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ACOUSTICAL GAS TEMPERATURE ESTIMATOR APPLYING TO GYMNASIUM AND OUTDOOR ENVIRONMENT FOR EVALUATION OF WATERING EFFECT

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Abstract. *An acoustical estimator system for gas temperature distributions that considers the times-of-flight of sounds on paths through an object has been developed. The system is based on the Maximum A Posteriori (MAP) criterion with local iterations to deal with non-linearity in the processes. For the purpose of identifying the times-of-flight, the system contains a matched filter of complex absolute detection type that is free from errors caused by unknown phase shift. For further improvement of the accuracy and for saving the estimation time with simultaneous time-of-flight identifications on several paths, the Gold sequence Phase Reversal Keying (PRK), which has sharp autocorrelations and low cross-correlations, is applied to the acoustic signals. The system is shown to have practical performance using the signals in he audio frequency region and effectively estimates the temperature distributions in a gymnasium and an outdoor environment, which are difficult to estimate using supersonic waves. For example, the effect of wetting down pavement to reduce the intense heat in summer, which conventional thermometers cannot measure without interference from solar radiation, has been estimated acoustically.*
Keywords: Gas temperature measurement, Acoustic time-of-flights, Gold sequence, Matched filter, MAP estimate, Audio frequency, Outdoor measurement

1. **Introduction.** Acoustic methods of estimating gas temperature distributions by examining variations in the speed of sound are required for measuring the temperature distributions in large-scale chambers, outdoor environments and furnaces, where contact type thermometers, thermo-couples, etc., are usually unable to set up in the air. Furthermore, contact type devices, which are commonly used, not only have temperature increasing error caused by radiation from the sun or the flames, but also accompany with response lag of measurement by their heat capacity, because these devices do not measure air temperature directly but rather provide the body temperature of the device. For example, rapid response of outdoor temperature after wetting the ground to ease the intense heat in summer cannot be measured by a thermometer in a white ventilated box, which is a common way to prevent interference from solar radiation, because the air in the box is not exchanged immediately with the outside air and the heat capacity of thermometer