Experimental Research Dynamic Characteristic of Proximity Sensor

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Abstract: In this paper, the measurable dynamic characteristic of proximity sensor in experimental and is presented. Through a dynamical model of proximity sensor was fabricated, the measurement results showed the optimal operating range of a mobile robot. If the output signal has more noise, or not smooth during the time spent the tests, control of the mobile robot is difficult. Therefore, the dynamic characteristic of proximity sensor plays a very important role in controlling mobile robot, and influence on the results of dynamic identification. By the hand-made measurement system is successful development, aluminum tapes (50×25) with different thickness are tested. The measured data have demonstrated the output signal of inductive proximity sensor is closely related to the parameters, such as: velocity, sensing distance, thickness of aluminum tape. In addition, base on the comparison results obtained with experimental aluminum tape, aluminum tape plus plastic tape, choose the appropriate thickness of aluminum tape and plastic tape to display results correctly. And when we have perfect models of the dynamic, it becomes the key point for control mobile robot.
Keywords: Dynamic Characteristic, Inductive Proximity Sensor, Mobile Robot, Identification, Sensing Distance

I. Introduction

1. Inductive proximity sensor

Inductive proximity sensor [1,2] detects metallic objects and is suitable for industrial applications. This type of sensors produces a magnetic field in the vicinity of an oscillation coil. When a conductive object gets near to the coil, the eddy current on the object induced by the magnetic field reacts with the coil to change the oscillation frequency. Although the inductive sensor is simple, sensitive and suitable for industrial applications, it is unable to detect nonmetallic objects. Proximity sensor configuration is shown in Figure 1.

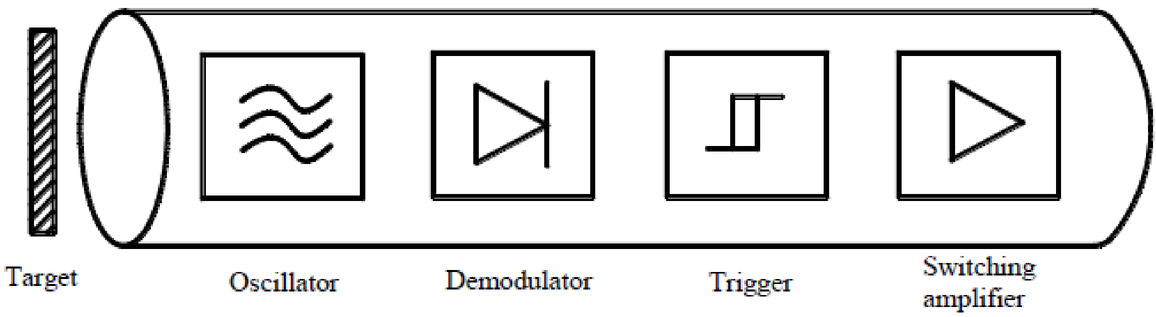

Figure 1. Inductive proximity sensor configuration

Proximity sensors have been widely used for mechatronics systems in manufacturing environments, and many of them are commercially available [3]. In robot applications, proximity sensors have been used for collision avoidance, precision assembly, or grasping. Several detection methods have been used such as ultrasonic, optical, inductive and capacitive measurement.

An inductive proximity sensor uses a radio-frequency (RF) oscillator, a frequency detector, and a powdered- iron core inductor connected into oscillator circuit, as shown in Figure 2. The oscillator is designed so a change in the magnetic- flux field in the inductor core causes the frequency to change. This change is sensed by the frequency detector, which sends a signal to the apparatus that controls the robot. In this way, if the system is designed properly, a robot can avoid bumping into metallic objects.

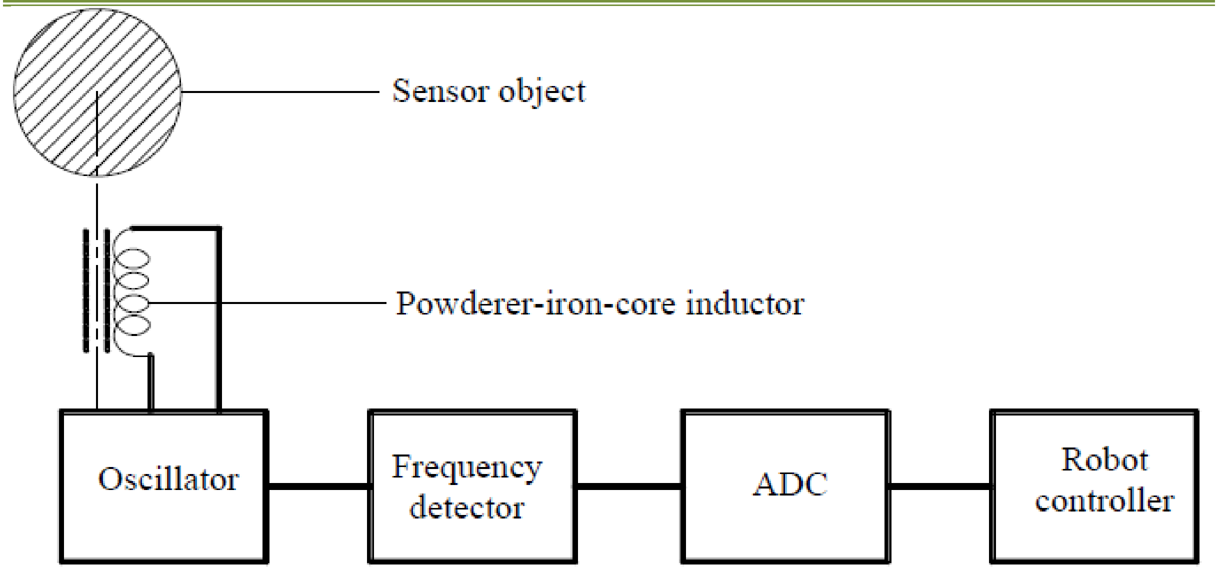

Figure 2. The function of the proximity sensor

2. Identification of proximity sensor

Nowadays, proximity sensors are mostly used for the identification in a mobile robot [4]. For static performance measurement of sensor, 6 types of metals are tested. The experimental results show that the signals of ferrous, non-ferrous and alloy metal tape have giant differences [5]. However, the impact of each position of the proximity sensor will be different in each material. The shape of the output signal definitely changes with the distance from 0.5mm to 0.7mm of the outer edge target [6]. Most of the technology uses simple HF-oscillation principle as an inductive proximity sensor with a decrease in the quality of the oscillator circuit's electromagnetic to find the tape. The impedance is used as a parameter for the proximity as shown in Fig. 3 [8]. By applying this technique, the external factors may cause negative effects to system performance. In paper [7] has been analyzed the influence of the obstruction sheet thickness and disturbance tape to the noise in received signals. By using unknown tape of the different thickness of plastic, prevent the disturbance from unknown tape under 10%. Furthermore, the results of the measuring activities also demonstrate that sensing range without the obstructive is larger than with the obstructive.

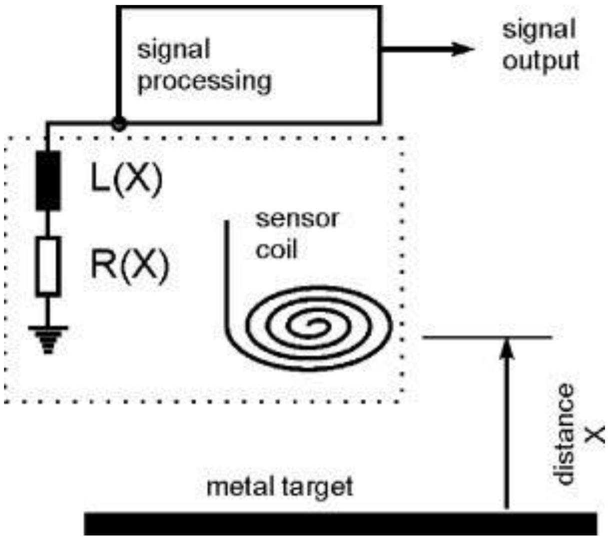

Figure 3. Principle of proximity measurements with an eddy current sensor coil [8]

II. Experimental Set-Up for Proximity Sensor Measurement

A testing set-up of measurement system is shown in Fig.4. The aluminum tape 1 is fixed on conveyor belt 3. The distance between them is equal on the conveyor length. Because while the conveyor belt moves, the surface of the aluminum is deformed, so the plastic tape 2 is placed beneath the aluminum tape to receive the output signal less noise. In order to determine the exact distance, the sensor is fixed at the electronic height gauge. The LED signals received from the sensors to know exactly the sensing distance h. The output signal of the proximity sensor is displayed on the oscilloscope, based on the change of parameters such as conveyor speed v, h, d, the relationship between the shapes of the signal with the above parameters. Continue to compare experimental results with theoretical to draw

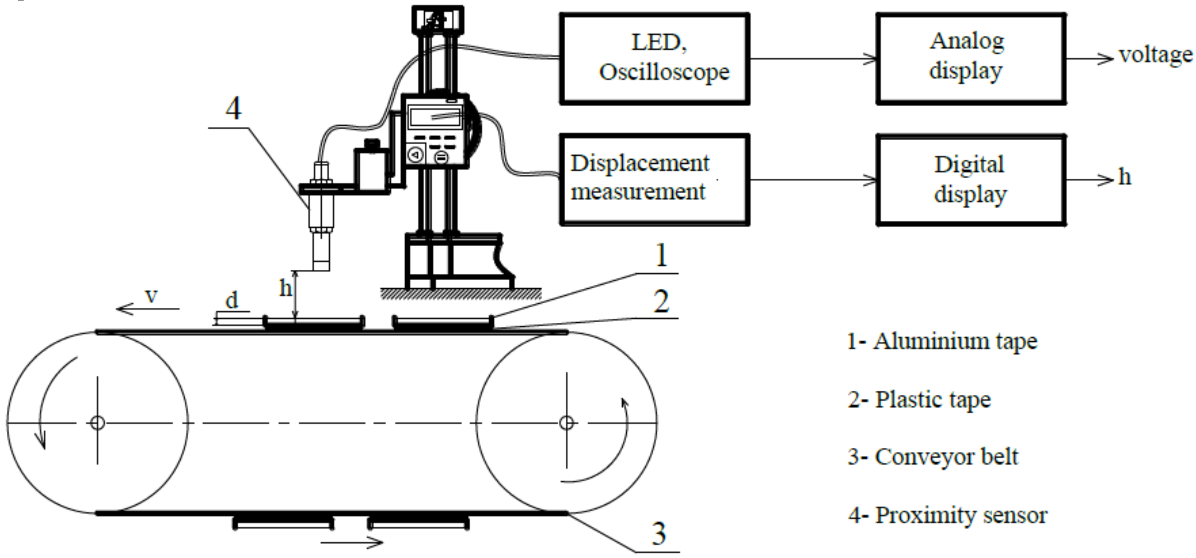

Figure 4. Experimental set-up for proximity sensor measurement

III. Result and Discussion

1. The relationship between the output signal of the sensor and sensing distance

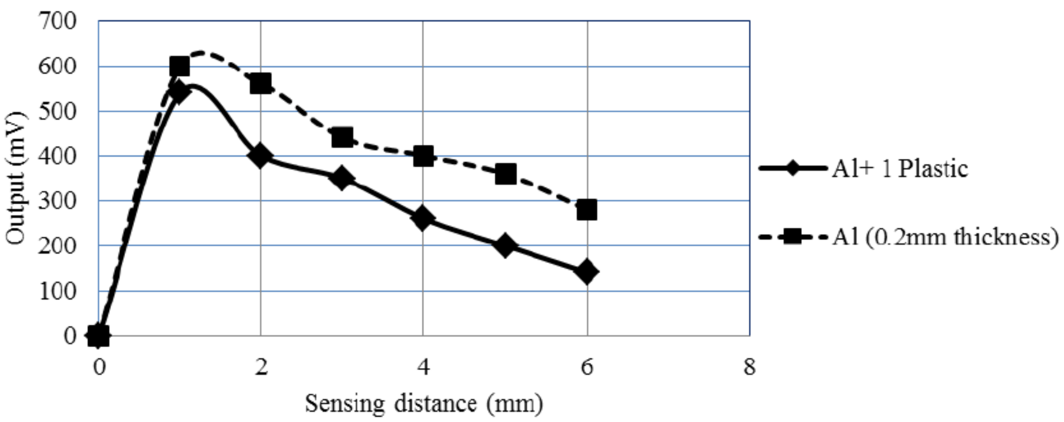

Figure 5. Sensor output for different aluminum sensing distance of Al tape and Al+ 1 Plastic tape

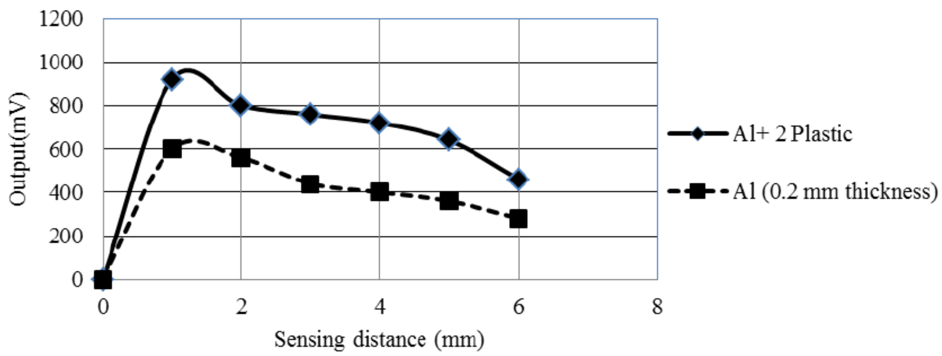

Figure 6. Sensor output for different aluminum sensing distance of Al tape and Al+ 2 Plastic tape

Experimental results indicate that the output signal of the sensor is inversely proportional to the sensing distance. However, if you use only a plastic tape under the aluminum tape decreases the average output voltage value is greater than the remaining cases (from 560mV to 140mV). Put as much of the plastic tape underneath the aluminum tape, the visibility of the output signal becomes clearer.

When using a plastic tape placed beneath the aluminum tape, the value of the average voltage is lower than when using only aluminum tape. The outputs signals are shown in Fig. 5. Meanwhile, if put two plastic tape bottom aluminum tape, the value of the average output voltage will be higher than if only one tape of aluminum. The outputs signals are shown in Fig. 6.

2. The relationship between the output signal of the sensor and speed of conveyor belt

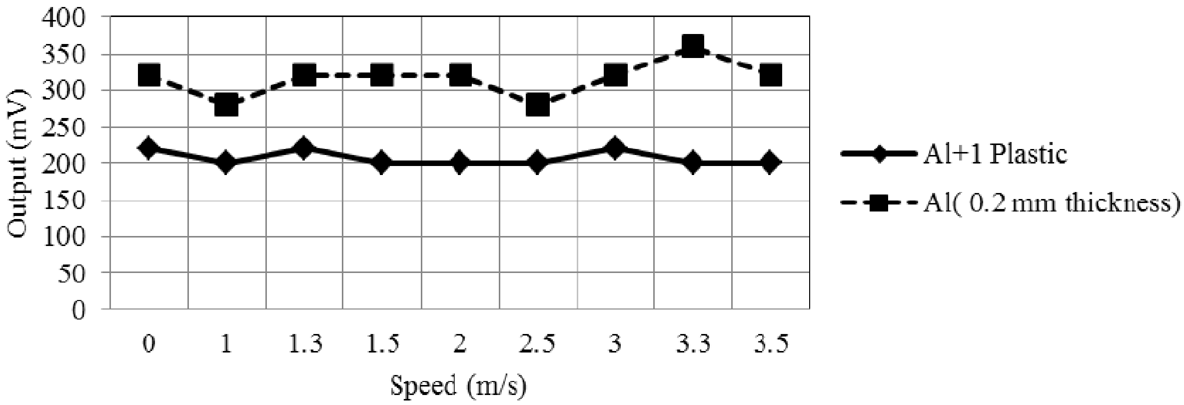

Figure 7. Sensor output for different conveyor belt speed Al tape and Al+ 1 Plastic tape

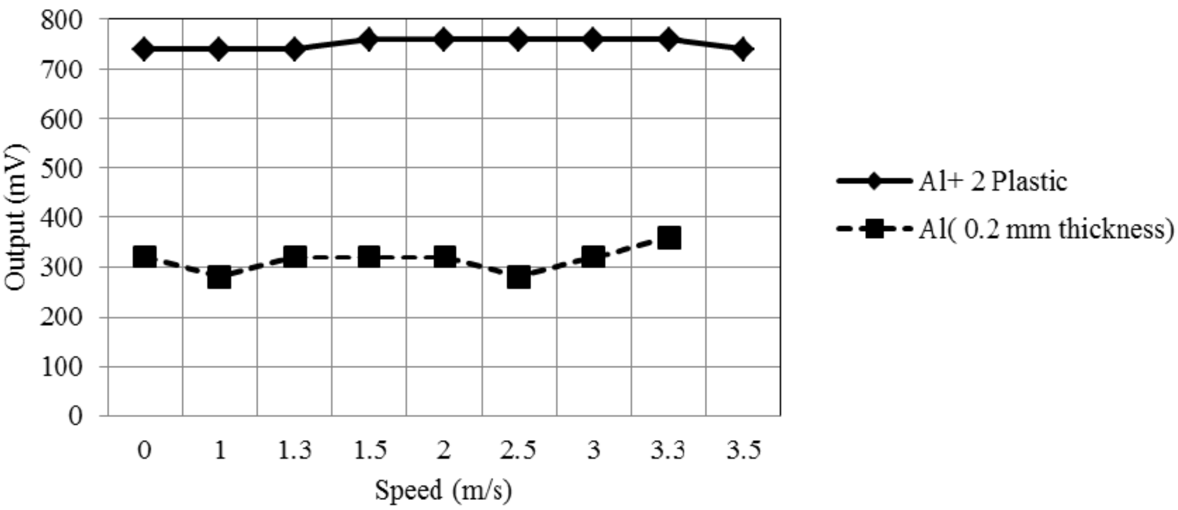

Figure 8. Sensor output for different conveyor belt speed Al tape and Al+ 2 Plastic tape

Based on Figure 7 and Figure 8, the output signal of the sensor hardly changed when increasing the value of the speed of the conveyor belt. When using an aluminum tape and a plastic tape placed beneath the aluminum tape, the value of average voltage is similar. Meanwhile, using 2 plastic tapes placed under aluminum tape, the average voltage values have large spreads. This result proves that the more is plastic tape below aluminum tape, the greater is the value of average voltage. When changing the thickness of the plastic tape placed beneath the aluminum tape also gives a similar result.

3. Changing the thickness of the aluminum

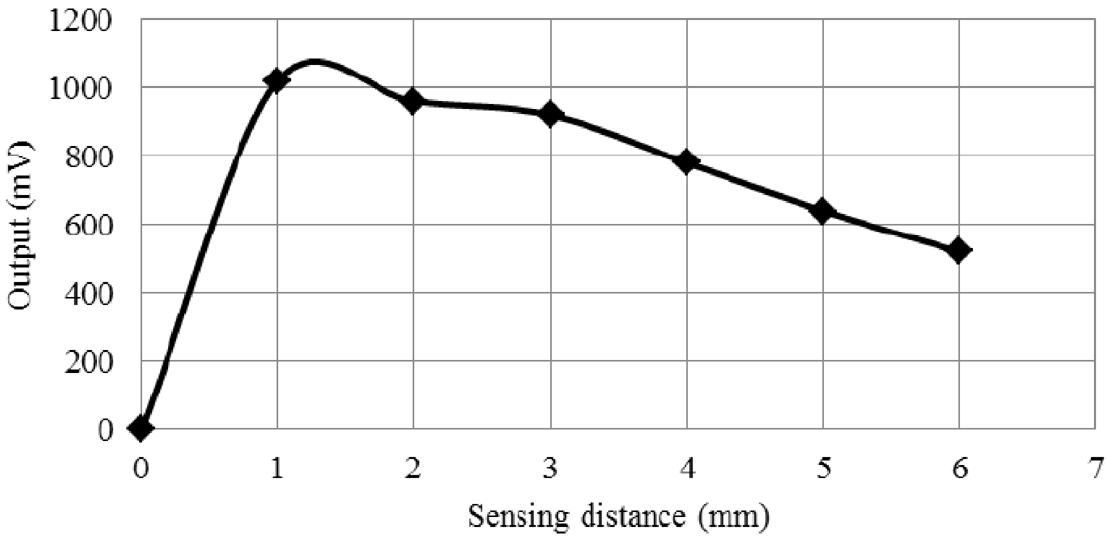

Figure 9. Sensor output for different aluminum sensing distance (Al thickness difference)

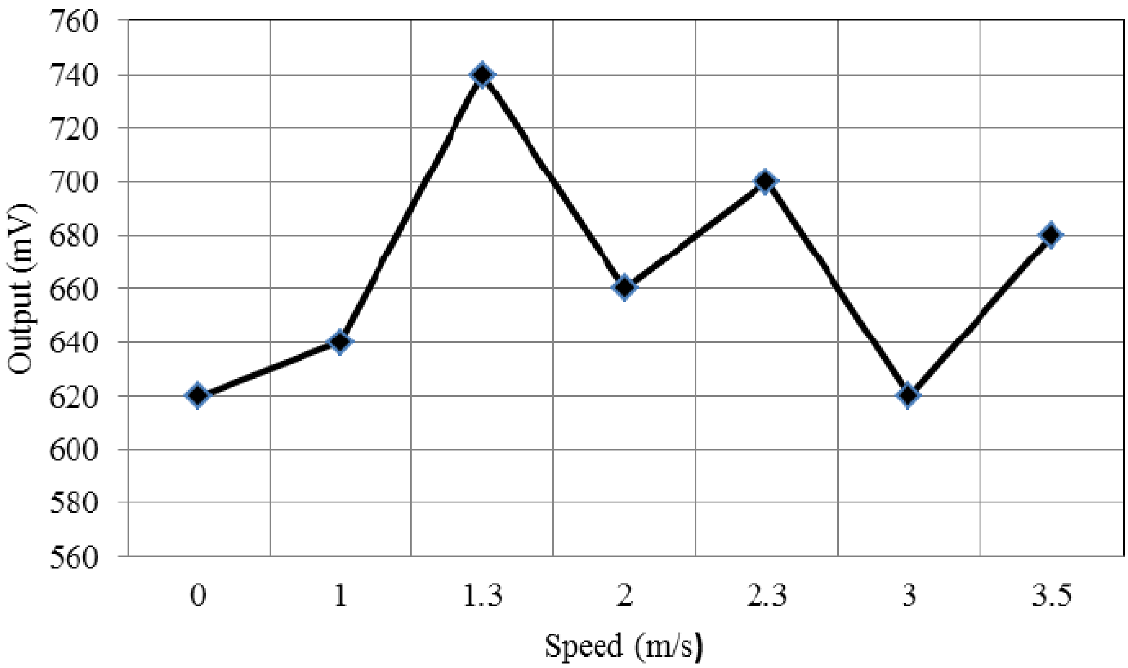

Figure 10. Sensor output for different conveyor belt speed (Al thickness difference)

When changing thickness of aluminum tape placed conveyor belt, the shape of output signal is showed on Fig. 9 and Fig.10. In particular, different from the previous case study, the value of the average speeds has changed of a small range from 620mV to 740mV. In general, this change is due to the arrangement of aluminum on conveyor with heterogeneous thickness. However, this arrangement does not affect the change of the output signal according to the sensing distance.

IV. Conclusion

In summary, the shape of the sensor's output signal will more clearly when placing plastic tapes with thickness suitable below aluminum tape. In all cases, the output voltage is always inversely proportional to the sensing distance. This is completely consistent with the theoretical basis as well as previous studies. Meanwhile, these signals do not depend on the velocity of the sensor or object.

In addition, with the use of multiple different aluminum tapes in one measurement, the display is relatively accurate results. From there it is easy to identify the optimal identification area for the proximity sensor.

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