DEVELOPMENT OF AN ULTRASONIC SENSING SYSTEM FOR THE DETECTION OF OIL LEAKAGE IN PIPELINES

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Abstract- The damage or leakage of pipeline was a main cause for 15% of oil contamination or pollution. In the present research account described the development of an ultrasonic sensing system study for the detection of oil leakage in pipelines consists of an ultrasonic sensor and a micro-controller.

Index Terms- Oil leakage, Oil pollution, Ultrasonic sensor, Micro-controller

Environmental and personal safety issues have created the need for more effective leak detection and location on oil pipelines. For companies operating these pipelines, a leak, no matter how insignificant it might seem, can result in major liabilities. As such, pipeline operators are increasingly concerned with monitoring the performance of pipes that are becoming fatigued and outdated. According to the Korea Ministry of Environment, as much as 15 percent of all oil contamination in gas stations was caused by pipeline failure [1]. This study aimed to develop an ultrasonic sensor which can be used to provide pipeline operators with timely, accurate, and repeatable leak detection and location.

There are two basic forms of ultrasonic flow measurement, transit time and Doppler. For the purposes of this study, we used transit-time technology, as it is the primary ultrasonic method in use in the oil industry for measurement of both refined products and crude oil in pipelines [2-3]. All transit-time ultrasonic meters are designed based on the principle that sound travels faster when moving in the same direction as flow and slower when traveling in the opposite direction as flow. By measuring the independent travel times of the sound transmission in each direction (upstream and downstream), the fluid flow velocity can be computed [4-5].

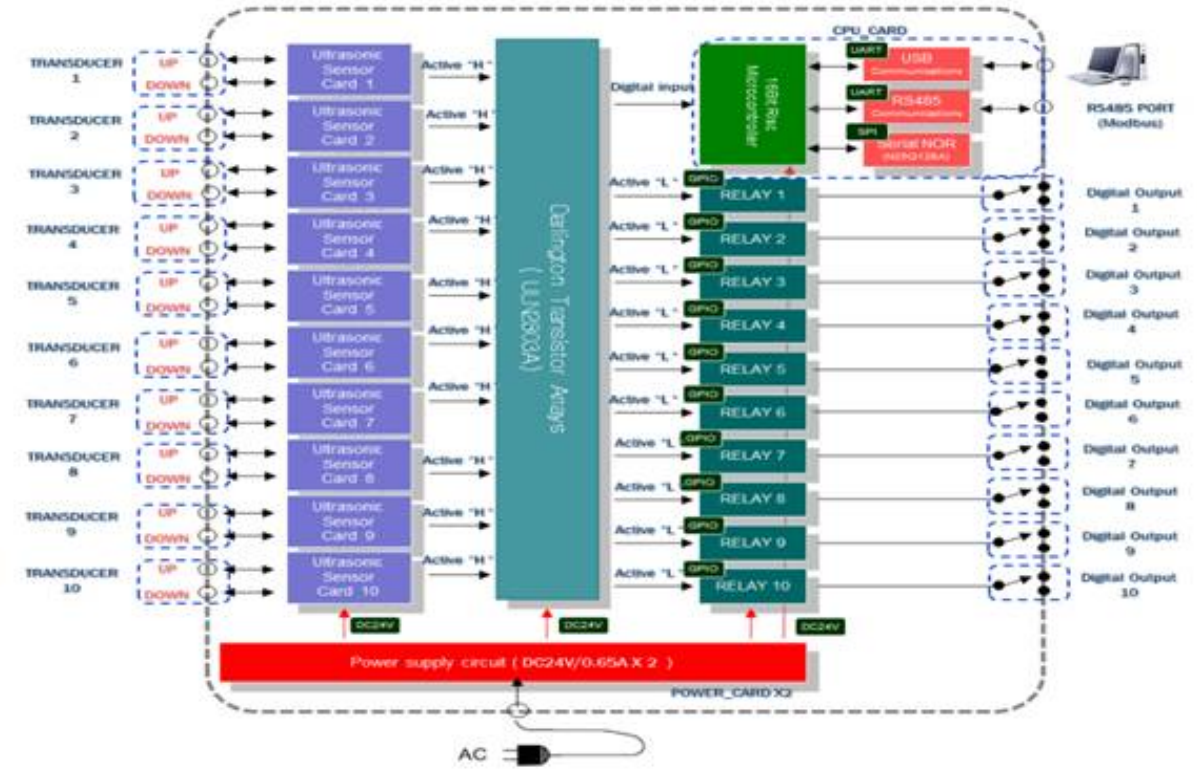


Figure 1. A diagram of the ultrasonic sensing system developed in this study

The ultrasonic sensing system developed in this study (Figure 1) for the detection of oil leakage in pipelines consists of a ultrasonic sensor and a micro-controller which are connected by bidirectional signal lines.
The installation of the ultrasonic sensing system followed a clamp-on system and does not require penetration of the pipe in a physical sense to arrive at a measurement and does not have the process to be shut down for installation or maintenance. The specification and configuration of the ultrasonic sensing system for the detection of oil leakage in pipelines is shown in Table 1 and Figure 2.

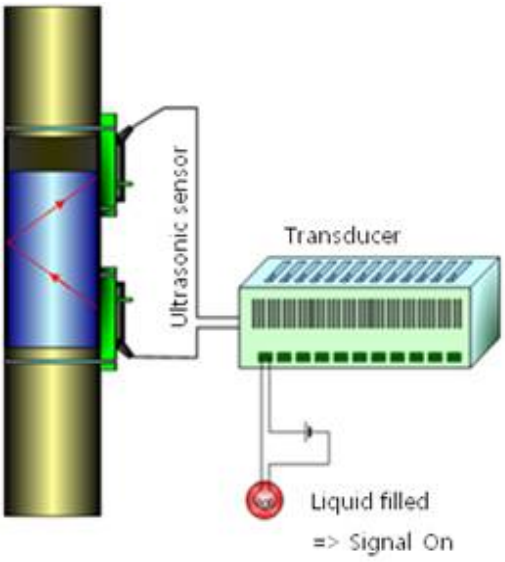


Figure 2. Configuration of the ultrasonic sensing system.

Table 1. Specification of the ultrasonic sensing system

Items	Spec.
Output type of ultrasound wave	Multi Pulse
Output frequency	1 MHz
Accuracy	±0.5%
Measurement pipeline diameter	40 mm
Measurement fluid	Oil, water
Power	AC (90~240)V, or DC (9~36)V
Operation temperature	Transducer : (-10~80) °C, Controller : (-30~80) °C
Transducer cable	Maximum 100 m
Installation type	Clamp-On
Data storage	Leakage signal(0 or 1), date, time
Protection level	Transducer : IP 67, Controller : IP 65

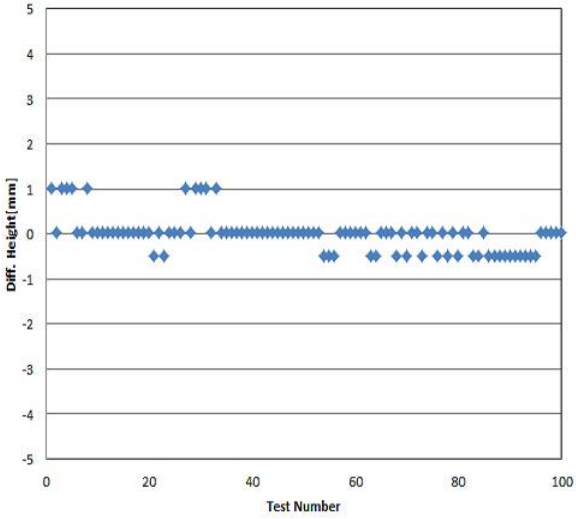


Figure 3. Performance test result of the ultrasonic sensing system.

The performance of oil leakage detection by the ultrasonic sensing system showed a standard deviation of measurement as ±10 mm with reliable accuracy (Figure 3).

ACKNOWLEDGEMENT

This work was supported by the Korea Ministry of the Environment as the "GAIA project (2014000530002)".

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