Advancements in Passive Amplifiers Used for Ultrasonic Range Sensors

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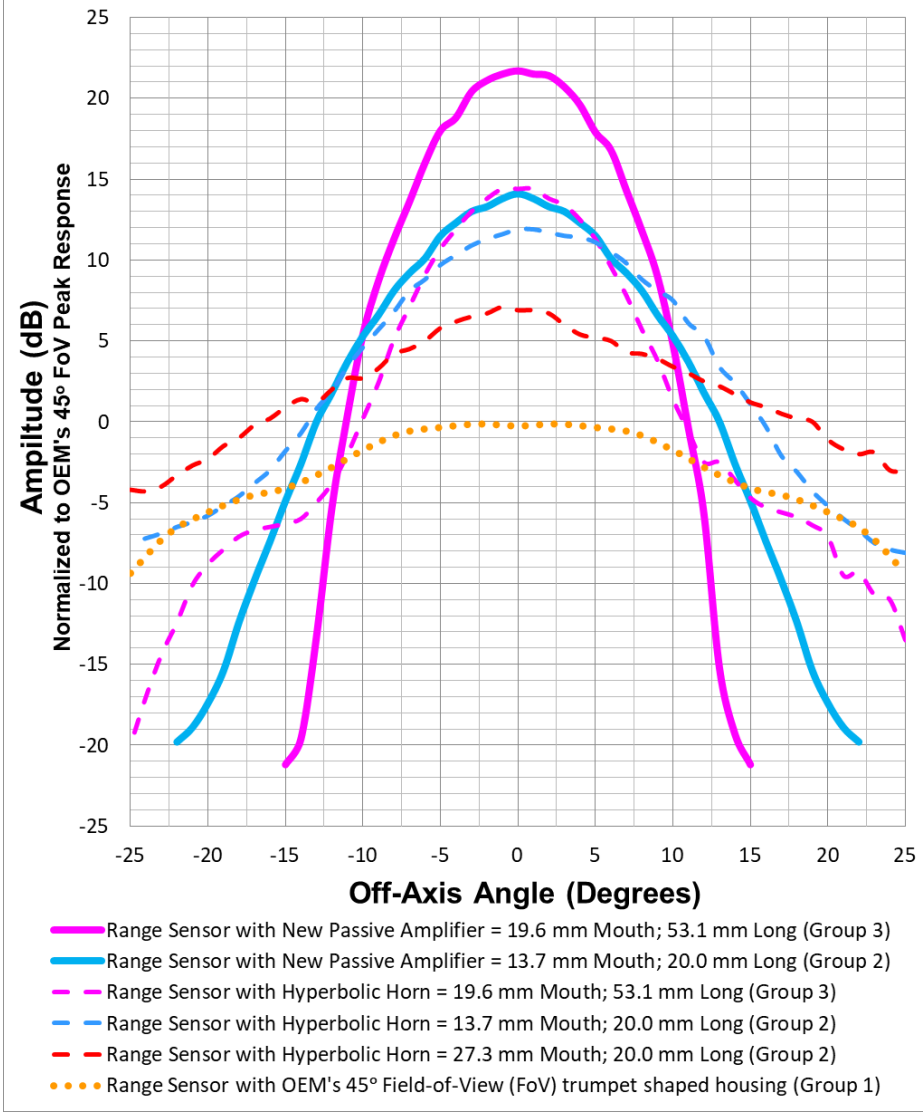
ABSTRACT- Newly developed passive amplifiers extend the range of ultrasonic pulse-echo detection.

Figure 1. Pulse-echo Beam Patterns



Searching for images of passive amplifiers will produce 100s of examples having forms similar to a trumpet (a hyperbolic horn). The hyperbolic horn is effective for amplifying (impedance matching) sounds introduced at the throat (the small end of the horn). It is less effective for increasing sound pressures for sounds received at the mouth (the large end of the horn).

Pixation and associates have made significant advancements in the field of passive amplifiers. In this paper we present experimental results of these advancements as applied to one type of MEMS ultrasonic range sensor operating at ~80 kHz (~4 mm wavelength). This specific MEMS ultrasonic range sensor limits range detection to 5 meters in hardware.

Methods

The MEMS ultrasonic range sensors were mounted on printed circuit boards and attached to different passive amplifiers. Each passive amplifier in the study had a throat diameter of 1 mm.

The pulse-echo beam patterns for six different configurations are depicted in Figure 1. These configurations comprise three groups of horns: (1) the OEM's housing; (2) three different passive amplifiers each measuring 20.0 mm in length; and, (3) two different passive amplifiers each measuring 53.1 mm in length. The beam patterns were obtained using the OEM's published procedures. To account for the expanded dynamic range of the newly developed passive amplifiers, the procedures were proportionately distance and target size modified.

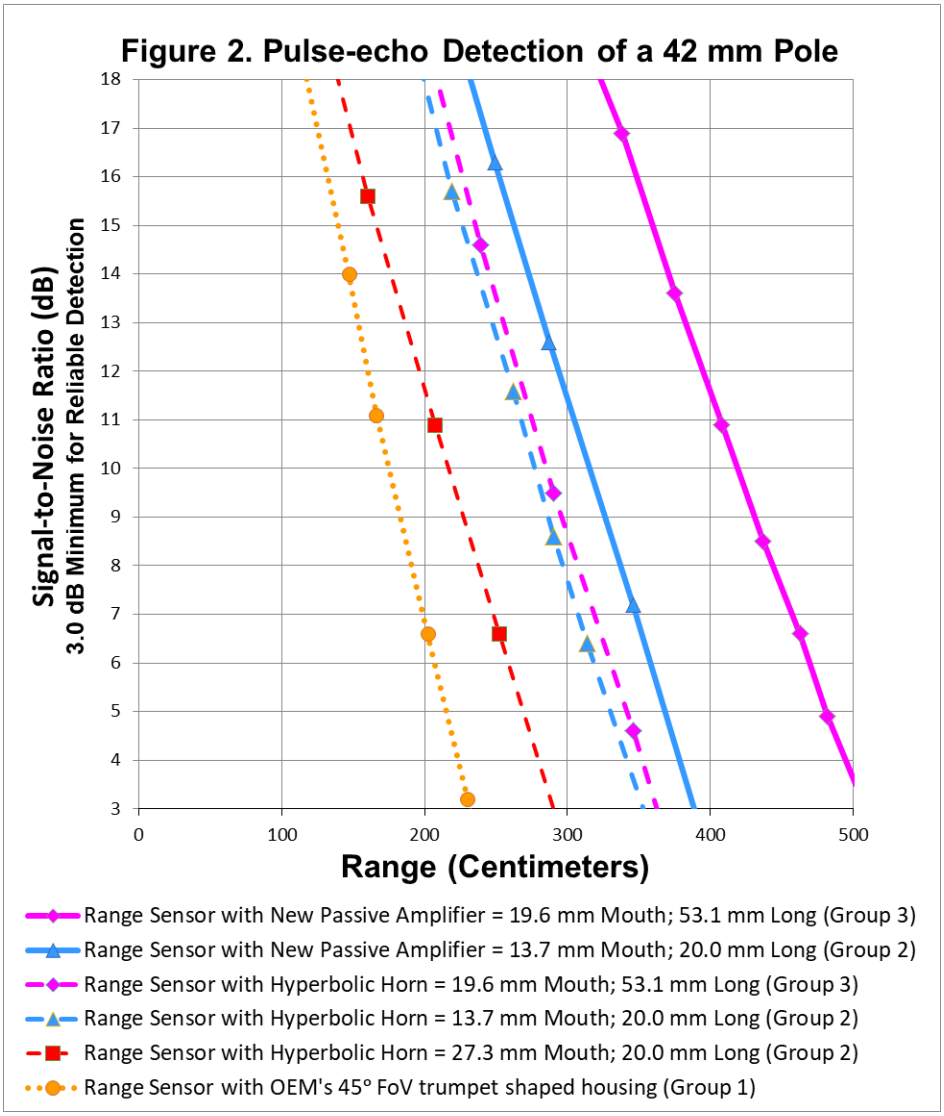
In Figure 1, amplitude is reported in normalized dB. The peak amplitude using the OEM's 45° Field-of-View (FoV) housing is set to correspond to 0 dB.

As reported in Figure 1, Pixation's newly developed 53.1 mm passive amplifier provides a return signal 21.7 dB greater than that of the OEM's device. Pixation's newly developed 20.0 mm passive amplifier provides a return signal 14.1 dB greater than that of the OEM's trumpet shaped housing.

The -6 dB FoV for Pixation's newly developed 53.1 mm passive amplifier is a mere 12°. The -6 dB FoV for Pixation's newly developed 20.0 mm passive amplifier is only 18°.

Figure 2 depicts pulse-echo detection performance for the six different configurations described above. A 42 mm diameter pole was used as the target. Again, the OEM's procedure for pole detection testing had to be modified (i.e. 42 mm diameter instead of 50 mm diameter) to account for the expanded dynamic range of Pixation's newly developed passive amplifiers.

Detection is deemed reliable when the amplitude of the signal returned is at least 3 dB above the amplitude of the sensor's noise floor or reference level. Signal-to-Noise Ratio (SNR) measurements for detection of the pole at varying distances are given in Figure 2 for each of the six tested configurations.



Conclusions

Ultrasonic pulse-echo sensors can be used for a myriad of detection tasks. The authors found the above experimental results surprising. Combining these newly developed passive amplifiers with MEMS or micro-machined ultrasonic transducers (MUTs) can increase ranging performance, small object detection, and angular location descrimination. Furthermore, by combining Pixation's newly developed passive amplifiers with low emission MEMS or MUTs, *significant ecological benefits can be obtained*.

Pixation is at the forefront of passive amplifier technological development. Pixation's newly developed passive amplifiers will find many other applications such as: (1) Hollywood-quality audio recording at distances beyond the range of shotgun microphones; (2) 3D audio virtual reality recording with direction and distance metadata exceeding Ambisonics; and, (3) hearing aids which are effective under typical distant listening conditions.

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