Profinet or other cellular communications such as Bluetooth and 4G, with recent installations of 5G across the world this will also become networked in mainstream industry. This data is then linked to a computing software package that allows for the continuous monitoring of the system and the application of programmed actions in relation to this data.

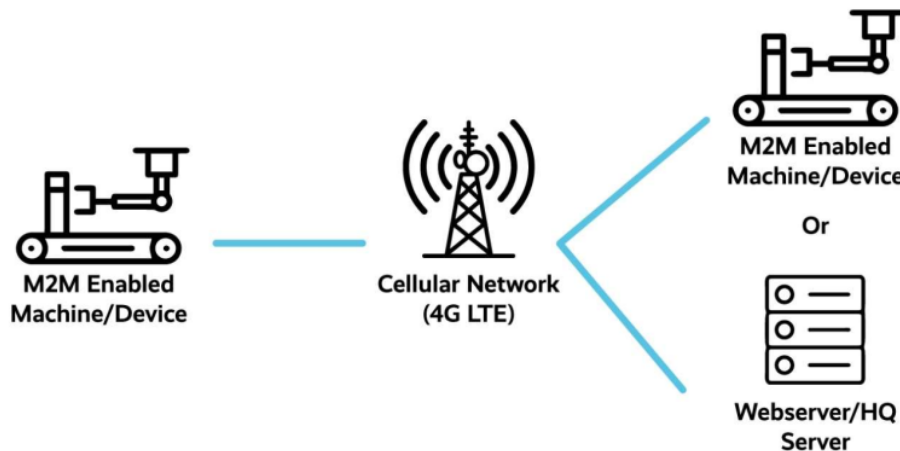


Figure 1

The above figure (1) shows a block diagram of how M2M communications work within industry. Each M2M device connects to a web server or another M2M device through a network, as stated above this can be through cellular or in many cases, Profinet and Ethernet.

Machine to machine network communication between devices has a number of advantages in industry today such as, offline programming, low maintenance demand, minimal downtime and higher control of systems.

Machine to machine networking may be costly to install in pre-existing systems, however with the increase in production, the scalability and the decrease in maintenance time due to the ability to maintain and monitor in real time remotely through the network this is greatly offset. The result is a system that allows for an increased production time and the ability to run networked programs when conditions are met such as the need to increase pressure in spot welding when resistance is high due to the need for tip changes.

Where are your citations?

Offline programming is one of the core tenants for M2M communication systems. It allows for the monitoring and changing of the program remotely, in turn, this enables lower downtime as it is possible to fix and monitor any issues while the machinery is running. Therefore, reducing downtime and increasing productivity, which in turn increases profit for the company in question. Remote programming offers several advantages in itself such as:

- Decreased downtime
- Increased production
- Lower cost of labour
- Reduced maintenance costs
- Ease of monitoring

It also allows for reduced overhead costs as the programmer can be employed remotely with access to the system, this then reduces the need for costs such as lighting and power to the company and increases the talent pool that the company is able to choose from.

Machine to machine networking is used in industry because it allows the customer a higher level of control, they are able to request changes to the product with minimal effort and downtime on the manufacturers part. It also allows for real time monitoring and decreased downtime; all of these factors will provide higher profit margins to all involved.

2. System Overview and Operation

Overview:

The following described system is the focus of the following program, as figure 2 shows it is a CIM system controlling a number of different systems.



Figure 2

The components included in this system include:

- Hydraulic robot and press
- Assembly robot
- Master CIM conveyor and tracking
- Vision inspection system
- Wagons
- Water recirculation system
- Process tanks and overhead robot
- Slider
- Pneumatic station

Pneumatic station:

The pneumatic station is the section of the system that houses the following components:

- Pallet manipulator robot
- Pallet storage
- Pneumatic PLC
- Stamp storage
- Handle manipulator robot
- Handle storage.

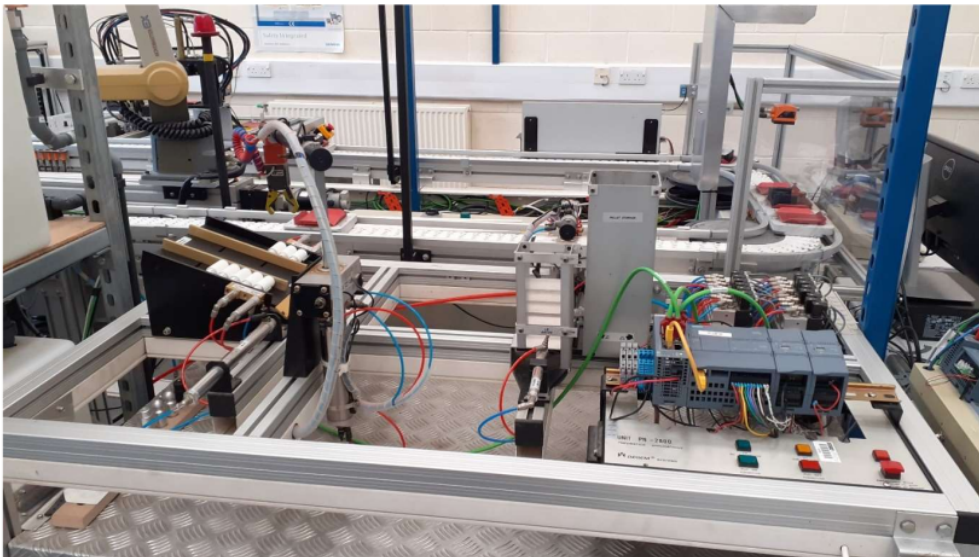


Figure 3

The handle storage and stamp storage have a number of components themselves. The pneumatic station is responsible for all of the pneumatic components in the system this includes the dispensing systems for the stamp and handle parts that will be assembled into the final product.

The pallet manipulator robot is responsible for transferring the pallets onto the conveyor system so that the parts being assembled may be placed on it from the pallet storage. The pneumatic PLC is responsible for the control of all pneumatic systems within this section including the handle storage, manipulator robot, and stamp storage. the pneumatic section also encloses a solenoid bank that controls all pneumatic valves and allows for manual manipulation of the system.

The plc used in this system is a siemens S7-1214c CPU unit with profinet attachments as well as an extra digital module to allow for more outputs and inputs to be wired in, and a relay output module to allow for the solenoid activation.

Vision station:

The vision station of the system comprises of profinet communications leading to the PLC stated above, and a IFM OD200 vision sensor, this sensor detects when a pallet is on the conveyor and where in the system it is, this then allows for the main master PLC to preform pre-programmed tasks when the conditions are met.

the main master PLC, the pneumatic PLC and the vision station are connected through Profinet communications, this integrates with industry 4.0 and machine to machine communications as stated in the previous chapter.



Figure 4

This sensor has a 10-meter detection range and therefore is able to detect the pallets on the conveyor belt from enough distance so as to not cause damage to any equipment through collision between components.

Master PLC – PLC 101:

The master plc houses the main digital input and output module, as well as the safety input and output modules, this allows for the safety system to be connected throughout the machinery, the S7-1511F safety CPU allows for the safety features such as emergency stops and the like to be programmed into the PLC.

The master PLC is connected to the system through profinet once again, this allows for the M2M communication that was discussed in the research section of this document.



Figure 5

Hydraulic Station:

the hydraulic station is responsible for a number of different components, this is all connected to a S7-1214 CPI with a digital and analogue module which is used for position feedback. A HMI is used here for human interaction with the machinery as well as manual switches to allow for the manual operation and disengagement of the machinery.

The analogue module is connected to a position sensor on the hydraulic operated robot which houses a gripper, this gripper is responsible for the picking up of parts to install onto the wagons on the conveyor system. A series of hydraulic pipes are connected to this robot with a solenoid bank to allow for manual and automatic control as well as manual shut off if required.

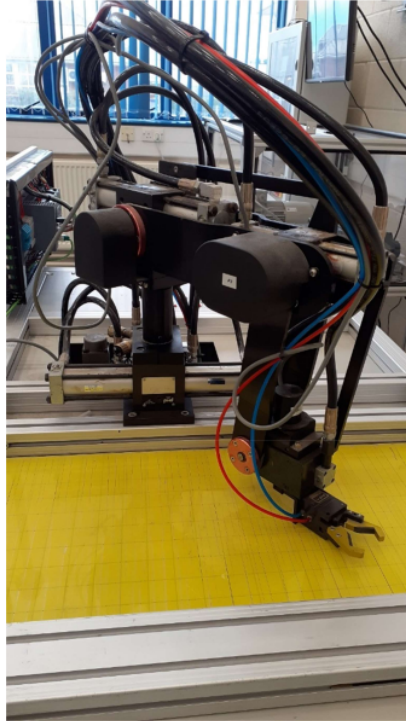


Figure 6

Assembly robot and slider:

the slider in this section refers to the horizontal movement the robot is capable of at the base of the robot, this allows the robot to move horizontally along the length of the system. The robot itself is responsible for the assembly of the parts. The robot is connected to an assembly robot controller with appropriate controls such as start, stop and emergency stop for the safety of the operator and the engineer.

This section is connected to a S7-1212c CPU or PLC 106, connected to a number of slider relays to allow for the safe and automatic operation of the slider. It is also connected to a RS232 module which converts the digital logic to RS-232 levels, this in turn allows for a PC to be connected using a cable. A digital module is also connected to PLC 106.



Figure 7

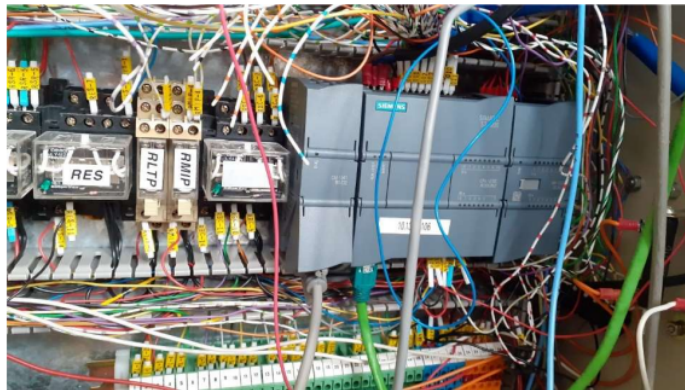


Figure 8

Process station

The process station consists of a pneumatic gripper with x, y and z traveling as well as the conveyor, the process tanks with an HMI 133 and S7-1214c CPU modules and the motorised valves, this is all controlled by the S7 PLC within this station named PLC 103. The PLCs in this system all communicate with M2M communication through profinet though as stated earlier in the document this could be through several methods.

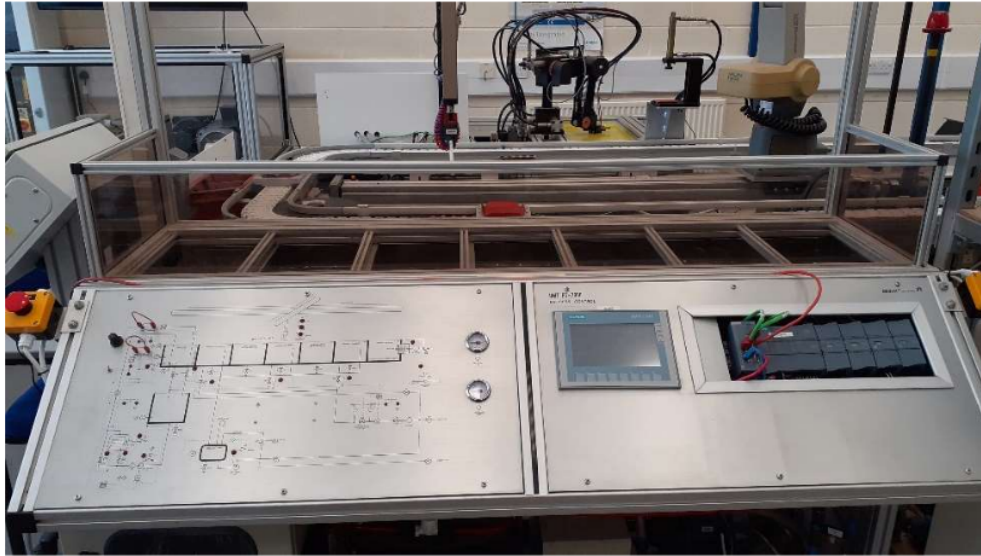


Figure 9

Water recirculation

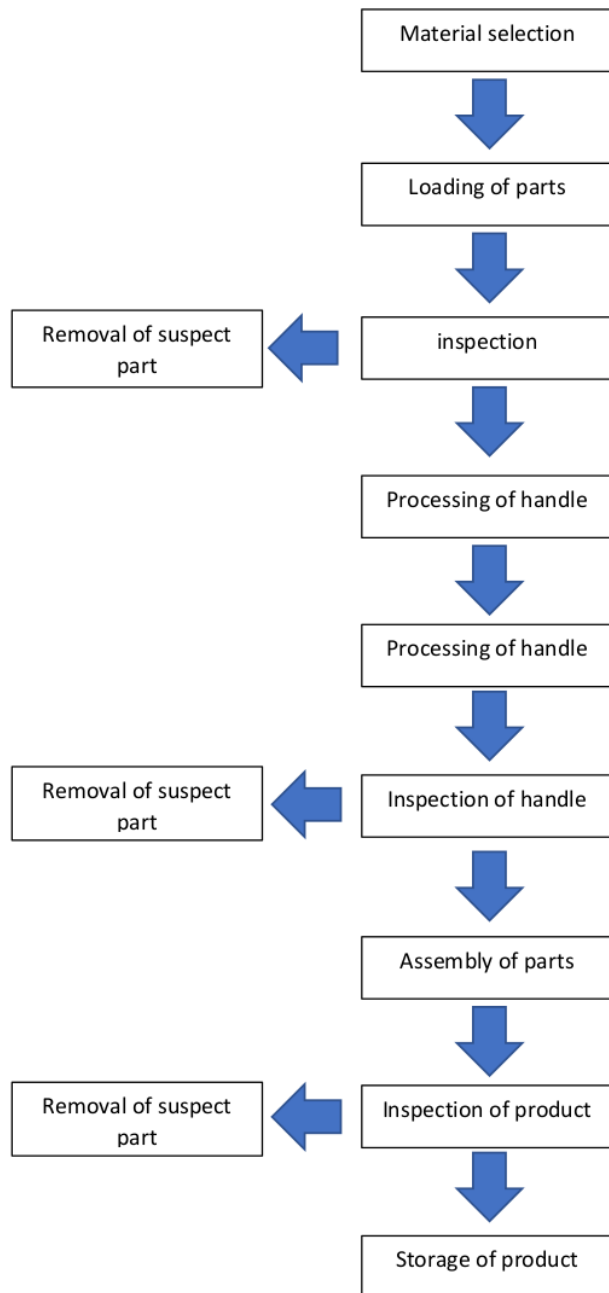
The water recirculation section of the system consists of the PLC S7-1212c with an IO link master module connected to the system and the other PLCs through a profinet system. It also consists of a HMI and level displays, this allows the engineer, or operator to visualise the system and shut the system off if this becomes necessary. There is start and stop buttons, both programmed onto the HMI and hard wired should the HMI fail for any reason such as damage or power loss due to external influences such as faulty wiring.



Figure 10

Process:

All of the above sub systems work together to create the following system that can be described by a flow chart.



Each of these processes and stages can be attributed to one of the subsystems within the hardware. After each action stage the system will perform a visual inspection using the IFM vision sensor to ensure that the product being produced has the quality that the customer is looking for and is correct to the specification such as the handle being the correct way around.

System:

Each of the PLCs used in this system is a Siemens PLC and therefore TIA portal will be used to program the system.

From the examples given this will include ladder programming for each sub system that allows for active operation and safety systems such as overloads and emergency stops to ensure the safety of the operator and engineer.

Each condition met and seen by the system will then have a 'SP' and 'PV' correlating, this could be such as the following:

6000	6007	Finished Product (Passed Inspection) (To Store)
6000	6008	Finished Product (Failed Inspection) (To waste)

Figure 11

Each of the four digits are given a condition which are known as set point registers. For example: 6000 refers to a finished product. Each station will look for the SP/PV of the product, in this case the wagon in order to release it to the next stage.

Function blocks are also used within the code so as to produce outputs which will then corollate to the relays and physical and programmed outputs within the system such as pneumatic relays and hydraulic relays, or lighting effects on HMI interfaces.

3. Health and Safety, Maintenance and Reliability Requirements

There are a number of health and safety hazards and risks when working on this machinery, all of which should be monitored closely and the proper precautions and regulations put into place.

The first regulation that should be observed is the display screen equipment regulations, these regulations state how long a person can safely sit behind any display screen equipment and how the display screen equipment should be set up. This is to reduce the stress to the body and in turn this will prevent mistakes from being made in the programming of the equipment, decreasing the chance of a malfunction on the programming side.

Due to the large number of moving pieces of equipment, including the two robots and the slider it as well as the conveyor belt it should be observed that ample emergency stops should be put into place as well as stops on any and all HMIs to allow for the instant shut down of the system.

As hydraulics are used within the system then COSHH should be observed whenever working with this system as hydraulic oil is a known irritant to the skin and may have other effects depending on the age of the oil and the construction of the oil itself.

As the system is configured for M2M communication it should be programmed that when an emergency stop is pushed either on the HMI or a physical button then all systems should stop immediately, however soft stops should also be installed so that the system may stop without issues that may occur with emergency stops such as damage to mechanical processes.

As the system also has pneumatic air within the system this should be monitored carefully and proper and regular maintenance should be conducted so that all safety systems are maintained and gages are accurate.

Within the programs ladders stops should be tested regularly and only those with correct knowledge and training should be able to conduct maintenance on programs or adapt programs to new processes to reduce risk to engineer and operator.

Maintenance of the system is imperative to ensuring the safety of all those in the vicinity of the machinery, including visitors, operators and staff, as well as engineers. Proper maintenance and checks on the machinery prevents injury and failure of the system. This should be continued on a basis that health and safety deem necessary including weekly and daily checks if needed. The proper maintenance and replacement, or repair of parts will reduce the risk to all persons involved and increase the productivity of the equipment.

A good assessment of risk but there is more you could have said

4. Team Working

When working on this system it was done individually, however if teamworking should have taken place then it would have been done as the following describes.

Each person within the team would be given a task or a series of tasks depending on the length of time the tasks would take, the difficulty and the skill set of the individual. Each task would then be integrated into the program to create one program that would run the system.

This method of team working ensures that all members contribute to the program and ensures that all members gain experience in the system and its intricacies.

In this circumstance communication between members would be imperative so that members would understand each part of the program.

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2. Layout of the CIM system (photo from PowerPoint presentation lesson B1), [Accessed 13 April 2022].
3. Layout Pneumatic station (photo from PowerPoint presentation lesson B1). [Accessed 13 April 2022].
4. Layout Vision station Plc 102 (photo from PowerPoint presentation lesson B1) [Accessed 15 April 2022].
5. Layout of master PLC and safety CPU PLC 101, (photo from PowerPoint presentation lesson B1) [Accessed 15 April 2022].
6. Layout of hydraulic station robot (photo from PowerPoint presentation B1) [Accessed 15 April 2022].
7. Layout of assembly robot and slider, (photo from PowerPoint presentation B1) [Accessed 15 April 2022].
8. Layout of PLC 106, including slider relays and RS232 module, (photo from PowerPoint presentation B1) [Accessed 15 April 2022].
9. Process station with PLC, HMI, process tanks and pneumatic gripper visible. (Photo from PowerPoint presentation B1) [Accessed 15 April 2022].
10. Water recirculation HMI and level displays, showing cut off and stop buttons. (Photo from PowerPoint presentation B1) [Accessed 17 April 2022].
11. Photo of SP and PV values (photo from PowerPoint lesson B2) [Accessed 19 April 2022]

1910605

GRADEMARK REPORT

FINAL GRADE

GENERAL COMMENTS

Instructor

30/100

PAGE 1

PAGE 2



Good Structure

Report is structured exactly as stated in the assignment brief.

PAGE 3

Text Comment. Where are your citations?

PAGE 4

PAGE 5

PAGE 6

PAGE 7

PAGE 8

PAGE 9

PAGE 10

PAGE 11

PAGE 12

PAGE 13

Text Comment. A good assessment of risk but there is more you could have said

GRADING FORM: NEW CSG-RUBRIC

KARLA WILSON

30

1. ENGAGEMENT WITH LITERATURE



There is evidence of reading from a wide range of sources but no citation in the text of the report.
8/20

8

2. KNOWLEDGE AND UNDERSTANDING



Excellent and detailed knowledge whown of the system wth a good sectionon safety and maintenance. Howwever, there is much more to say. 12/20

12

3. COGNITIVE AND INTELLECTUAL



No assessment of risk, no testing and no conclusions. 0/20

0

4. PRACTICAL APPLICATION



No evidence of practical work 0/20

0

5. TRANSFERABLE SKILLS



Report is well structured and presented and not correctly formatted. No evidence of team working.
10/20

10