Topological Study on the Design of Soft Strain Sensors for Simultaneous Multi-point Contact Localization

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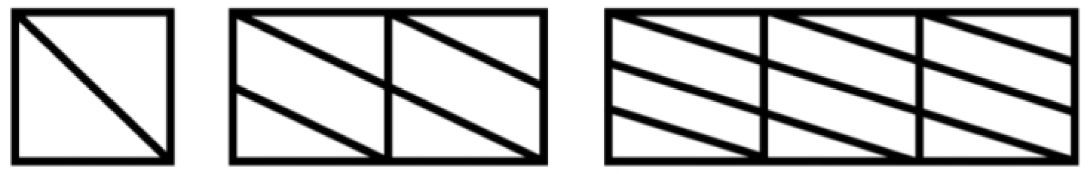
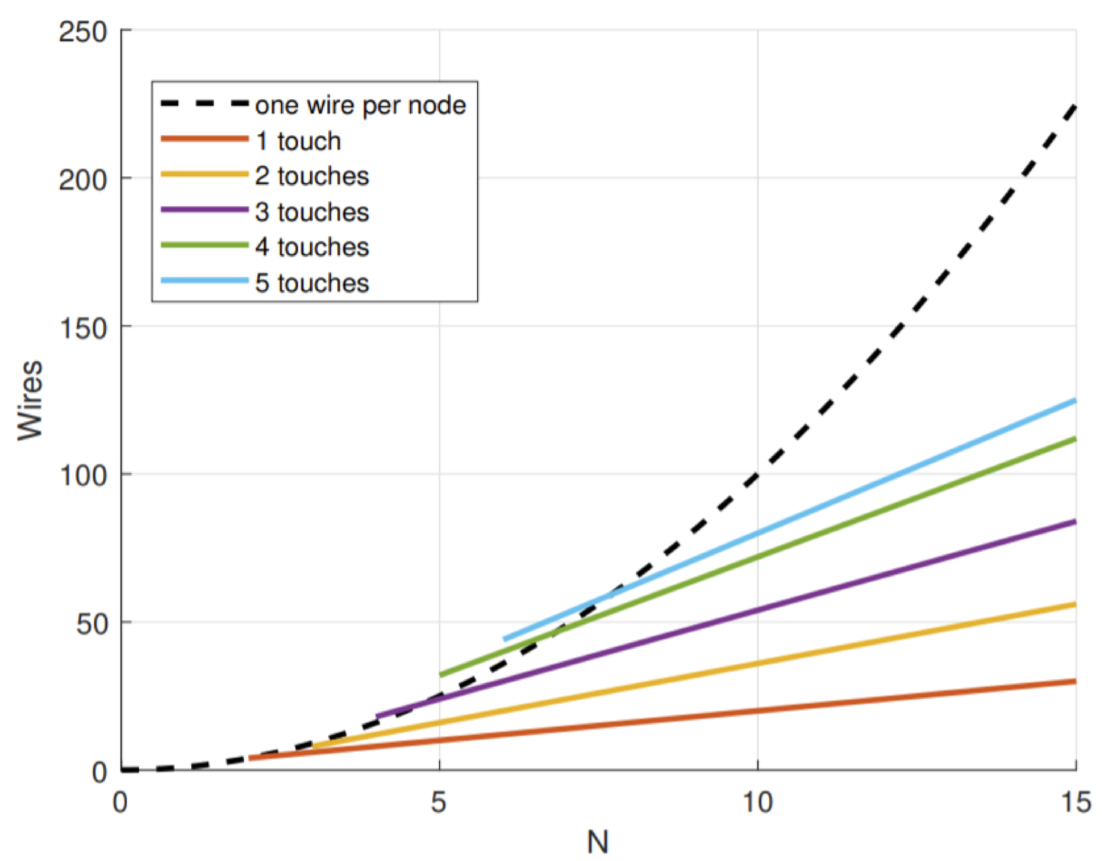
Methodology

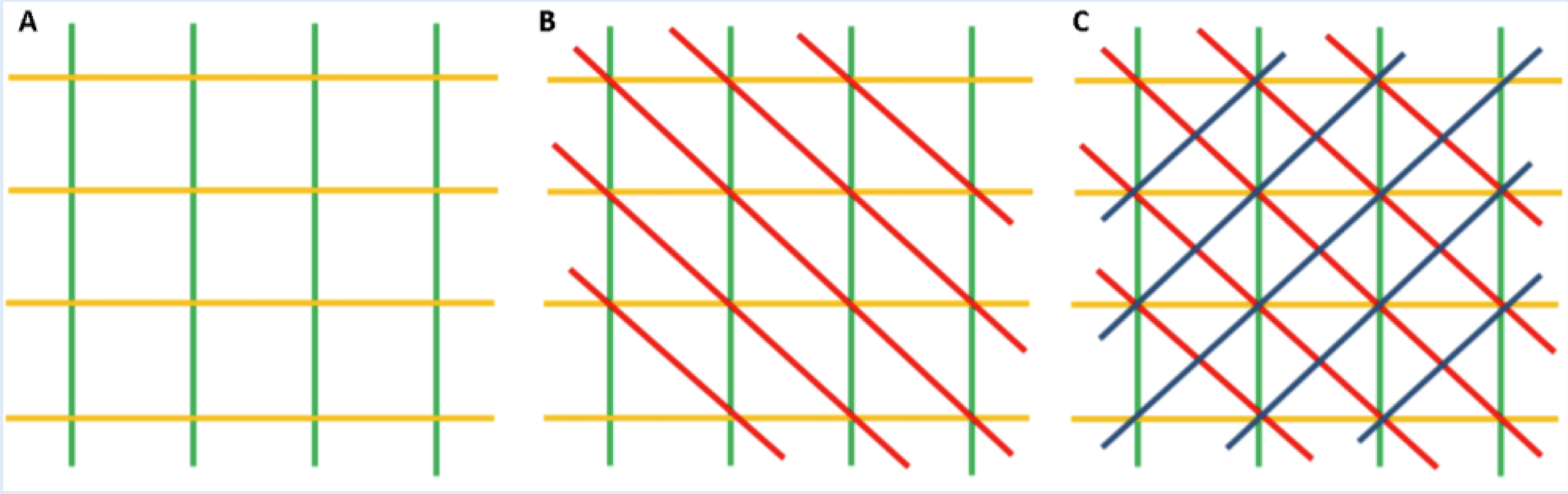
The fundamental idea of this study is to add diag-onal grids of variable orientation on top of the standard architecture. Starting from the classic square architecture with only horizontal and verti-cal fibers, diagonal grids of different orientations can be added (i. e. three different possible orien-tations are shown).



Any architecture is then evaluated by considering two metrics: the maximum number of simultane-ously detectable points P_{max} and the size of its limit grid.

When compared with the ideal solution of *one wire per node*, our methodology is shown to be more efficient in terms of needed wires for any fixed number of maximum detectable points.





Suitable architectures for (A) one, (B) two and (C) three simultaneously detectable points

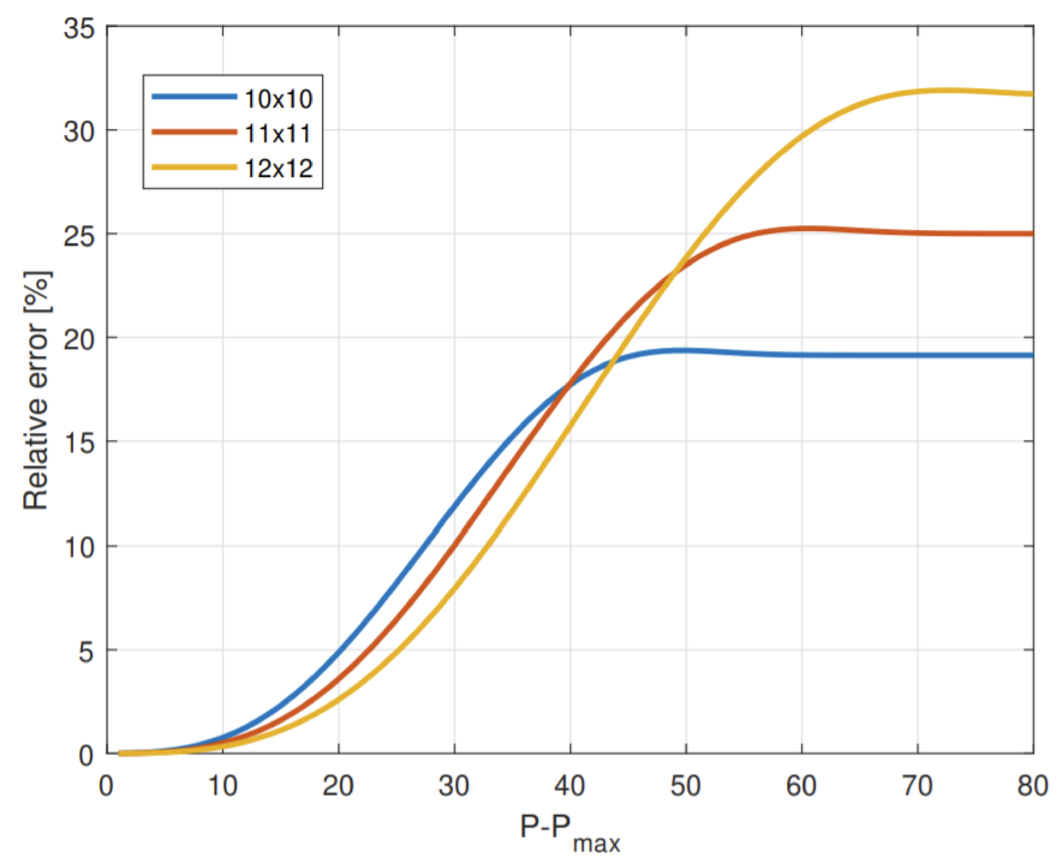
We introduce a smart design methodology for grid-based soft touch sensors that allows the simultaneous detection of up to a finite num-ber of points thanks to the introduction of diagonal grids

Motivation

Soft strain sensors have been widely used for the development of electronic skins for both robotic and wearable ap-plications [1,2]. To sense contact loca-tion on a wide surface, the standard methodology consists of square grids that are able to detect single contact points but fail to detect multiple ones simultaneously [3,4]. To avoid such a problem, state-of-the-art technologies implement sequential samp-ling that isolates each sensing node, but at the cost of a lower sampling rate [5,6]. This theoretical study proposes a design methodology for multi-touch detection for parallel processed grid-based strain sensors. The fundamental idea is to add diagonal grids of varying orienta-tions on top of the standard architec-ture to achieve multi-touch detection. The maximum number of detectable points, the number of required strain fibers and the overall geometry of the sensor are studied along with the error introduced when trying to sense more contact points than designed for. We also provide metrics to evaluate the performance of any given architecture. Overall, compared with state-of-the-art design methodologies, our work pro-vides a guideline for more efficient grid-based architectures that are able to simultaneously detect up to a fixed fi-nite number of contact points.

Error estimation

For a given architecture, when trying to detect a number of points $P > P_{max}$ some errors are intro-duced. To estimate the quantitative value of these errors, all the combinations of points that cannot be uniquely mapped to a single combination of touched nodes are computed. We report such re-sults in the case of square grids of different sizes.



At first, the relative error increases as P increases since the number of undetectable combinations in-creases every time a new point is added. Then, the error stabilizes because the number of all possible combinations out-scales the number of wrong ones. The asymptotic value and the increasing rate are strongly dependent on the size of the grid.

References

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