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Abstract:
Uncertainty due to measurement repetition is quantified by transforming data from measurement space to uncertainty space using transition equations. Measured data is fit with a reference function that serves as the basis for the envelope used in uncertainty space to quantify measurement uncertainty. This method's sampling criterion which prevents information loss also uses the reference function. The method quantifies uncertainty in terms of the random effects associated with a measurement system and the uncertainty associated with the finite resolution capabilities of the measurement system. Uncertainties calculated using the proposed method were equal to expanded uncertainties ($k = 2$) calculated using the standard method. This nonparametric method for uncertainty analysis quantifies uncertainty due to measurement repetition and establishes that the uncertainty due to data discretization is the minimum achievable uncertainty.

Keywords: Metrology, calibration, statistical analysis, sampling, signals

1. INTRODUCTION

Uncertainty is a measure of the dispersion of the quantity values of the measurand typically obtained by replicate measurements on the same or similar objects under repeatable or reproducible conditions of measurement [1-5]. Repeatable conditions include the same measurement procedure, same operators, same measuring system, same operating conditions and same location, and replicate measurements on the same or similar objects over a short period of time. Reproducible conditions are broadened to include different locations, operators, measuring systems, and replicate measurements on the same or similar objects. Electronic instrumentation including sensors, meters, and probes require repeatable and reproducible measurements [6-11]. Standards and calibration procedures that certify instrumentation and reference materials demand measurement conditions that minimize uncertainty [12-17]. Repeatability is also a routine concern in the experimental sciences where physical, chemical, and biological properties of objects are scrutinized [18-22]. References 6 – 22 express measurement uncertainty numerically using the standard deviation, s, which is the standard method for estimating the average uncertainty of a set of measurements and will serve as the basis for comparison in this paper [23, 24]. The uncertainty space method quantifies the uncertainty associated with qualified measurements as having two components, one due to components