DEBIASING OF POSITION ESTIMATIONS OF UWB-BASED TDOA INDOOR POSITIONING SYSTEM

- Systematic errors occur when localising object using indoor positioning system (IPS) based on ultra-wideband (UWB) technology and time difference of arrival (TDoA) algorithm.
- Theoretical estimation of these errors is complex.
- **NOVEL FILTERING ALGORITHM** introduced to reduce bias of position estimations, thus increasing accuracy. Solution uses statistics of real data.

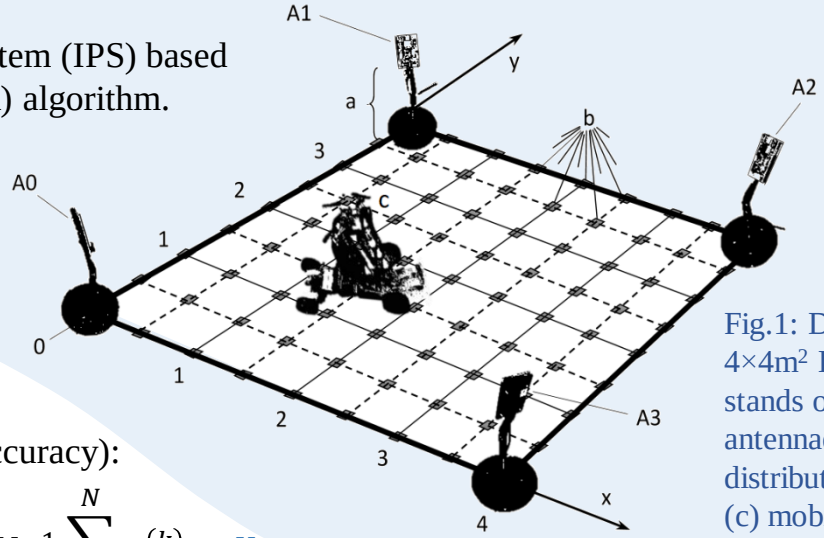
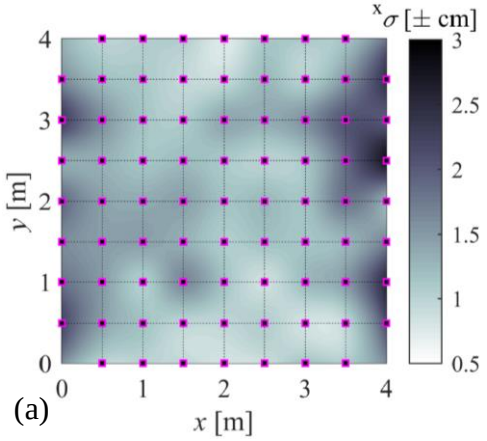
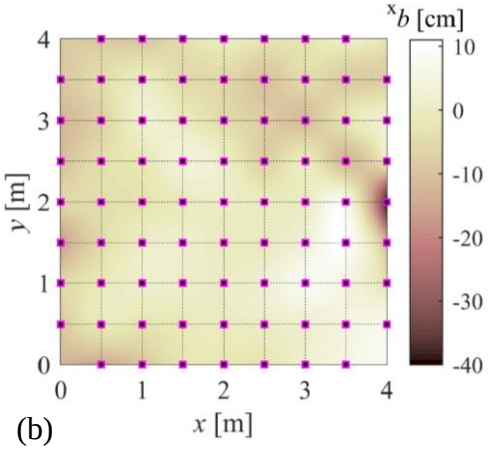


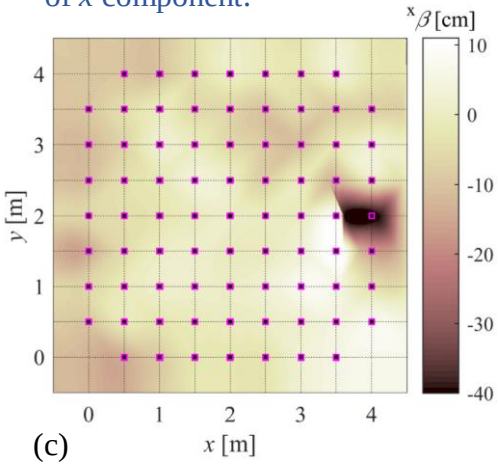
Fig.1: Diagram of the setup of the studied 4×4m² IPS for 2D localisation: (a) adjustable stands of the (A0-A3) transmitting anchors antennae, (b) measurement points evenly distributed every 50 cm in both directions, and (c) mobile stand for the object to be localised.



(a)



(b)



(c)

Fig.2: Experimental estimation of (a) precision and (b) bias; and (c) debiasing for measurements of *x* component.

Large number of **MEASUREMENTS** (N=700) taken at sampling frequency of 100 Hz while keeping the drone still on each marker (X_{ij}) and oriented along the *x*-axis.

Bias (accuracy):

$$^{x}b_{ij} = N^{-1}\sum_{k=1}^{N} x^{(k)} - X_{ij}$$

Standard deviation (precision):

$$^{x}\sigma_{ij} = \left(^{x}\mathrm{MSE}_{ij} - {}^{x}b_{ij}^{2}\right)^{0.5}$$

The debiasing surface (Fig.2c) is the interpolation of the debiasing values on a discrete number of points $\mathbf{X}_{ij}$:

$$\left[\bar{X}_{ij}\ \ \bar{Y}_{ij}\ \ {}^{x}\beta_{ij}\right] \xrightarrow{\text{interp.}} {}^{x}\beta(\mathbf{x})$$

where the debias value is

$$^{x}\beta_{ij} = -{}^{x}b_{ij}$$

and the deformed grid is

$$\bar{\mathbf{X}}_{ij} = \mathbf{X}_{ij} + \left[{}^{x}b_{ij}, {}^{y}b_{ij}\right]^{\mathrm{T}}$$

- The main **OUTCOMES** of this work are:
  - The formulation of a **debiasing filter**:

    filtered estimations: $\hat{x} = x + {}^{x}\beta(\mathbf{x})$, $\hat{y} = \mathrm{y} + {}^{y}\beta(\mathbf{x})$
  - The measured **precision** of the studied IPS are bounded by the expected value of **±3cm** (theoretically estimated).

- **FUTURE WORK** is concerned with the **improvement of the debiasing filter** accounting for the precision of the measurements, the development of a more **comprehensive filtering process** to further improve both precision and accuracy, the **3D generalisation**, and **validation** of the algorithms through experiments using the IPS in AVAILab.

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