

# **CHAPTER 1**

## **INTRODUCTION**

### **1.1 Background of Study**

Malaysia is a well-known country for production of oil and gas. Malaysia own its oil and gas company PETRONAS which produces oil by extracting crude oil from the sea. Oil and gas productions from Malaysia are also well-known for good quality and clean with high demand in the market.

The automatic control of processes is fundamental to the successful operations of modern oil industry. Modern manufacturing, processing and transportation systems are heavily dependent on automatic control system. The benefit of automatic control includes more consistent operation, greater safety for the processes or operating personnel and reduced operating cost due to improved utilization and reduction in manpower requirements. [1]

Reduced cost and increasing performance of digital computers has significant impact on the way control systems are designed and implemented. That is why the author tries to implement a control system in the project.

## 1.2 Problem Statement

Large vessels and container are often used in oil and gas plant for storage purposes. The oil level in the vessel must be monitored automatically. This project is to design and build a system called “Online Controller for Level Measurement”. There are several problems identified in the current oil level measurement in the industry:

- Inefficient methods of measuring level of oil in the vessel.

In the current methods, LD 301 Pressure Transmitter is used in order to measure oil level in vessel. The pressure transmitter is controlled by computer system. The measurement of the level is read manually whereby the figure shown by LD 301 Pressure Transmitter is recorded. For this project, the current method will be improved by capturing the measurement into the software by using LabVIEW. It will be more efficient since the reading process is been automated and data can be recorded and processes easily using computer.

- Unorganized data storage.

In the current method, the measurement of oil level in vessel is saved manually whereby the data is recorded in the system one by one after the reading of the oil level measurement. This manual reading method leads to human errors. By using the automatic recording system which will be developed, the reading will appear automatically on screen and the data can be saved in more efficient way. It will reduce time consuming in doing the record keeping of the measurement.

## **1.3 Objectives and Scope of Study**

### *1.3.1 Objectives*

The need for level measurement in the oil and gas industry is fundamental. Whether it provides simple indication or warning or provides the input to a complex level control loop or telemetry system used for the purpose, accuracy and reliability are of considerable importance [2]. The objective of the research is to study the development of the online monitoring system for the industry and possibility to install in an oil and gas plant. The research also studies the affect of the system optimization at oil and gas plant in order to reduce hazard at the plant especially oil to the environment and people. The online monitoring with Graphical User Interface (GUI) eases the operator to analyze the system and at the same time monitor the level of the oil in the vessel.

### *1.3.1 Scope of Study*

The research and information that have been done so far rely on development of the system itself by identifying and understanding the system. All the information need to be gathered in order to develop the online monitoring system. This will ease the operator to analyze the system and at the same time monitoring the level.

The scope of this project can be defined as below:

- i. Design and develop Data Acquisition (DAQ) system for level measurement control process.
- ii. Develop User Interface using Laboratory Virtual Instrument Engineering Workbench (LabVIEW).
- iii. Design system prototypes for level measurement.

## **CHAPTER 2**

### **LITERATURE REVIEW**

#### **2.1 Concept of Controlling a Plant (Hardware)**

The concept of controlling a plant is not simplistic in nature. It involves a systematic approach. The algorithm involves the following steps:

- i. Determine the sequence of operation in order to achieve objectives (parameters)
- ii. Assignment of inputs and outputs to be determined
- iii. Develop flow chart of the system
- iv. Writing of the program
- v. Install the system

#### **2.2 Sensor validation**

The operation of each industrial plant is based on the readings of a set of sensors. Their reliable functioning is essential as the output of sensors provides the only objective information of the process. The task of the sensor validation is intended to confirm whether the sensors are functioning properly. The validation process must be robust enough to detect multiple sensor faults as well such as bias, drift, spike, short circuit, open circuit and cyclic noise. So the real-time process sensor validation is very important, based on the object-oriented flexible design and flexible control theory [3].

## **2.3 Software development (Data Pre-Processing)**

Project requires Graphical User Interface (GUI) to help maximized the operation of the system while monitoring the level. Software in the laboratory needed to test the development of online monitoring system. It is used the data pre-processing. Data preprocessing is taken as some serious sensors faults such as short circuit and open circuit can be detected by analyzing the salient change of sampling data. On the other hand, if variable variance exceeds the controlled limits, an alarm will be produced.

## **2.4 Level measurement**

It is the method of determination of the linear vertical distance between a reference point or datum plane and the surface of a liquid or the top of a pile of divided solids.

### *2.4.1 Liquid level measurement*

Satisfactory measurements are possible only when the liquid is undisturbed by turbulence or wave action. When a liquid is too turbulent for the average level to be read, a baffle or stilling chamber is inserted in the tank or vessel to provide a satisfactory surface. [4]

## **CHAPTER 3**

### **METHODOLOGY**

#### **3.1 Procedure Identifications**

In order to achieve the objectives of this project, research had been done using some resources such as technical books and papers etc. As the early stage of the project and the author's lack of knowledge of the system, further discussion was done with supervisor. Due to this, the author's came out with flowchart activities during this project shows in figure 1 and figure 2 as follow:

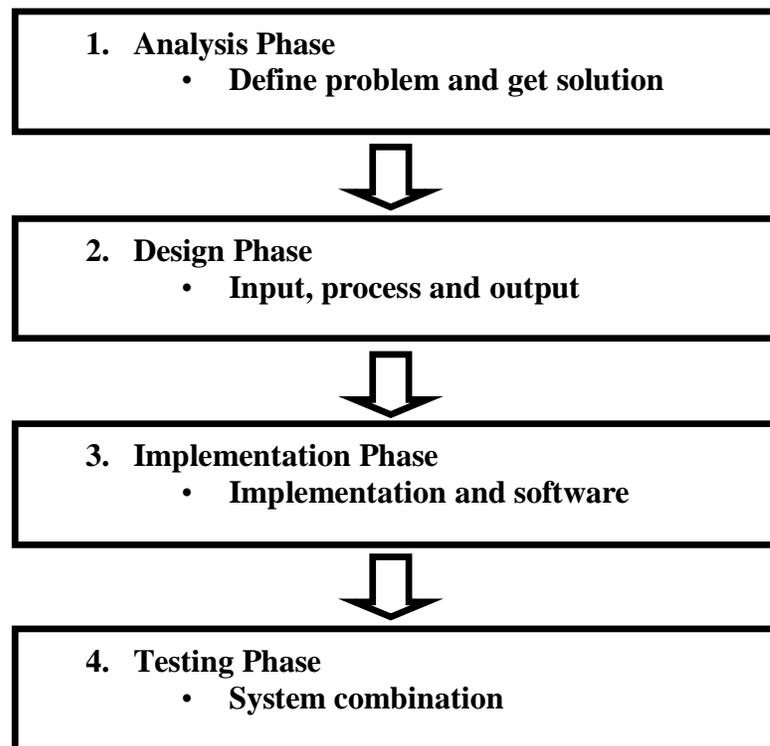


Figure 1: Project Activities Flow Chart

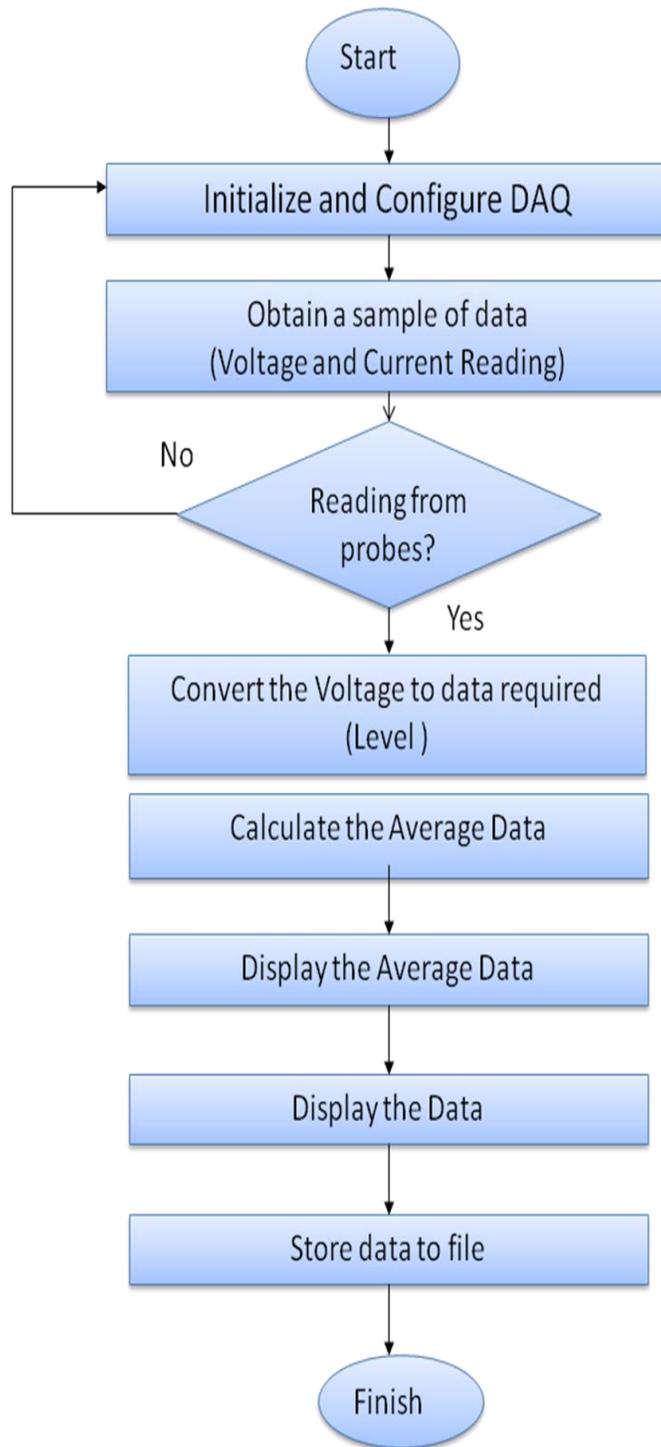


Figure 2: Tasks Performed in the GUI's Background

Data acquisition refers to any process where information is converted into a form that can be handled by a computer. Computer based data acquisition system is a system where parameter, or parameters are detected by a sensor, the output signal is then suitably conditioned, and this data is then stored or processed by computer [12]. Figure 3 below shows the path from sensor which is differential pressure transmitter to the computer. So, from this the author know the flow how the sensor connecting to the computer.

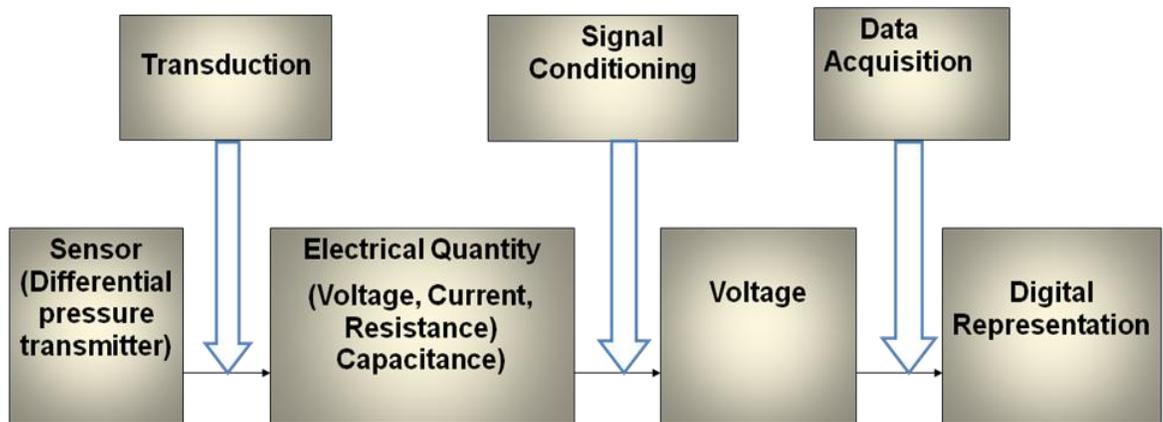


Figure 3: The Path from Sensor to Computer

### 3.1.1 Theoretical Study

Theoretical study is a very powerful tool in strengthening the knowledge related to the project. Most of the knowledge is an extension from the syllabus. By doing desk study, we also can get the latest updates of the devices or equipment that will be used. Understanding the fundamentals is the key in solving problems which occurs later. Ideas and improvement can also be acquired from numerous physics principle or existed inventions. The main sources for study are reference books, journals, articles, reports as well as the internet.

### *3.1.2 Design of Suitable Prototypes*

The design starts from rough sketch of the prototype. Some limitations and constraints is considered during the process to fulfill the objectives. This is to make sure the device practically works as intended. The design should comply with all needs and try to simplify the mechanism so that the later phase is easier to proceed.

### *3.1.3 Fabrication Process*

Fabricating the model combines both electrical and mechanical part of the project. All parts used will be considered according to the specification in the design. A suitable fabrication process is determined to procedure the frame of the model while the circuit has to be double checked because an error could cause damage to all components.

### *3.1.4 Simulation Analysis*

After the model is ready, the author test and compared with result from simulation from appropriate software according to the real time situation. Various conditions will be considered to check the effectiveness and faulty that may occur. Any problems and consequences are identified to provide information for possible modification and upgrades. The process goes back to simulation analysis phase until the objectives met it expectation.

### 3.2 Milestone

The steps for developing online controller for level measurement are categorized in two phases, 1<sup>st</sup> semester and 2<sup>nd</sup> semester of the final year.

#### ❖ 1<sup>st</sup> Semester

- Theoretical study
- Design of suitable model
- Choosing component
- Software study

#### ❖ 2<sup>nd</sup> semester

- Fabrication process
- Develop and upgrades Human Machine Interface using Lab VIEW
- Simulation analysis
- Final report

With two main phases of the project fulfilled now, the next step is the crucial part for this semester. Human Machine Interface development using LabVIEW is important part of this project. A good understanding of the LabVIEW software is very useful for this project. The author needs to further study about this software and review the manual guide given in the software to make sure that the author can achieve his objective in developing this project. By the end of this semester, the author should know about this software and the full design of the model should be finished.

### **3.3 Tools Required**

Some of the tools that may require during this project include:

- Graphical User Interface
- Computer system
- LabVIEW to build the human machine interface
- HART calibrator to calibrate differential pressure transmitter

### **3.4 Components Involved**

- Sensors ( Differential Pressure Transmitter LD 301)
- Water Pump
- Hand Valve
- DAQ Card (PCI 6024 E)
- Connector Block (CB 68 LP)

### 3.5 Cost Estimation

Cost that is considered in this project includes direct and indirect cost. As for right now the project still ongoing, only the estimation cost can be done so far. Table 1 shows the estimation cost for this project.

Table 1: Cost Estimation of the Project

#### Direct cost

Items	Quantity	Cost	Total Cost
Pipe Fitting	6	\$2.00	\$12.00
Tank and Pipe	1	\$120.00	\$120.00
Stand and Plywood	1	\$70.00	\$70.00
<b>Total</b>			<b>\$202.00</b>

#### Indirect cost

Items	Quantity	Cost	Total Cost
Differential Pressure Transmitter	1	\$1370.00	\$1370.00
Software LabVIEW	1	\$1,700.00	\$1,700.00
DAQ Card	1	\$300.00	\$300.00
Computer	1	\$2,500.00	\$2,500.00
<b>Total</b>			<b>\$5,870.00</b>

$$\begin{aligned}\text{Overall cost estimation} &= \text{Direct cost} + \text{Indirect cost} \\ &= \text{RM } 202.00 + \text{RM}5870.00 \\ &= \underline{\text{RM } 6072.00}\end{aligned}$$

### 3.6 Overall System Structure

Combining all the information and understanding of the project, the structure of the system has been developed. Figure 7 shows the overall system structure that has been divided to 3 main parts which were

1. Circuit sensors
2. Software including equipments
3. Visualization

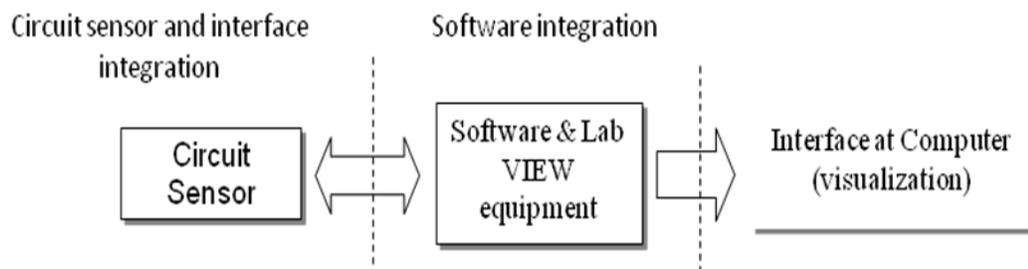


Figure 4: System Development Structure

The establishment of GUI then will be connected through DAQ card to get the real time data. These data then need to be analysis and compared with the data that has been stored in the system. The data being showed on the screen are the data that has been compared to the stored data to ease operator analyzed the level. Figure 8 shows the project visualization after all the setting has been established.

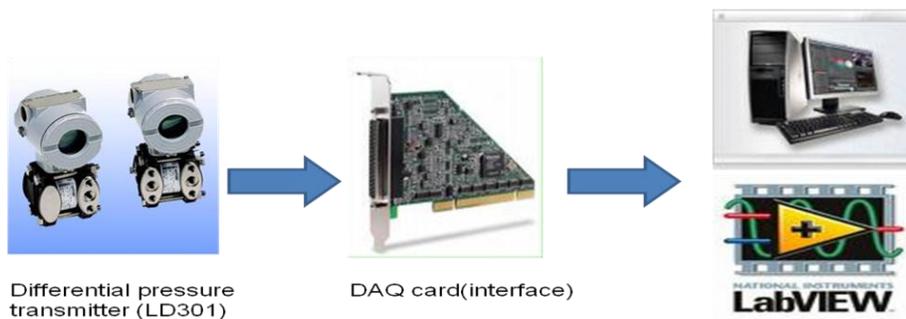


Figure 5: Project overview

## **CHAPTER 4**

### **RESULT AND DISCUSSION**

Through this project, the author has carried out the research and development an online controller for level measurement has progressed finely. Two main phases of the project namely theoretical study and design of suitable model were completed.

#### **4.1 Development of Interface Using LabVIEW**

##### *4.1.1 LabVIEW Software*

LabVIEW (Laboratory Virtual Instrumentation Engineering Workbench) is a platform and development environment for visual programming language from National Instruments. The graphical language is named "G". LabVIEW is commonly used for data acquisition, instrument control, and industrial automation on a variety of platforms.

LabVIEW ties the creation of graphical user interfaces GUI (called front panels) into the development cycle. LabVIEW programs/subroutines are called virtual instruments (VI). Each VI has three components: a block diagram, a front panel, and a connector panel. The last is used to represent the VI in the block diagrams of other, calling VIs. Controls and indicators on the front panel allow an operator to input data into or extract data from a running virtual instrument. However, the front panel can also serve as a programmatic interface. Thus a virtual instrument can either be run as a program, with the front panel serving as a user interface, or, when dropped as a node onto the block diagram, the front panel

defines the inputs and outputs for the given node through the connector pane. This implies each VI can be easily tested before being embedded as a subroutine into a larger program.[8]

The graphical approach also allows non-programmers to build programs simply by dragging and dropping virtual representations of lab equipment with which they are already familiar. The LabVIEW programming environment, with the included examples and the documentation, makes it simple to create small applications.

One benefit of LabVIEW over other development environments is the extensive support for accessing instrumentation hardware. Drivers and abstraction layers for many different types of instruments and buses are included or are available for inclusion. These present themselves as graphical nodes. The abstraction layers offer standard software interfaces to communicate with hardware devices. The provided driver interfaces save program development time.[8]

A benefit of the LabVIEW environment is the platform independent nature of the 'G' code, which is (with the exception of a few platform-specific functions) portable between the different LabVIEW systems for different operating systems (Windows, Mac OS X and Linux).

#### 4.1.2 DAQ Hardware

DAQ hardware without software is of little use-and without proper controls the hardware can be very difficult to program. The purpose of having a appropriate software is the following: [7]

- Acquire data at specified sampling rate
- Acquire data in the background while processing in foreground
- Stream data to and from disk
- Integrate different DAQ boards in a computer and use various functions of a DAQ board from a single user interface.
- Interfacing the hardware, systems and software programming to process control and instrumentation.

The driver software is a lower level driver that interfaces LabVIEW software with the DAQ boards. As a user of LabVIEW one does not have to worry about configuration and control of components within DAQ boards. LabVIEW identifies each board by a *device* number and therefore one can have as many devices as many as the computer can accept on their expansion slots. LabVIEW can also combine and display inputs from various sources like inputs from serial and parallel port, data acquisition board on a single interface as shown in the figure 6 below.

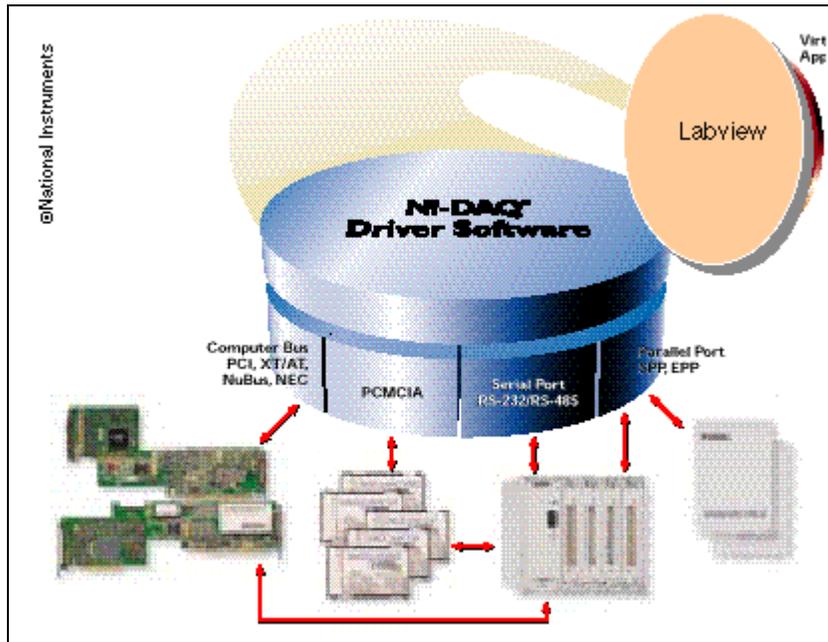


Figure 6: LabVIEW Software and DAQ system

LabVIEW is provided with set of icons that represents controls and functions, available in the menu of the software. Such a programming is called *visual programming* and National Instruments calls it ‘G’. The user interface which is called a *vi* consists of two parts- a *front panel* and a *diagram*. This is similar to that of an instrument where a front panel is used for a input, output controls, and to display the data whereas the circuit resides on the circuit board. Similarly you can bring the buttons, indicators and graphing and display functions on the front panel.

### 4.1.3 Interface Development

Using LabVIEW 6i from National Instrument, the interface for the system so far is doing goods. Some explanations really needed to verify the system itself. Figure 11 shows the loop diagram used in the system. The function of the while loop diagram is to make sure the system is in continuous condition (looping).



Figure 7: While loop diagram

This while loop diagram working so fast to get the data. In order to slow down the process, there is need for Wait until Next ms Multiple as shown in Figure 12.



Figure 8: Wait until Next ms Multiple diagram

The author currently develop a human machine interface (HMI) using labVIEW.. There were a few problem encountered by the author when developing this HMI. The problems are when the author have connected the wiring in the block diagram there a few errors occurs. The author trying a lot to make sure that the project finished within the due date. This problem actually have been solved before the due date of the project. This is a result of developing the labVIEW have shown in figure 9

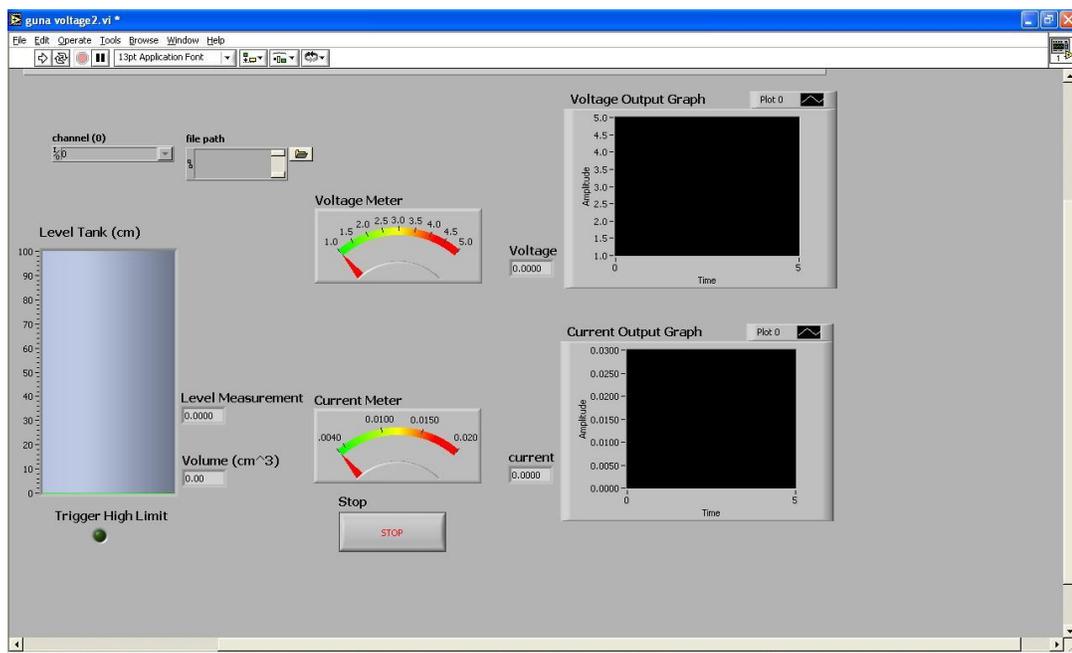


Figure 9: Interface LabVIEW Visual Programming

Figure 10 and figure 11 above the block diagram for LabVIEW visual programming. It is in two condition which are true condition and false condition.

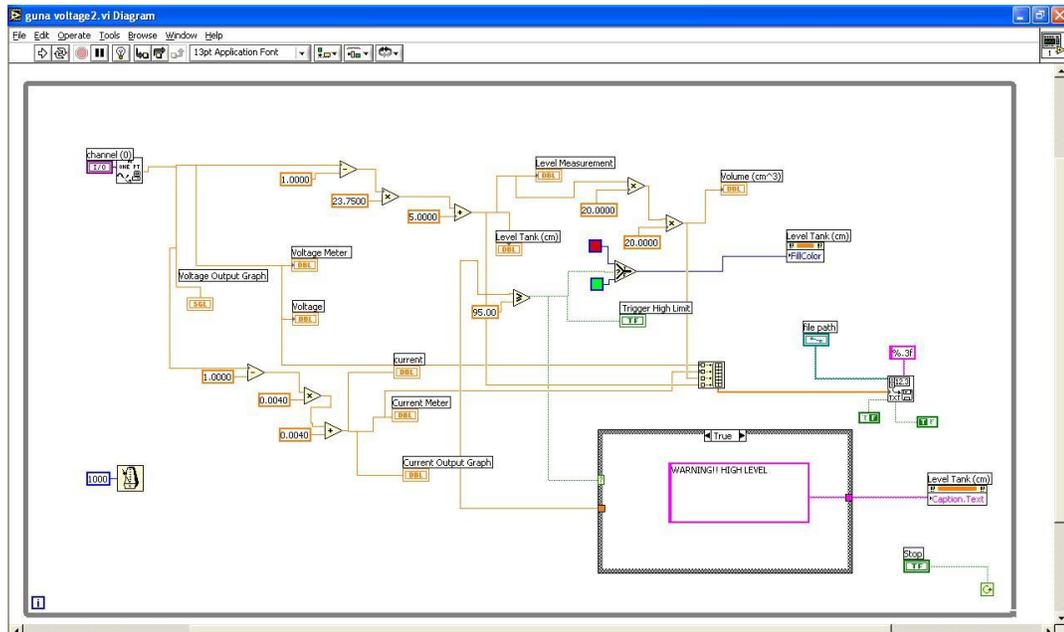


Figure 10: True Condition of LabVIEW Block Diagram

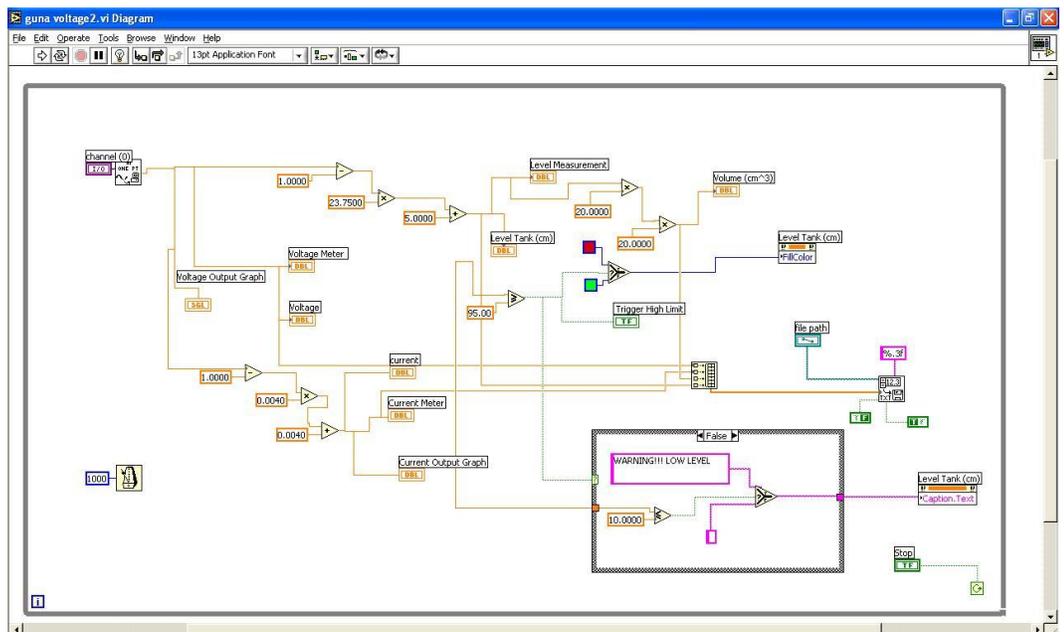


Figure 11: False Condition of LabVIEW Block Diagram

#### PROGRAMMING EXPLANATION

- If using voltage input. (1V-5V)

$$\text{Level} = [(X-1)*23.75] + 5$$

$$\text{Volume} = \{[(X-1)*23.75] + 5\} * 20 * 20$$

;X=1 to 5

- If using current input. (4mA-20mA)

$$\text{Level} = [(Y-0.004)*5.9275] + 5$$

$$\text{Volume} = \{[(Y-1)*23.75] + 5\} * 20 * 20$$

;Y=4mA to 20mA

#### 4.1.4 Measurement and Automation NI-MAX Configuration for Level

So far, the configuration for level measurement in NI-MAX has been done. Before using the interface, user first has to assign which channel has to be assigned according to the system interface using Measurement and Automation Explorer (MAX). Figure 12 the pin assignment for the sensor in MAX.

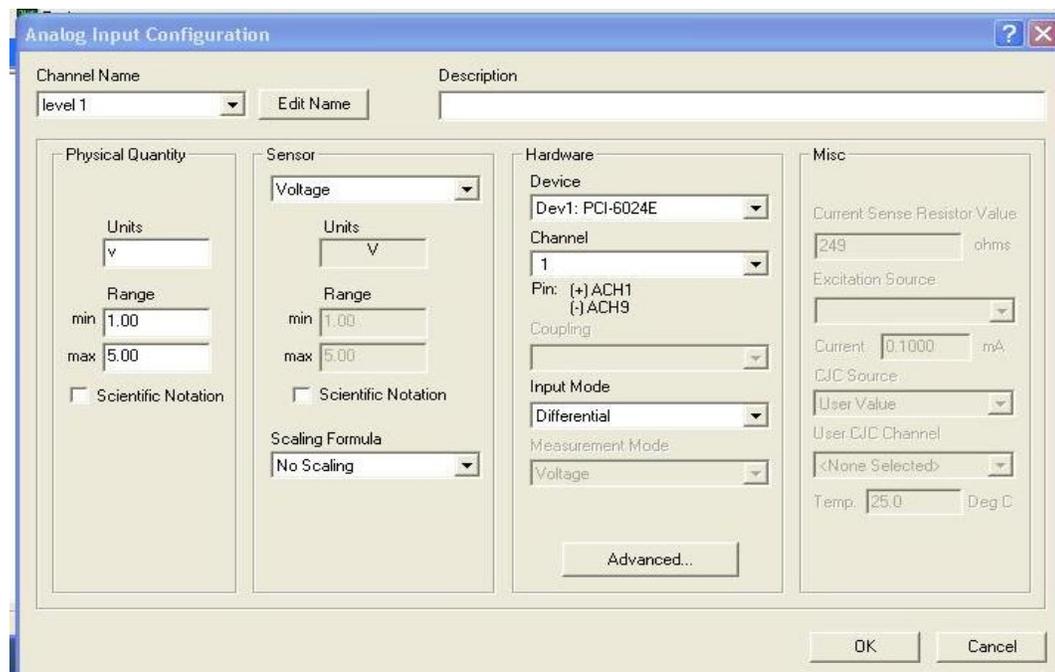


Figure 12: Assign input channel for ach0 and ach9 in MAX

Then, the connection will be done for the pin at pin block. This assign pin must be the same as indicated in MAX in order to get the data correctly. Figure 13 shows the pin assignment at the connector block. The pin assignment must follow the wiring diagram (Refer Appendix C).



Figure 13: Pin assignment at the connector block

#### 4.1.5 Result

At the interface in LabVIEW, there is also some point where user needs to assign the channel for the system and also where all the data should be kept. After the setup being done, user can now run the program and the result will appear at interface as shown in Figure 14 figure 15.

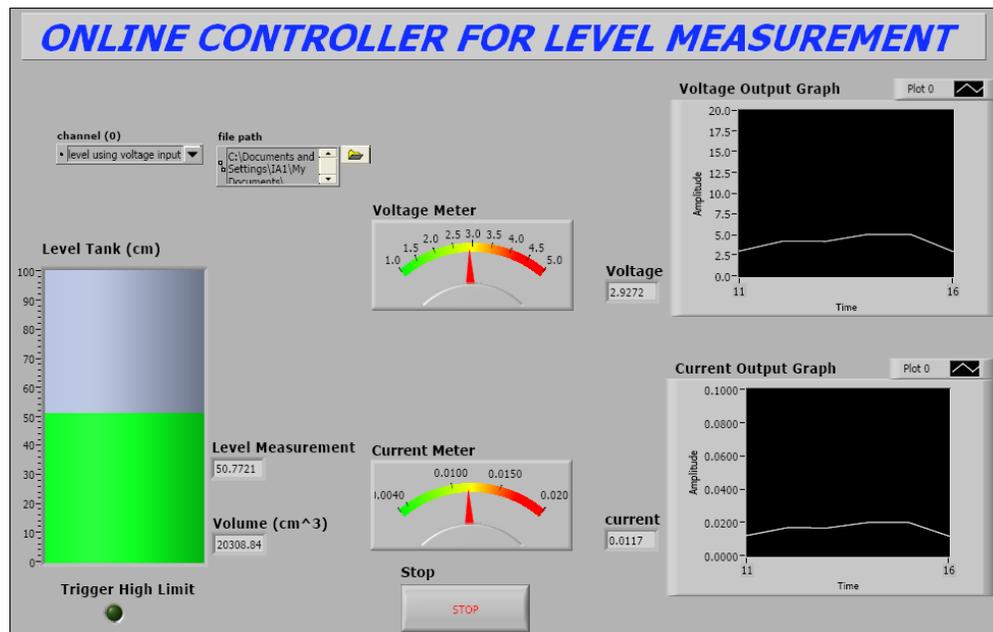


Figure 14: Result output voltage at 2.92v

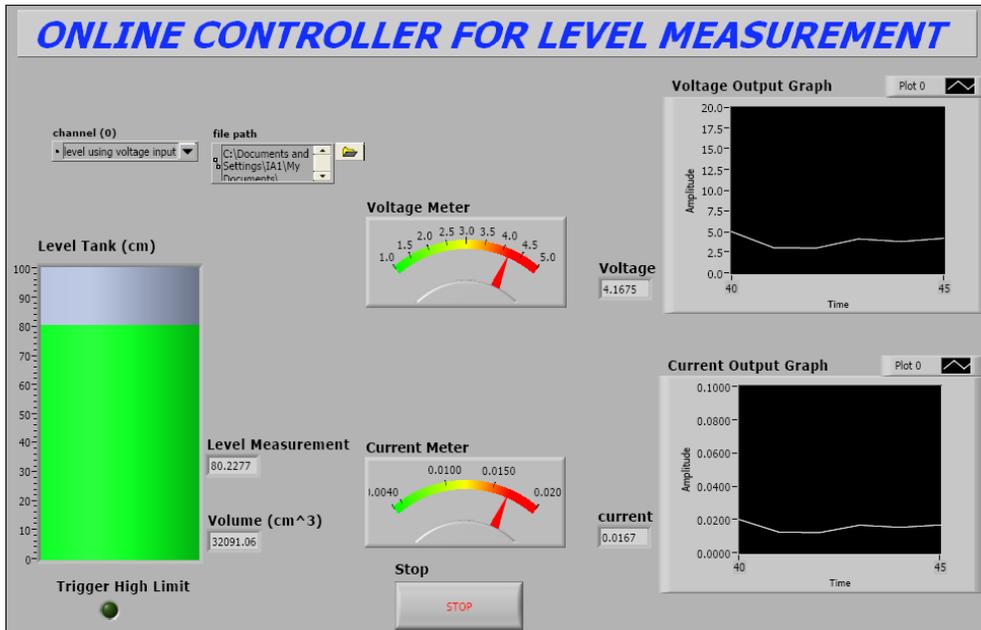


Figure 15: Result output voltage at 4.16v

The system will alert the user if the high limit is detected for the monitoring system as shown in Figure 16.

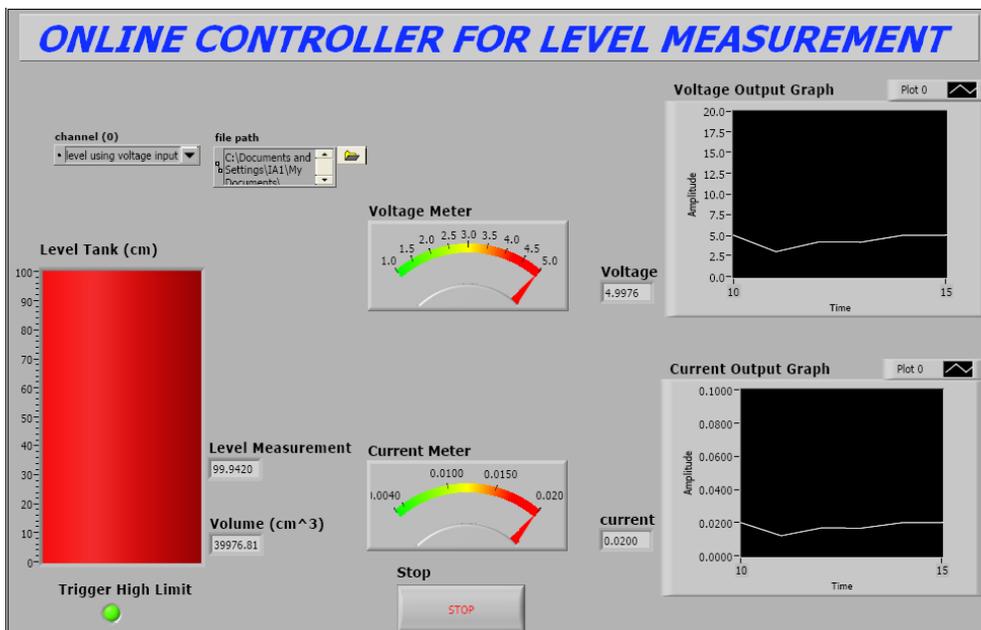


Figure 16: Result output voltage at 5v

#### 4.1.6 Data Saving

The data will be saved in the data.doc format. Example of how to save the data show in figure 17 and the result for data saving shows below.

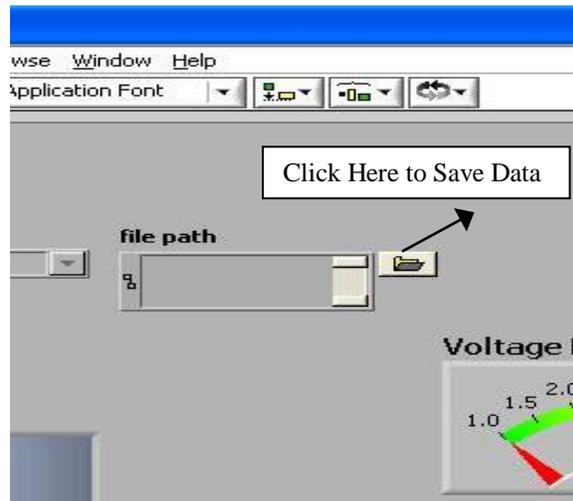


Figure 17: How to save data

#### Example of data saving

```
10/13/2009
4:45 PM10/15/2009 2.9907 0.0120 52.2997 20911.87
4:45 PM10/15/2009 3.9819 0.0159 75.8209 30328.37
4:45 PM10/15/2009 4.9976 0.0200 99.9420 39976.81
```

## 4.2 Development of The Prototypes System

### 4.2.1 *Differential Pressure Transmitter (LD301) Study*

The **LD301** series uses, as its measuring principle, the well known and field proven technique of capacitance sensing, enhanced by a microprocessor based electronics.[5] Designed for process control applications, these 2-wire transmitters generate a 4-20 mA or 1-5V signal proportional or characterized to the applied differential pressure. This signal can be transmitted over a pair of twisted wires through long distances (limited only by the wire resistance and load). Digital communication for remote calibration and monitoring is also provided, superimposing a digital signal on the same pair of wires that carries the 4-20 mA signals. The transmitter consists of two main parts which are the sensor (a capacitance variation cell) and the electronic circuit. The sensor is schematically shown in the figure 18. A sensing diaphragm (**1**) is shown at the centre of the cell. This diaphragm deflects, as a result of the difference between the pressures applied to the left and right sides of the sensor. These pressures are directly applied to the isolating diaphragms (**2**) that provide isolation and resistance against process fluid corrosion. The pressure is transmitted to the sensing diaphragm through the filling Fluid (**3**). The sensing diaphragm is also a moving capacitor plate, and the two metallized surfaces (**4**) are fixed plates. The sensing diaphragm deflection results in a variation on the capacitances between the moving and fixed plates.

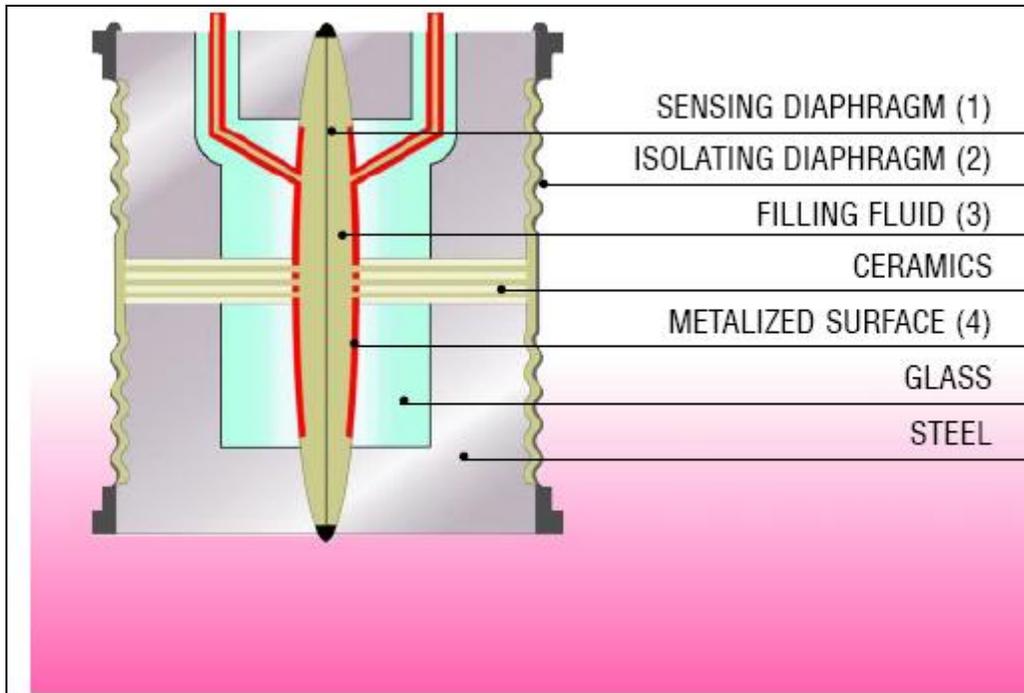


Figure 18: LD301 Architecture

The Electronic Circuit measures the variation of the capacitance between the moving and fixed plates, and generates a 4-20 mA signal, that can be proportional to the differential pressure applied or characterized (square root, special function, etc.) to it. Being microprocessor based, the electronic circuit is extremely versatile and accurate. Transmitter performance is improved by continuous monitoring of the sensor temperature and corresponding corrections. The transmitter can also operate as a combination of transmitter plus controller. In this case, the 4-20 mA signals is used as the output of a PID control function (optional), while the digital signal may be used for remote monitoring and operation. Besides the LD301 series was developed according to the international safety standards to attend the functional safety requirements in plants that need safety and reliability to protect people, ambient and assets, etc. Figure 19 shows the sensor and main board assembly.

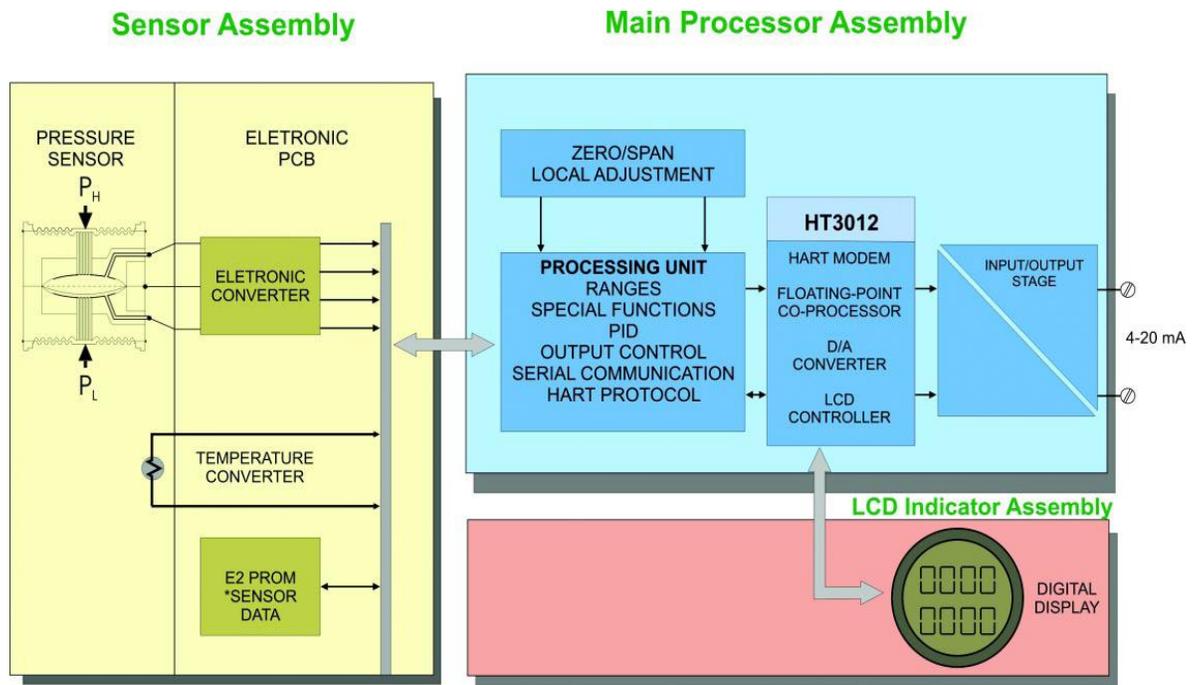


Figure 19: Sensor and Main Board Assembly

***The Main Features for Transmitter (LD 301)***

- ▣ 0.075% accuracy
- ▣ 0-125 Pa to 0-40 MPa (0-0.5 inH<sub>2</sub>O to 0-5800 psi)
- ▣ Direct digital capacitance sensing (No A/D conversion)
- ▣ 4-20 mA output plus direct digital communication (HART® Protocol), according to NAMUR-NE-43 standard
- ▣ On-line and off-line programming
- ▣ Capable of handling most process fluids
- ▣ Small and lightweight
- ▣ Explosion proof and weather proof housing.
- ▣ Constant signal generation for loop tests
- ▣ Fail-safe level
- ▣ Applicable in safety areas according to SIL (Safety Integrity Level) requirements

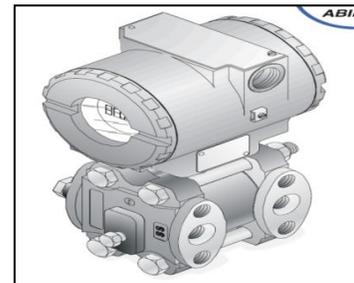


Figure 20: LD301 Differential Pressure Transmitter

#### 4.2.2 Hand Valve and Water Pump

##### Flow Valve

A **valve** is a device that regulates the flow of a fluid (gases, fluidized solids, slurries, or liquids) by opening, closing, or partially obstructing various passageways. Valves are technically pipe fittings, but are usually discussed as a separate category. Figure 21 shows the architecture of hand valve.

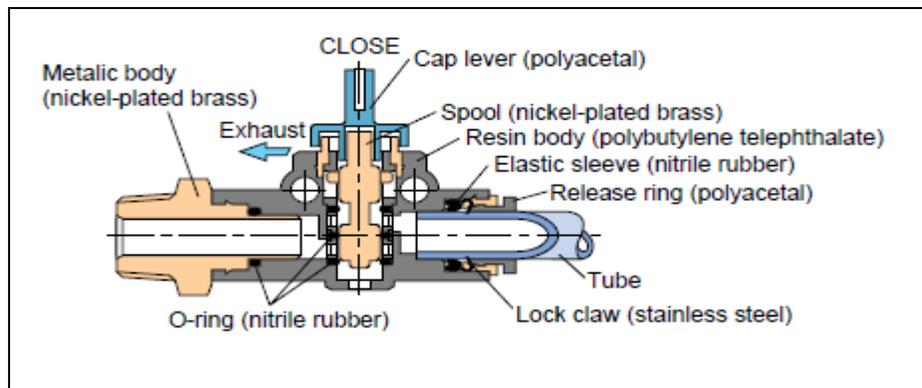


Figure 21: Architecture of hand valve

Valves are used in a variety of contexts, including industrial, military, commercial, residential, and transportation. Oil and gas, power generation, mining, water reticulation, sewerage and chemical manufacturing are the industries in which the majority of valves are used.

Valves may be operated manually, either by a hand wheel, lever or pedal. Valves may also be automatic, driven by changes in pressure, temperature or flow. These changes may act upon a diaphragm or a piston which in turn activates the valve, examples of this type of valve found commonly are safety valves fitted to hot water systems or steam boilers.

More complex control systems using valves requiring automatic control based on an external input (i.e., regulating flow through a pipe to a changing set point) require an actuator. An actuator will stroke the valve depending on its input and set-up, allowing the valve to be positioned accurately, and allowing control over a variety of requirements. [9]

### Water Pump

A **pump** is a device used to move fluids, such as gases, liquids or slurries by producing high pressure. A pump displaces a volume by physical or mechanical action. One common misconception about pumps is the thought that they create pressure. Pumps alone do not create pressure; they only displace fluid, causing a flow. Adding resistance to flow causes pressure.

Pumps are used throughout society for a variety of purposes. Early applications include the use of the windmill or watermill to pump water. Nowadays, the pump is used for irrigation, water supply, gasoline supply, air conditioning systems, chemical movement, flood control, marine services, etc.

Because of the wide variety of applications, pumps are available in many shapes and sizes: from very large to very small, from handling gas to handling liquid, from high pressure to low pressure, and from high volume to low volume.

Liquid and slurry pumps can lose prime and this will requires prime the pump by adding liquid to the pump and inlet pipes to get the pump started. Loss of "prime" is usually due to ingestion of air into the pump. The clearances and displacement ratios in pumps used for liquids and other more fluids cannot displace the air due to its lower density. [10]

#### 4.2.3 Design of Model

The project proceeds to the prototype design. The author was using AutoCAD to design the model. The prototypes designs are shown in figure 22 and figure 23.

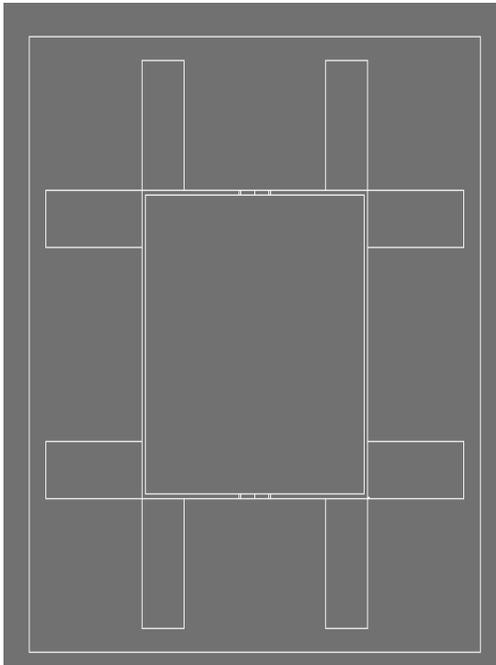


Figure 22: Top view of AutoCAD model

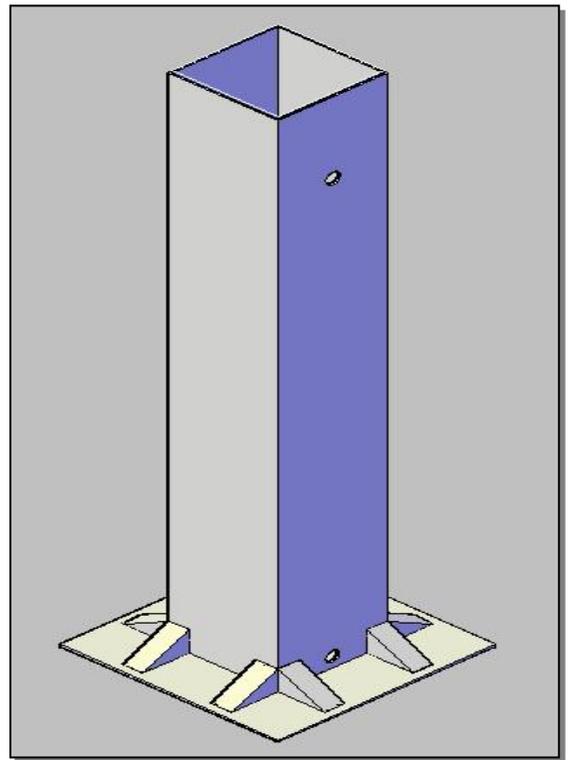


Figure 23: 3D front view of AutoCAD model

#### 4.2.4 Calibration Differential Pressure Transmitter LD 301

Calibration is the method validation of specific measurement techniques and equipment. At the simplest level, calibration is a comparison between measurements-one of known magnitude or correctness made or set with one device and another measurement made in as similar a way as possible with a second device. The calibration process begins with the design of the measuring instrument that needs to be calibrated. The design has to be able to "hold a calibration" through its calibration interval. In other words, the design has to be capable of measurements that are "within engineering tolerance" when used within the stated environmental conditions over some reasonable period of time. Having a design with these characteristics increases the likelihood of the actual measuring instruments performing as expected. [11]

Calibration is carried out:

- for a new instrument
- when a specified time period is elapsed
- when a specified usage (operating hours) has elapsed
- when an instrument has had a shock or vibration which potentially may have put it out of calibration
- whenever observations appear questionable

The differential pressure transmitter must be calibrated according to the tank before can be used for the level measurement. This is to make sure that the measurement can be done without any errors of measurement. The objective of calibration is to verify the measurement accuracy of any particular instrument that contributed to the quantification of medium at operating conditions is within the legally required limits. A pressure transmitter is to be calibrated. The input pressure range is 0 to 950 mmH<sub>2</sub>O. The output from the transmitter is 4 to 20mA and 1-5V.

Pressure Unit: mmH<sub>2</sub>O

Table 2: Calibration result (current output)

Calibration Reading	Input Pressure Percentage	Input Pressure	Calculated Output Current	Actual Output Current	Percentage Different
1	0	0	4mA	3.99mA	1%
2	25	237.5	8mA	8.09mA	9%
3	50	475	12mA	12.02mA	2%
4	75	712.5	16mA	16.03mA	3%
5	100	950	20mA	19.97mA	3%

Table 3: Calibration result (voltage output)

Calibration Reading	Input Pressure Percentage	Input Pressure	Calculated Output Voltage	Actual Output Voltage	Percentage Different
1	0	0	1V	0.99V	1%
2	25	237.5	2V	2.02V	2%
3	50	475	3V	3.01V	1%
4	75	712.5	4V	4.02V	2%
5	100	950	5V	4.98V	2%

Calibration was performed using Highway Addressable Remote Transducer (HART) Communicator shown in figure 24. HART communicator is a hand-held interface that provide a common communication link to all HART-compatible, microprocessor-based instruments.

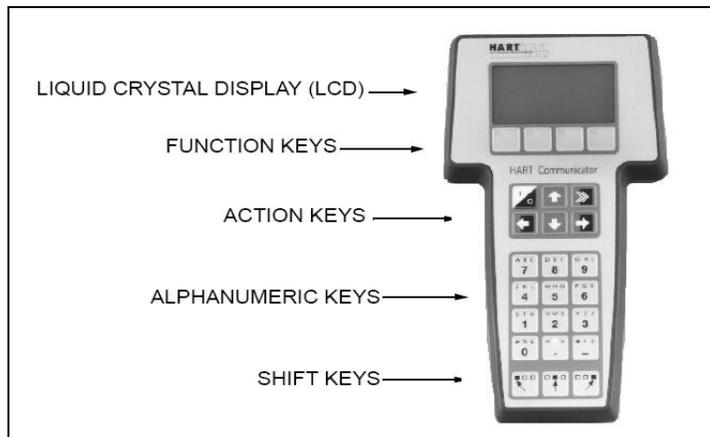


Figure 24: HART Communicator

Figure 25 above show the calibration hook-up diagram. The diagram shows how to do a wiring connection when to perform calibration.

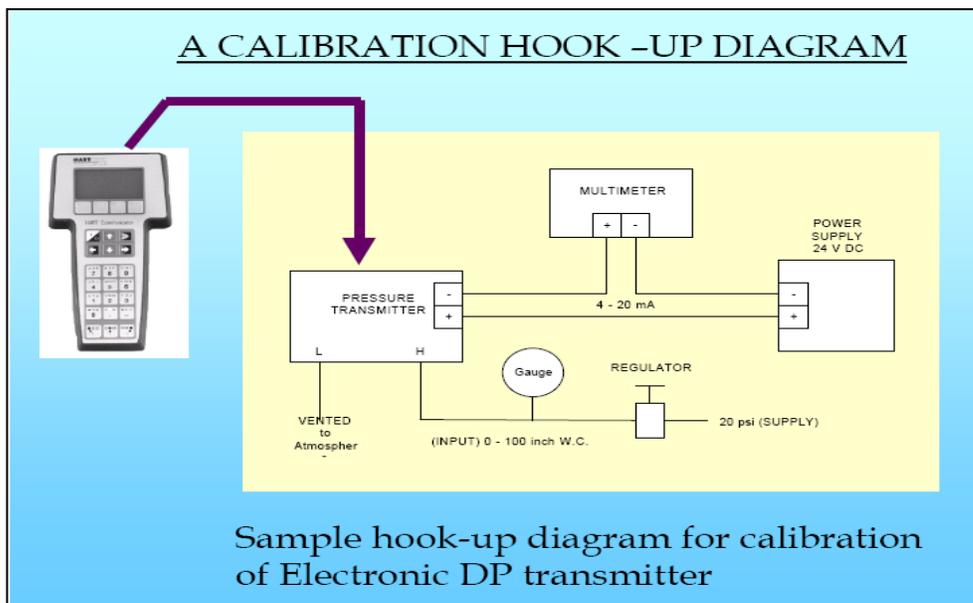


Figure 25: Calibration Hook-Up Diagram

#### 4.2.5 *Fabricate Model*

Metal fabrication is a value added process that involves the construction of machines and structures from various raw materials. Standard raw materials used by metal fabricators are plate metal and fitting. The raw material has to be cut to size. This is done with a variety of tools. The most common way to cut material is by Shearing (metalworking). Shearing is a metalworking process which cuts stock without the formation of chips or the use of burning or melting. Figure 26 shows the shearing machine.



Figure 26: Shearing Machine

After shearing and shaping the material, welding has been performed. Welding is a fabrication or sculptural process that joins materials, usually metals or thermoplastics, by causing coalescence. This is often done by melting the work pieces and adding a filler material to form a pool of molten material (the *weld pool*) that cools to become a strong joint, with pressure sometimes used in conjunction with heat, or by itself, to produce the weld. This is in contrast with soldering and brazing, which involve melting a lower-melting-point material between the work pieces to form a bond between them, without melting the work pieces. Figure 27 shows the welding process.



Figure 27: Welding Process

The author used galvanized steel material for this project. As a result, a tank which was designed using autoCAD has been completely fabricated. The dimension of the tank is 200mm×200mm×1200mm. The prototypes which is completely fabricate are shown in figure 28, figure 29, figure 30 and figure 31.

### Prototypes



Figure 28: Interior View



Figure 29: overall view



Figure 30: Bottom View



Figure 31: Prototypes with stand

## **CHAPTER 5**

### **CONCLUSION AND RECOMMENDATIONS**

#### **5.1 Conclusion**

Research and study had given a better understanding of the online monitoring system in the industry. There were a lot of considerations when doing this project. Various concept of sensing, real time control and manufacturing process are implemented in this project. Each aspect needs to be evaluated carefully so that the flow of the project is smooth and can be developed as desired. By evaluating the current progress, the author believes to implement a prototype which produces the required results for online control of level by using LabVIEW software and level controller hardware circuit.

#### **5.2 Recommendations**

The system is still new in implementation. Some improvements can be done in the future to upgrade the system. The system could be improved further by:

1. Implement other types of parameters to the LabVIEW programming. For example the parameters like temperature, pressure and flow.
2. Using wireless connection to connect the hardware and software which is the labVIEW programming and the system.
3. Using water pumps and water sensor to control the water level. When the sensor sense the maximum level, the water pump will be stop.

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## **APPENDICES**