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Comparison dynamic testing of analog proximity sensor for a autonomous vehicle

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Abstract: In recent years, a large number of analog proximity sensors (APSs) are used in the field of autonomous vehicle control due to their wide operation area. In this research, two experimental methods by hand to determine the dynamic properties of the sensor are presented.

A comparison of the results obtained from the output signal will provide an optimal experimental selection for application in mobile devices. The outcomes prove that the shape and the noise of the output signal depend on the installation of a fixed sensor or fixed material. This is critical key for studying the methods of minimizing signal interference in fact.

Keywords: Dynamic testing, Analog sensor, Autonomous vehicle, Identification, Sensing distance

I. INTRODUCTION

APS is a device used to detect the presence of an object [1]. It concludes four components: the coil, oscillator, detection circuit, and output circuit. The target material, environment, and mounting restrictions all have an influence on these items and on the senor's operation, magnetic nature, and shielding. The oscillator produced a fluctuating, doughnut-shaped magnetic field around the winding of the coil, which is navigated in the device's sensing face. Structure of an APS is shown in Fig.1

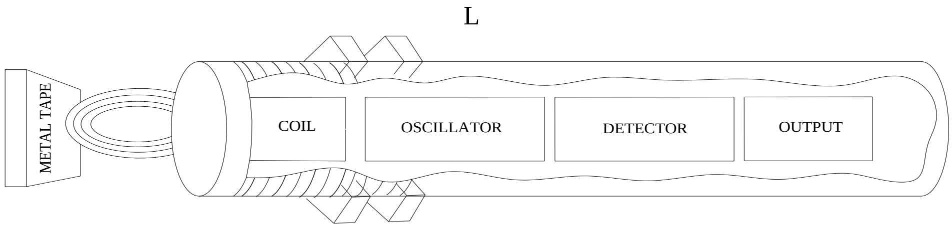


Fig.1. Analog proximity sensor structure [2]

When a metal tape moves into the sensor's field of testing, eddy currents build up in the object, magnetically push back, and finally dampen the sensor's own oscillation field [3]. The sensor's detection circuit monitors the amplitude of the oscillation and when it becomes sufficiently damped, triggers the output circuitry.

APSs come in shielded and unshielded versions [4]. Without any shielding, the doughnut-shaped magnetic field generated by the sensor's coil is unrestricted. As a result, the sensor will be triggered when any metal object comes from behind, along side, or in front of the device. In a shielded sensor, a ferrite core directs the coil's magnetic field to radiate only from the sensor's detection face. Even unshielded inductive proximity sensors have peeled-back ferrite-core shielding, which gives them a longer sensing distance than the shielded versions. At the same time, this feature interferes false readings caused by objects behind the detection face. APSs shielded and APSs unshielded are shown in Fig.2

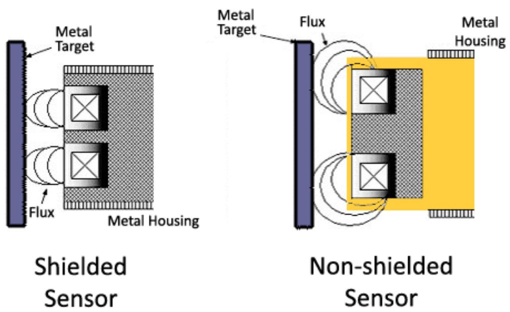


Fig.2. Shielded and unshielded sensor [5]

Detection distance is the position at which the APS is triggered when a standard detectable object is moved in front of it in a defined manner. In order to determine this distance for a sensor with an end (or "front") detection surface, the sensor's center line is aligned with the standard detectable object's center line [6]. Then, the object is moved toward the sensor's face until the sensor changes output states. Detection distance is effected both by the conductivity and the thickness of the metal tape. Highly conductive materials make poor targets for traditional APSs. Thick materials are harder to test than thin ones. Both factors relate to the generation of eddy currents in the target. A conductive material disperses eddy currents, so the target becomes harder to detect. But a thin material, with its reduced ability to move current, causes a buildup of eddy currents. This makes it detectable at greater distances. Detection distance is shown in Fig.3

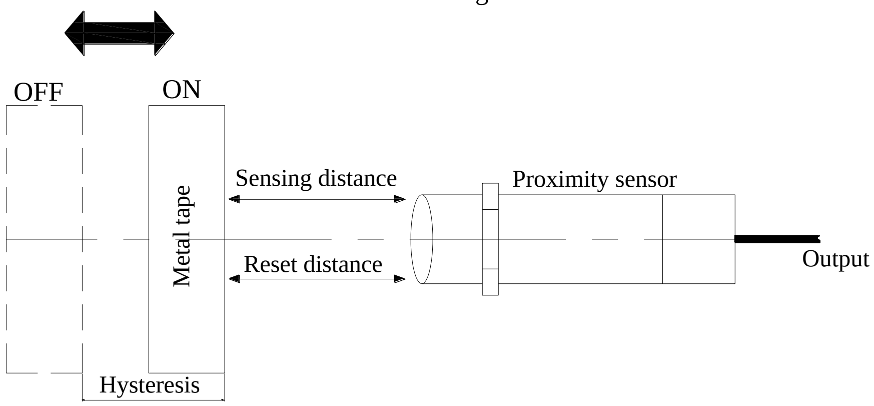


Fig.3. Sensing distance definition [7]

II. METHOD

1. Metal tapes move and IPS is fixed

With this measurement method, IPS is kept on the device, which may determine sensing distance (h) according to various metal tapes while the large number of materials (copper, aluminium) are held on the conveyor and moved along with it. In the process of moving the metal tapes, the velocity of the conveyor is controlled. From that the relationship between the sensor's output signal and the velocity is established in this case. In particular, since the conveyor belt is moving at high speed, the output signal is more noise. Therefore, into reduce noise, the bottom of the tape metals is placed a plastic tape. This hand-made testing method is shown on Fig.4

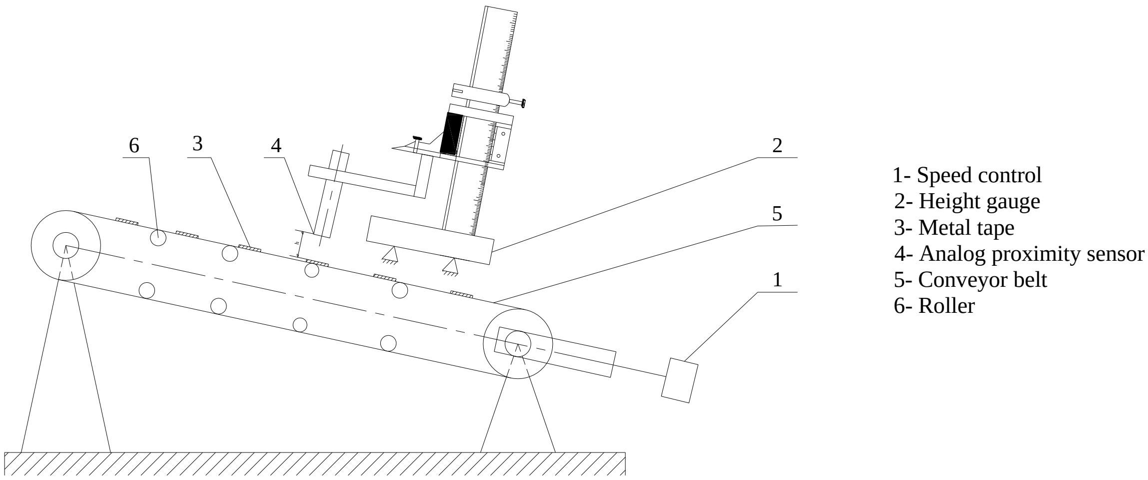


Fig.4. Metal tapes move and IPS is fixed dynamic measurement

2. IPS move and metal tapes are fixed

With this testing procedure, the sensor moves along the flat table. Its speed is controlled by controlling the operation of the stepper motor. Meanwhile, the various metal tapes are pasted on testing table with constant spacing. In this case, the velocity of IPS is is set at a constant value. The difference in signal shape of the materials over time is built, and compare the results with the previous one and draw conclusions. This hand-made measurement method is shown on Fig.5

Volume – 03, Issue – 05, May 2018, PP – 35-39

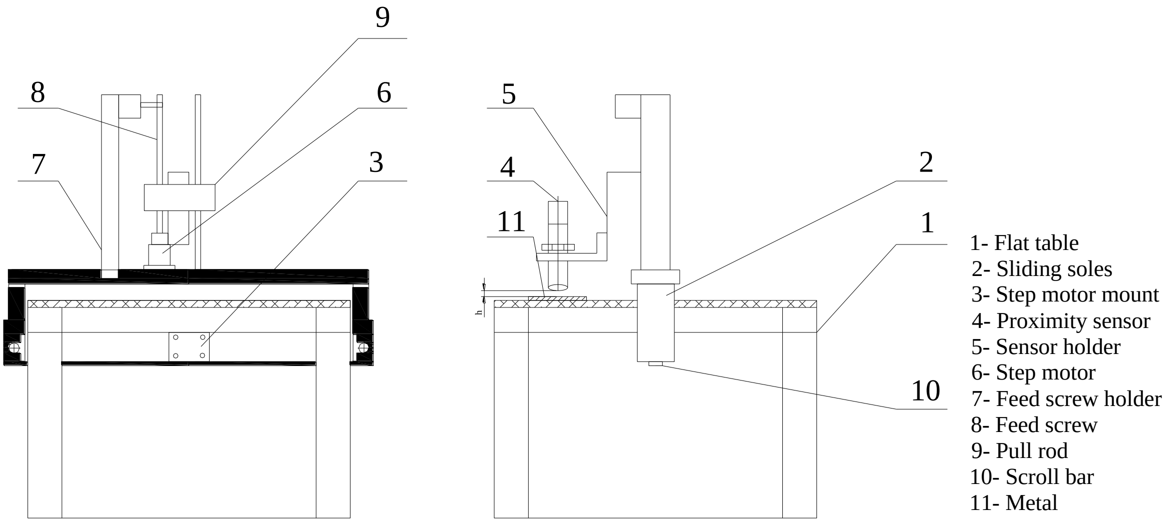
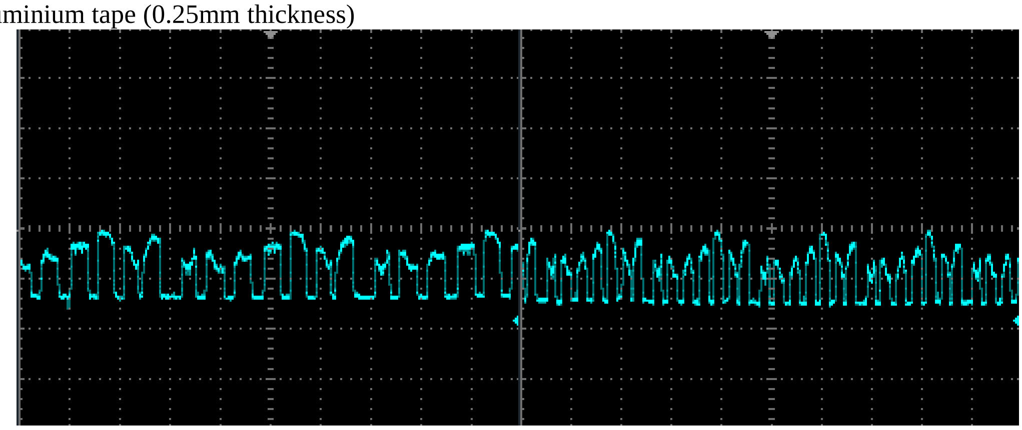


Fig.5. IPS move and metal tapes are fixed dynamic measurement

III. RESULT AND DISCUSSION

1. First experimental method

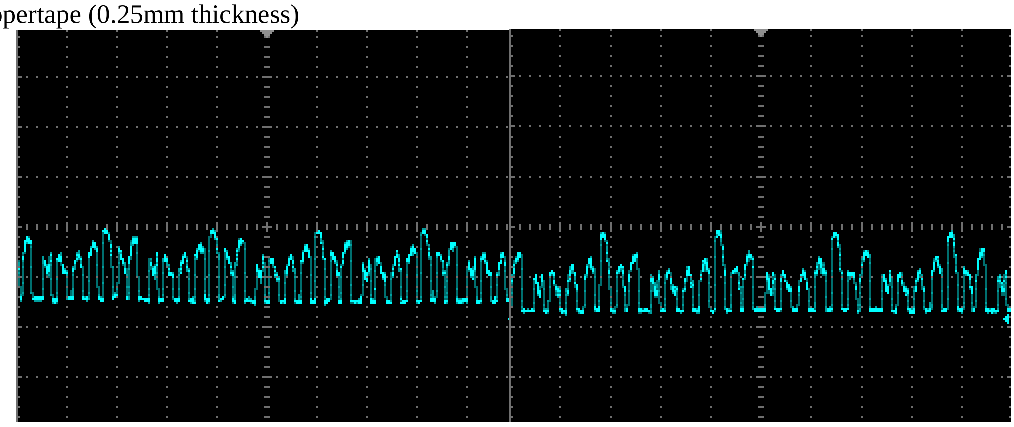
1.1. Aluminium tape (0.25mm thickness)



(a) (b)

Fig.6a,b. Output signal of APS when testing aluminium tape

1.2. Coppertape (0.25mm thickness)



(a) (b)

Fig.7a,b. Output signal of APS when testing copper tape

2. Second experimental method

2.1. Aluminium tape (0.1mm thickness)

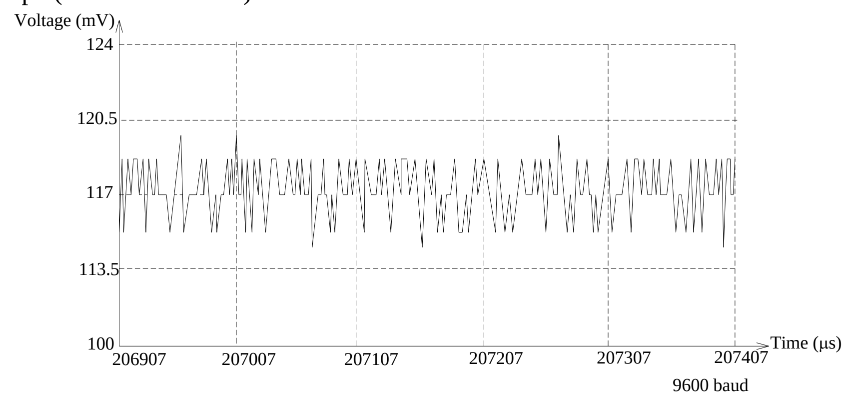


Fig.8. Output signal of APS when testing aluminium tape

2.2. Copper tape (0.1mm thickness)

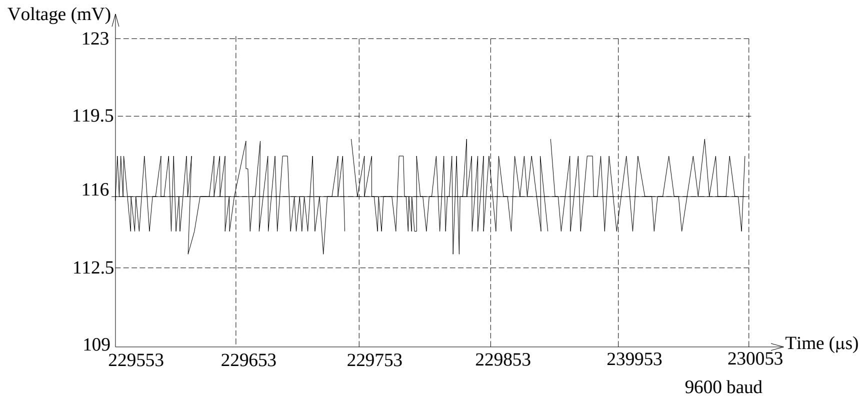


Fig.9. Output signal of APS when testing copper tape

The experimental results are shown in Fig.6-9. The output signal of APS on non-ferrous materials is similar. Nevertheless, the noise of the signal is different in the two measurement methods. Signal distortion is greater when the sensor moves away from the metal tapes. Measurement outcomes are shown in Fig. 8-9.

In addition, since the velocity of the conveyor belt is usually enormous, in order to ensure the accuracy of the output signal, the plastic sheet is placed underneath the metal plate so that it does not deform in motion.

In Fig.6-7 show that the amplitude of the signal increases according to the speed of the conveyor belt. With the first measurement method, the conveyor speed is easily controlled by its cyclic movement. In second case, the velocity of APS is controlled by stepper motor operation on table flat, which is not cyclicial. That is why the output signal amplitude is not clear according to the material tapes.

IV. CONCLUSION

The shape of the output signal depends on on the movement speed of the instrument. Signal distortion is reduced if the material deformation is impeded by movement or flatness of the test surface. In addition, the output signal of the sensor from the non-magnetic metal is analogious. Measurement method with standstill sensor and periodic moving material is selected well than the other method due to the clarity of measurement results.

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