Collins Aerospace Machine Vision Filter Methodology

Graph Sampling and Construction:

Given a Neuromorphic Camera with a resolution H × W, the events captured by the camera can be represented as a tuple

(1) $\{e_i\} = \{x_i, y_i, t_i, p_i\}$. (add I range)

The pair $(x_i, y_i) \in \mathbb{R}^{H \times W}$ represents the spatial coordinates where the event occurred on the 2-dimensional plane, t_i represents the timestamp of when the event occurred, and p_i represents the polarity of the event (either +1 or -1 signifying a raise in light intensity or a drop in light intensity respectively). The tuple e_i can be represented as a combination of the desired signal S and unwanted noise n

(2) $\sum e_i = S_i + n_i$

A 3-dimensional plane can be constructed using (x_i, y_i, t_i) as coordinates. The pixel density around a given event can determine if the event belongs to the signal $e_i = S_i$ or is noise $e_i = n_i$ by taking a observing a sample space around e_i. The sample space can be represented by a 3-dimensional volume V where (voxel)

(3) $V = (x + \Delta x) \times (y + \Delta y) \times (t + \Delta t), V \in \mathbb{R}^{H \times W}$ (alter to represent e_i in center)

Inside of the sample space V there may be a certain number of events e_n. If any given point $e_n \ni V$ it can be counted as a local hit represented as a variable M where

(4) $M = \sum(e_n \ni V)$

Suppose variable j represents the number of elements in M and R represents an arbitrary pixel density threshold

(5) $e_i = n_i \mid j < R$ or $e_i = S_i \mid j \geq R$

By using the Euclidean distance formula, the distance D between the original point e_i and the sampled point e_n can be represented as

(6) $D = \sqrt{(x_i - (x_i + \Delta x))^2 + (y_i - (y_i + \Delta y))^2 + (t_i - (t_i + \Delta t))^2}$

Using the distance D it can be determined if the sampled point e_n lies within the sample space V. After isolating the desired signal S where $\sum e_i = S_i$, the events can be split into sets based on polarity. Let A represent a set where

$e_i \in A \mid p_i = 1$

let B represent a set where

$e_i \in B \mid p_i = 0$

and let C represent a set where

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Commented [OSJ2]: Not sure if this is the correct notation, trying to represent M as a collection of events that lie within the sample space V

$C = A \cap B.$

Using the spatial coordinates (x_i, y_i) the desired signal can be plotted, being grouped based on timestamp where G is the lower threshold and H is the upper threshold, a plot F can be represented as a collection of spatial coordinates (x_i,y_i) where $G < t_i < H$. The set to which the event e_i belongs, either A, B, or C will denote the color of the plotted point. Set A will be shown as red, set B as blue, and set C as purple.