PRIFYSGOL BANGOR UNIVERSITY

School of Computer Science and Electronic Engineering

Gas Pipe Leakage Detection Using AI

Author: Sultan F S J A F Almerri (500525394)

Supervisor: Dr. Zengbo Wang

Abstract

Gas pipe leakage is one of the biggest contributors to gas losses during gas transportation and requires the high cost for detection and repairing. This project proposed linear and non-linear regression methods to predict gas pip leakage based on pressure data. The pressure data can be easily observed at very low cost and continuous form. The linear regression algorithm was able to predict the exact leakage location accurately. The algorithm is expected to reduce the cost of gas pipe leakage location detection therefore reduce the losses.

Objectives:

This project aims to develop a low cost system for gas pipe leakage detection based on pressure sensor network. The project objectives are:

1- Review latest gas pipe detection techniques and regulations
2- Review pressure and temperature sensors network models
3- Design pressure and temperature sensors network
4- Design and build connective predictive model of pressure and temperature change within leakages
5- Test model on several gas leakage scenarios

Research Approach

The approach is mainly based on hardware and software design with industrial background and support. The project is expected to reflect realistic gas pipe leakage detection within industry in Kuwait.

During the course of this project, I will be researching the literature for the latest technologies and techniques, approach industry with realistic plans and designs, and test on simulation system based on simulation aid software such as Matlab.

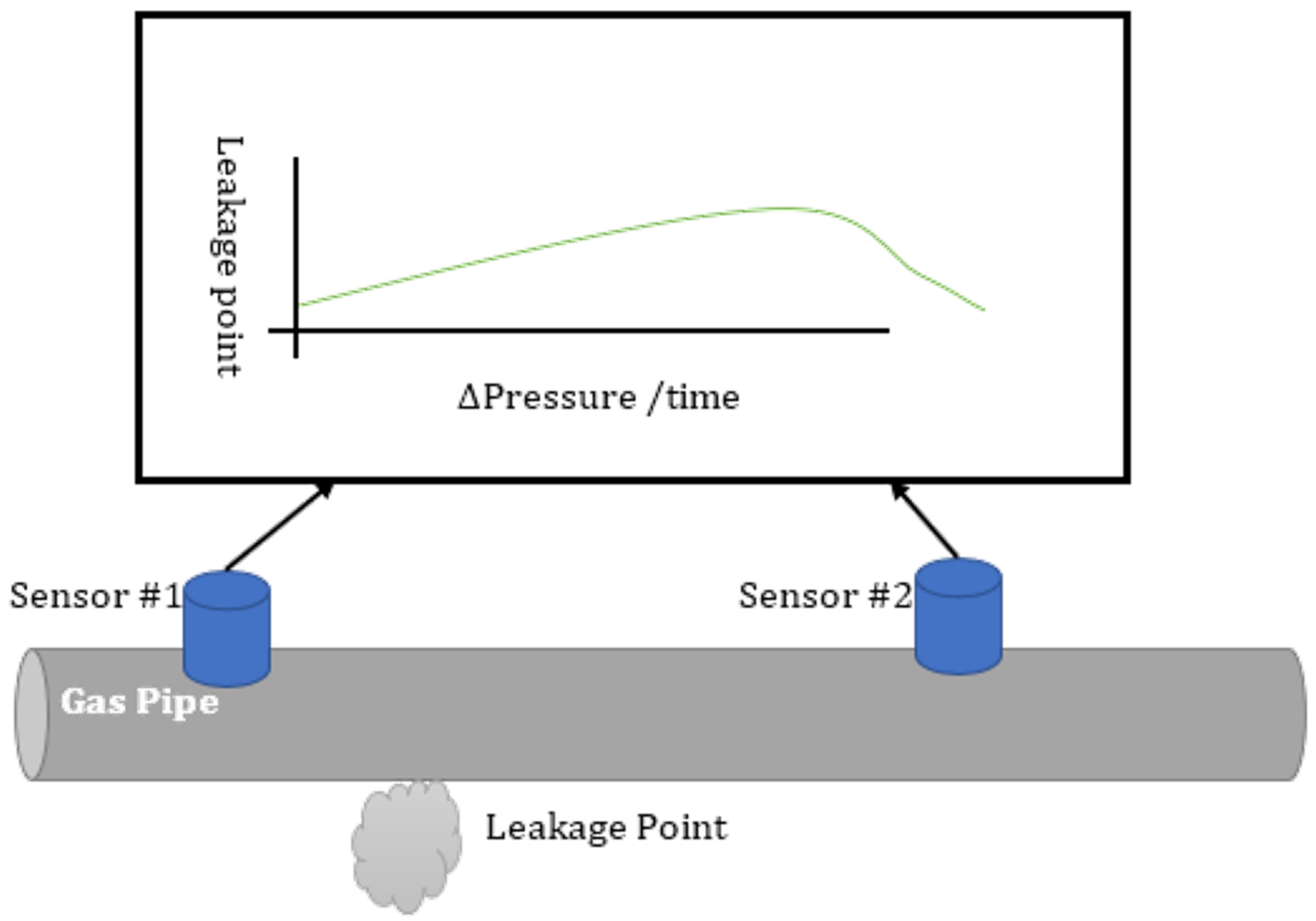


Figure 1: Proposed System Block Diagram

Methodology

The method used in this project is divided into two stages:

1. Obtaining training Dataset for the AI model: Dataset is very hard to produce in real environment as the cost could rock up. I have contacted few gas companies and they all admit the problem of gas leakage and the economical loss but they couldn't consider the typical experiment to generate the training dataset due to the very high cost and time required to build the framework to produce the data.
2. Develop AI model, train the model and use it for prediction: the obtained training data will require pre-processing stage and then building a non-linear model such as artificial neural network.

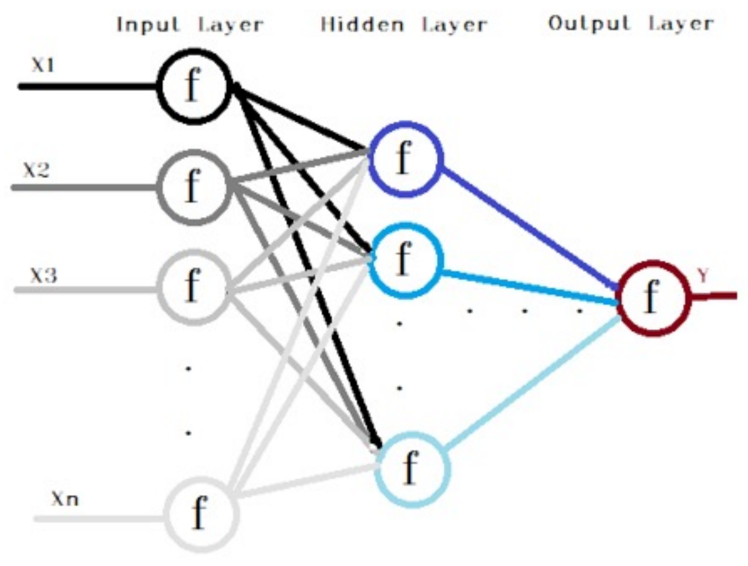


Figure 1: Artificial Neural Network

Table 1: Example Pressure Data at 1% leakage rate (from [1])

24 inch		20 inch		16 inch		12 inch		POS
Flow-in Pressure	Discharge Pressure	Flow-in Pressure	Discharge Pressure	Flow-in Pressure	Discharge Pressure	Flow-in Pressure	Discharge Pressure	
300.0334	294.2856	300.8005	287.0524	300.8501	260.7521	300.8965	140.5074	100
300.4861	294.7381	300.0224	286.2741	300.9849	260.886	300.8162	140.4235	200
300.1358	294.3877	300.3769	286.6283	300.9486	260.8487	300.5484	140.1521	300
300.7747	295.0265	300.9448	287.1958	300.6164	260.5157	300.8553	140.4552	400
300.7565	295.0082	300.8577	287.1084	300.5609	260.4593	300.1867	139.783	500
300.939	295.1747	300.4764	286.6888	300.5911	260.377	300.2532	139.3953	12800
300.8647	295.1003	300.3505	286.5625	300.5766	260.3615	300.9052	140.0437	12900
300.9778	295.2132	300.7666	286.9784	300.3733	260.1573	300.9048	140.0396	13000
300.1302	294.3655	300.8599	287.0713	300.7846	260.5677	300.0903	139.2214	13100
300.3859	294.6211	300.7624	286.9736	300.969	260.7512	300.2226	139.35	13200
300.2946	294.5037	300.8516	287	300.262	259.86	300.7438	139.1279	33300
300.3751	294.584	300.3637	286.5118	300.7503	260.3475	300.6413	139.0217	33400
300.7725	294.9813	300.4167	286.5644	300.3462	259.9424	300.0103	138.3871	33500
300.3693	294.578	300.7939	286.9414	300.3502	259.9455	300.5665	138.9397	33600
300.8469	295.0554	300.2945	286.4416	300.1168	259.7112	300.0168	138.3862	33700

Results

The two inputs are for pipe diameter 20 inch for an initial test. The two data were merge in a matrix which is passed to the training method 'fit'. The model is then tested on a single pair of pressure measurements and output is evaluated .

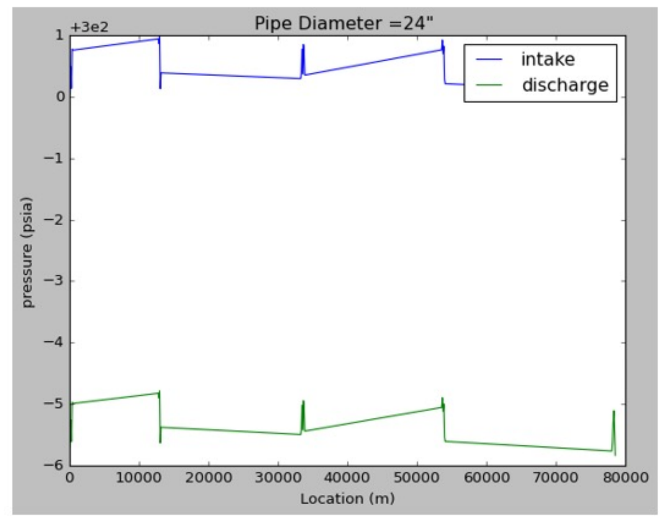


Figure 3: Intake and Discharge Pressure vs leak location at 24" pipe

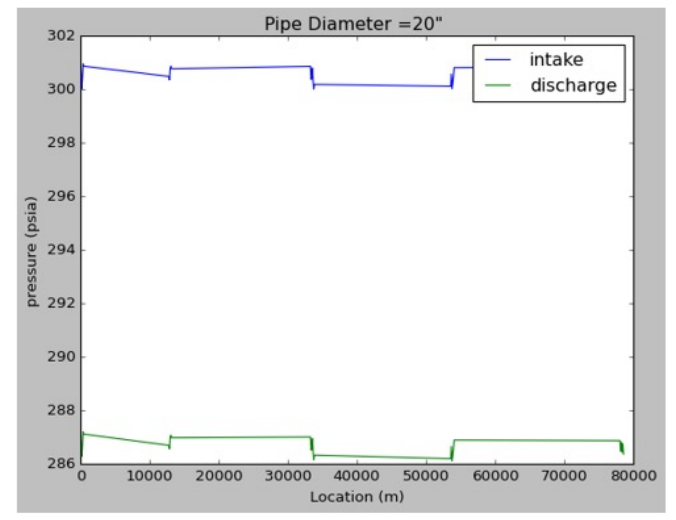


Figure 4: Intake and Discharge Pressure vs leak location at 20" pipe

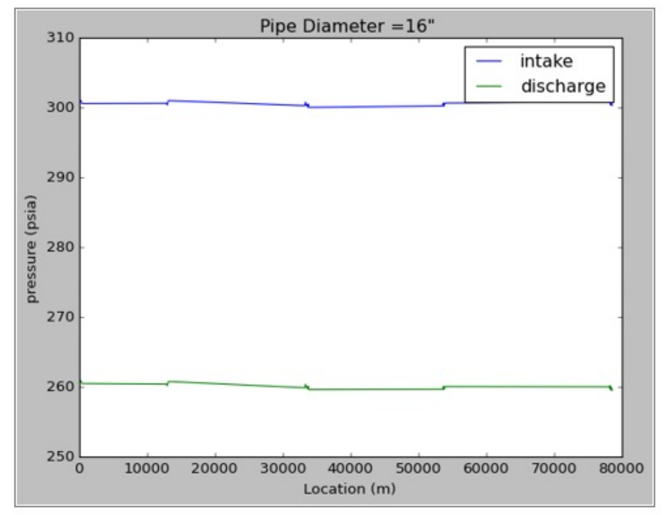


Figure 5: Intake and Discharge Pressure vs leak location at 16" pipe

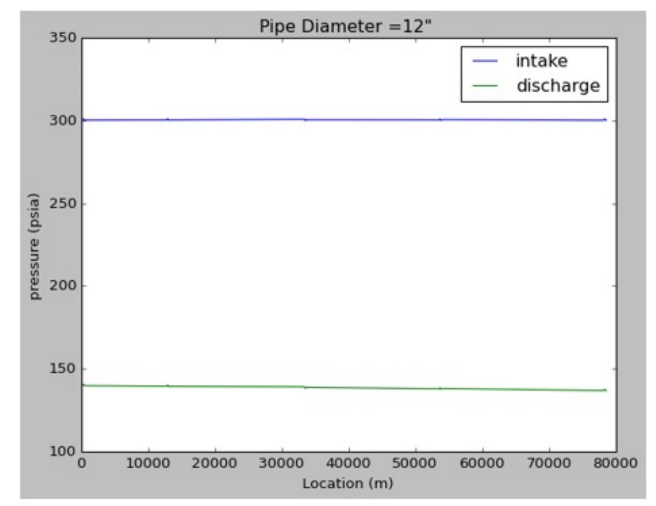
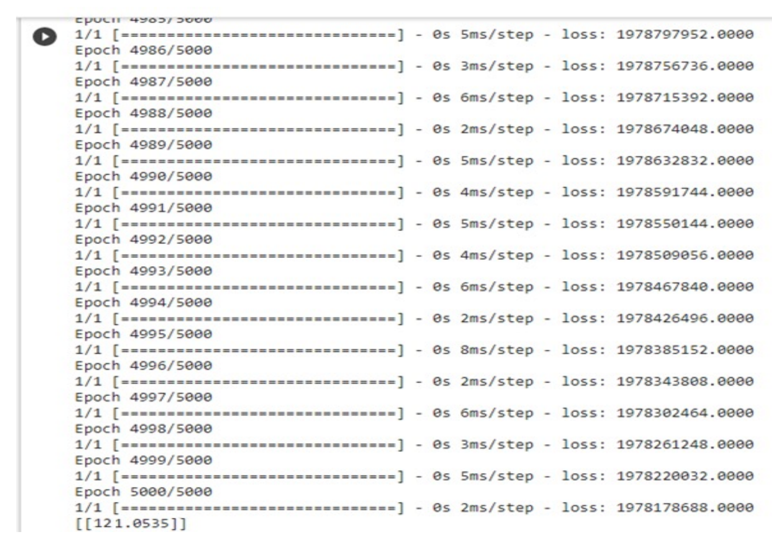


Figure 6: Intake and Discharge Pressure vs leak location at 12" pipe



```
1/1 [==============================] - 0s 5ms/step - loss: 1978797952.0000
Epoch 4986/5000
1/1 [==============================] - 0s 3ms/step - loss: 1978756736.0000
Epoch 4987/5000
1/1 [==============================] - 0s 6ms/step - loss: 1978715392.0000
Epoch 4988/5000
1/1 [==============================] - 0s 2ms/step - loss: 1978674048.0000
Epoch 4989/5000
1/1 [==============================] - 0s 5ms/step - loss: 1978632832.0000
Epoch 4990/5000
1/1 [==============================] - 0s 4ms/step - loss: 1978591744.0000
Epoch 4991/5000
1/1 [==============================] - 0s 5ms/step - loss: 1978550144.0000
Epoch 4992/5000
1/1 [==============================] - 0s 4ms/step - loss: 1978509056.0000
Epoch 4993/5000
1/1 [==============================] - 0s 6ms/step - loss: 1978467840.0000
Epoch 4994/5000
1/1 [==============================] - 0s 2ms/step - loss: 1978426496.0000
Epoch 4995/5000
1/1 [==============================] - 0s 8ms/step - loss: 1978385152.0000
Epoch 4996/5000
1/1 [==============================] - 0s 2ms/step - loss: 1978343808.0000
Epoch 4997/5000
1/1 [==============================] - 0s 6ms/step - loss: 1978302464.0000
Epoch 4998/5000
1/1 [==============================] - 0s 3ms/step - loss: 1978261248.0000
Epoch 4999/5000
1/1 [==============================] - 0s 5ms/step - loss: 1978220032.0000
Epoch 5000/5000
1/1 [==============================] - 0s 2ms/step - loss: 1978178688.0000
[[121.0535]]
```

Conclusion:

The work consists of the regression model and the data generating model. The data generation model is a key to simulate the problem and generate huge amount of data for the regression model to work. The simulation platform is built based on the mathematical understanding of the leakage problem and modelled at the best known mathematical description of the gas density, velocity, and pipe parameters.