Maestría en Ingeniería en Automatización de Procesos Industriales

Title

Development of automatic sensing system for water flow based on noncontact pointer with self-sustaining capacitance signal principle

Author

José Luis Ibarra Zamudio

Contributor

Mario Espinosa Tlaxcaltecatl

Juan Antonio Arizaga Silva

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Development of automatic sensing system for water flow based on noncontact pointer with self-sustaining capacitance signal principle

José Luis Ibarra Zamudio, Mario Espinosa Tlaxcaltecatl, Juan Antonio Arizaga Silva
Maestría en Ingeniería en Automatización de Procesos Industriales
jose.ibarra@uppuebla.edu.mx
Tercer Carril del Ejido Serrano S/N. San Mateo Cuanalá, Juan C. Bonilla, Puebla, México

1. Introduction

The conventional water meter employ a mechanism structure in which the water flow drives gears that move an arrow pointer on a scale panel. Figure 1 shows a typical water meter that includes four coarse numbers and four fine arrow scales and a complete outline of the project. When the water flow is recorded using the simple mechanical structure, the meter does not require electrical power. However, recording the water flow using a mechanical device that requires values be recorded manually. That's why this prototype for automatic sensing system water meter reading is based on noncontact pointers self-sustaining with capacitance signal principle and wireless data processing environment.

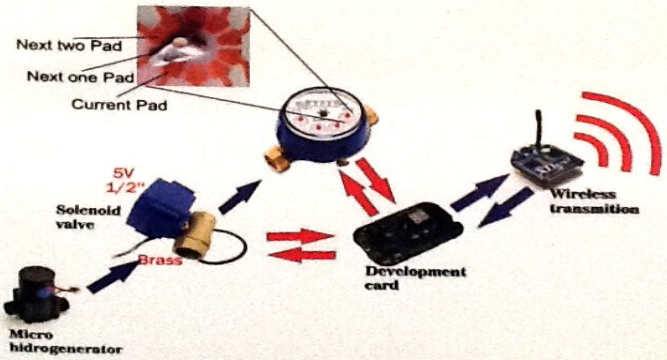


Figure 1. Water meter mechanical with arrow scales.

2. Aim

Implement of the integration of an embedded system together with the automatic electrical / mechanical water meter based on noncontact pointer with self-sustaining capacitance signal principle with wireless data processing.

- Design and implement contactless sensors based on capacitive measurement.
- Implement wireless communication system for remote monitoring and automatic processing.
- Implement electronic module acquisition, processing and data storage.

3. Method

The first point has made the implementation and design of the sensors.

This sensing system employs a method of sensing based on pointers panels without contact, for detecting the position of a pointer and the optimal frequency is based on transfer theory of capacitive signal and is made of low cost of implementation, Figure 2 shows the physical structure of the arrow sensor with on PCB (Printed Circuit Board).

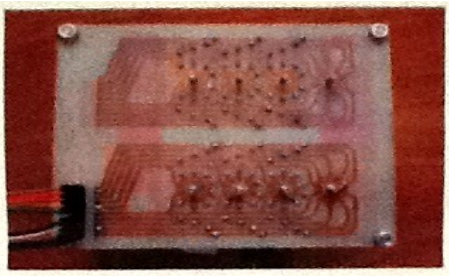
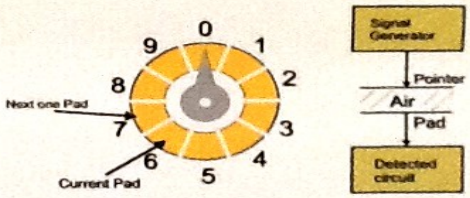


Figure 2. Sensors noncontact pointers with capacitive effect shown on a printed circuit board (PCB).

To detect the numbers 0 to 9, we added copper foil into a PCB underneath the position of each number to act as a sensing pad for the signal detection. The structure in Figure 3 acts like a capacitor between the sensing pad and the metal pointer. The air between the two parallel pieces of metal, provides the medium of the capacitor.

Figure 3. Physical structure of pointer meter sensor



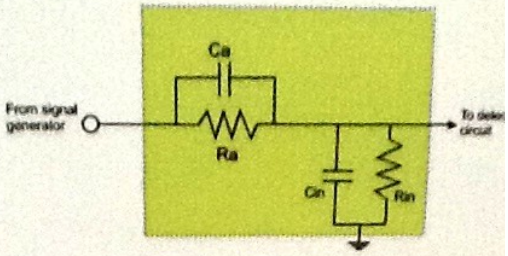
To solve the signal circuit is determined by a transfer function between input and output as shown in Figure 4 equivalent circuit, which is given by:

$$H(s) = \frac{V_{out}}{V_{in}} = \frac{\frac{R_{in}}{(R_{in}SC_{in}+1)}}{\frac{R_a}{(R_aSC_a+1)} + \frac{R_{in}}{(R_{in}SC_{in}+1)}}$$

The frequency can be determined by:

$$f = \frac{2R_{in} - R_a}{j2\pi R_a R_{in}(C_{in} - 2C_a)}$$

Figure 4. Equivalent circuit of pointer sensor



The second point is to implemented a Zigbee network for data processing via remote.
It worked with the wireless signal, allowing to perform a network between XBee modules with star topology as Figure 5 shows.

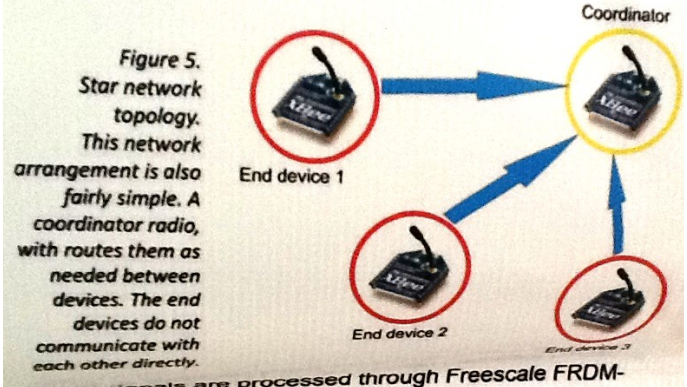


Figure 5. Star network topology. This network arrangement is also fairly simple. A coordinator radio, with routes them as needed between devices. The end devices do not communicate with each other directly.

These signals are processed through Freescale FRDM-KL25Z development board and programmed in the MBED platform, then are sent to the Xbee modules that act as end devices and they send the signal to a coordinator module for storage. As shown in Figure 6.

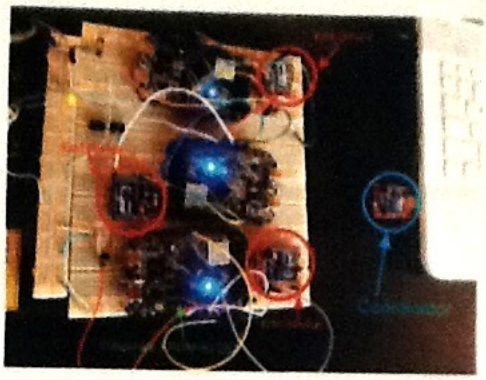


Figure 6. Xbee modules acting as coordinator and end devices and the processed signal Freescale FRDM-KL25Z development board.

In this project is to have a complete sensing system of automatic water flow, which is capable of obtaining self-sustaining energy through a microhidrogenerador and management of a control valve for opening and closing the water flow, as shown in the block diagram of Figure 7.

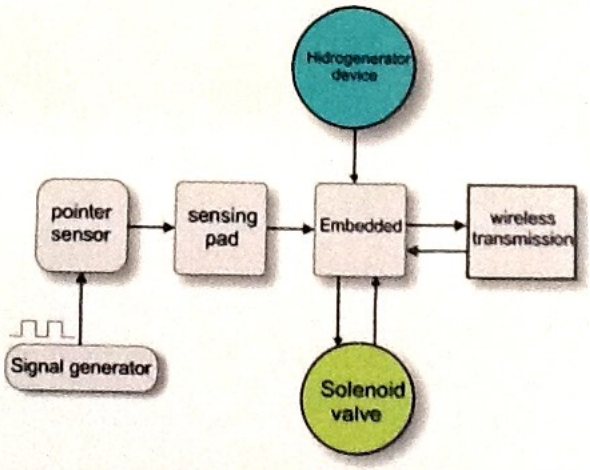


***Figure 7.** Complete measurement system automatic water flow.*

4. Results

The water flow meter consists of a pointer with four dials. According to the water flow, the pointer moves and the corresponding readings are recording in a oscilloscope or a PC. As the supply voltage is 3.3, the minimum high-level is approximately 1 V for an acceptable sensing level. Dielectric was used for better viewing on the oscilloscope in the first result sensing system, is working on the type of dielectric be more sensitive measurement as shown in Figure 8.

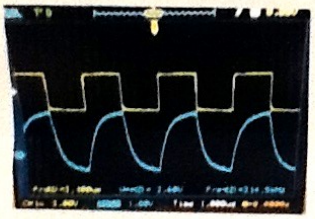


Figure 8. Signal obtained with an oscilloscope at a certain frequency in a pointer contactless sensor.

On the other hand, the range for wireless data transmission through the Xbee modules are:

Indoor is ±10 meters and outdoor line is ±55 meters.

5. Conclusion

In this poster behavioral outcomes measurement system water flow are presented like an electrical circuit on a PCB to the meter body for reading the pointer scale. Based on capacitive signal response, the best frequency is found to promote the sensitivity by analysis of transfer function.

Acknowledgements

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