Dynamic Sound Fields Clusterization using Neuro-Fuzzy Approach

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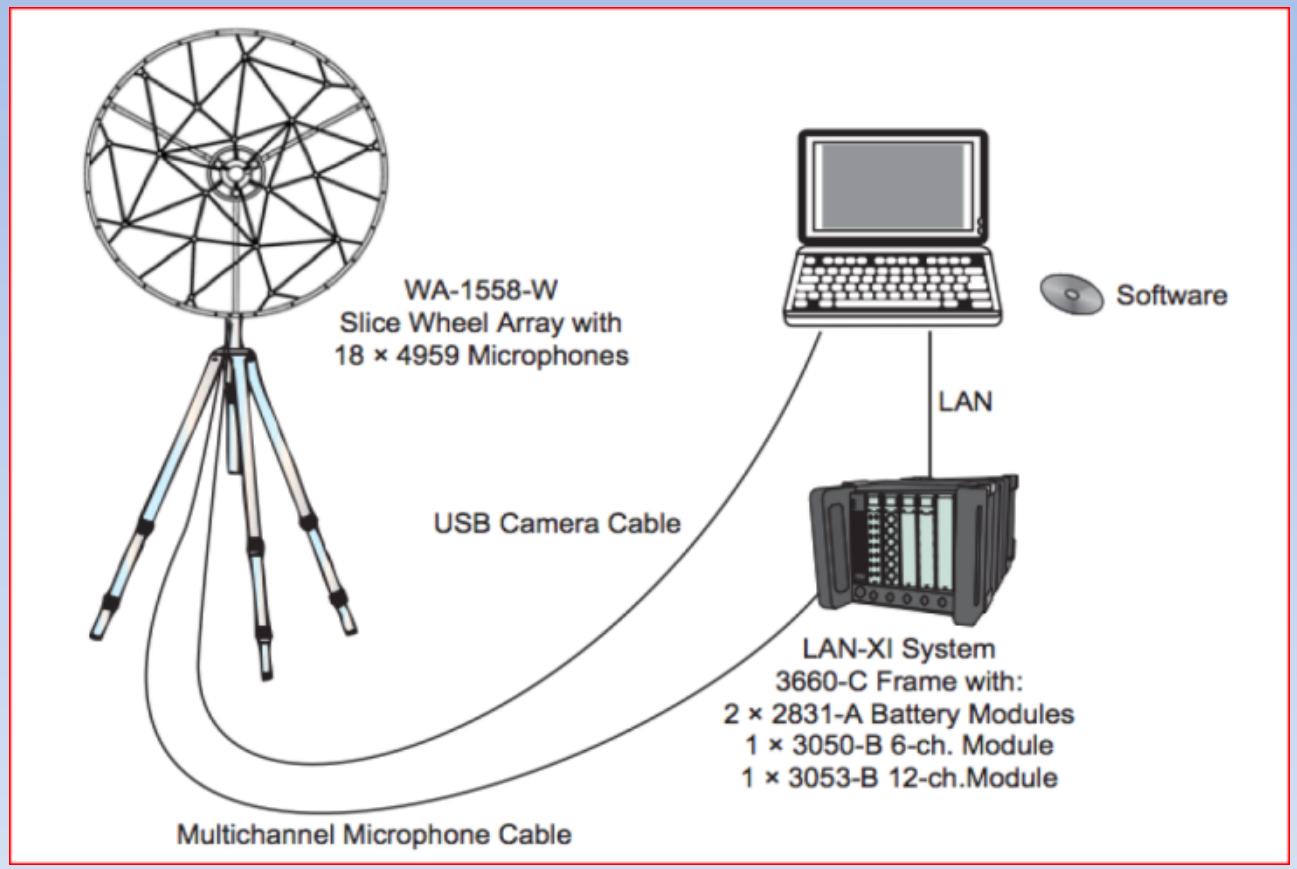
Presentation schedule

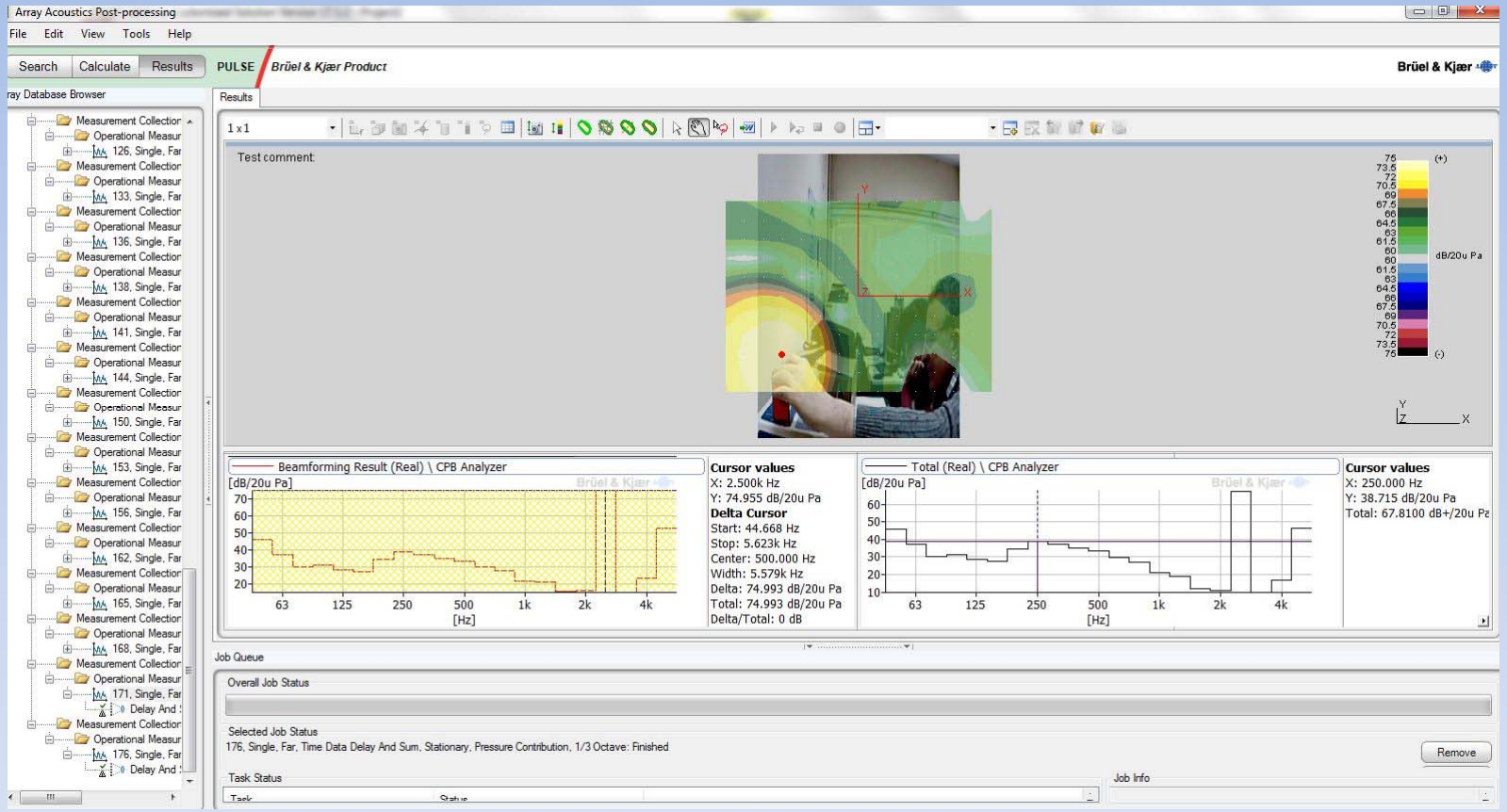
- Experimental set-up
- Proposed algorithm
- Receptive fields for signal preprocessing
- Echo state networks
- IP improvement of reservoir and its exploitation for clustering
- Results and discussion

Experimental set-up



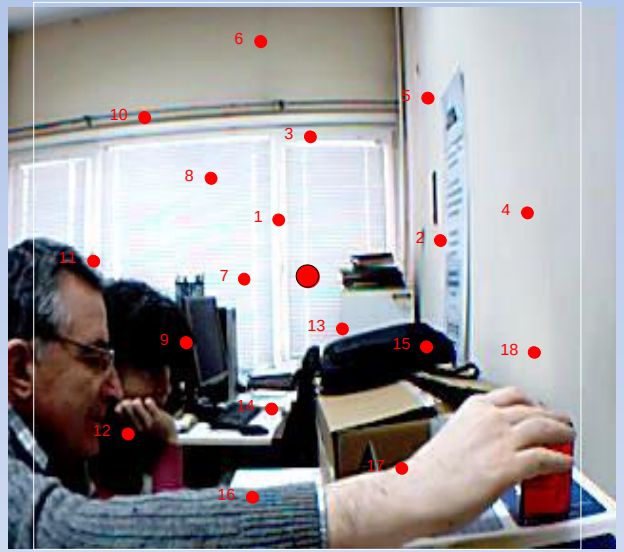
Experimental set-up

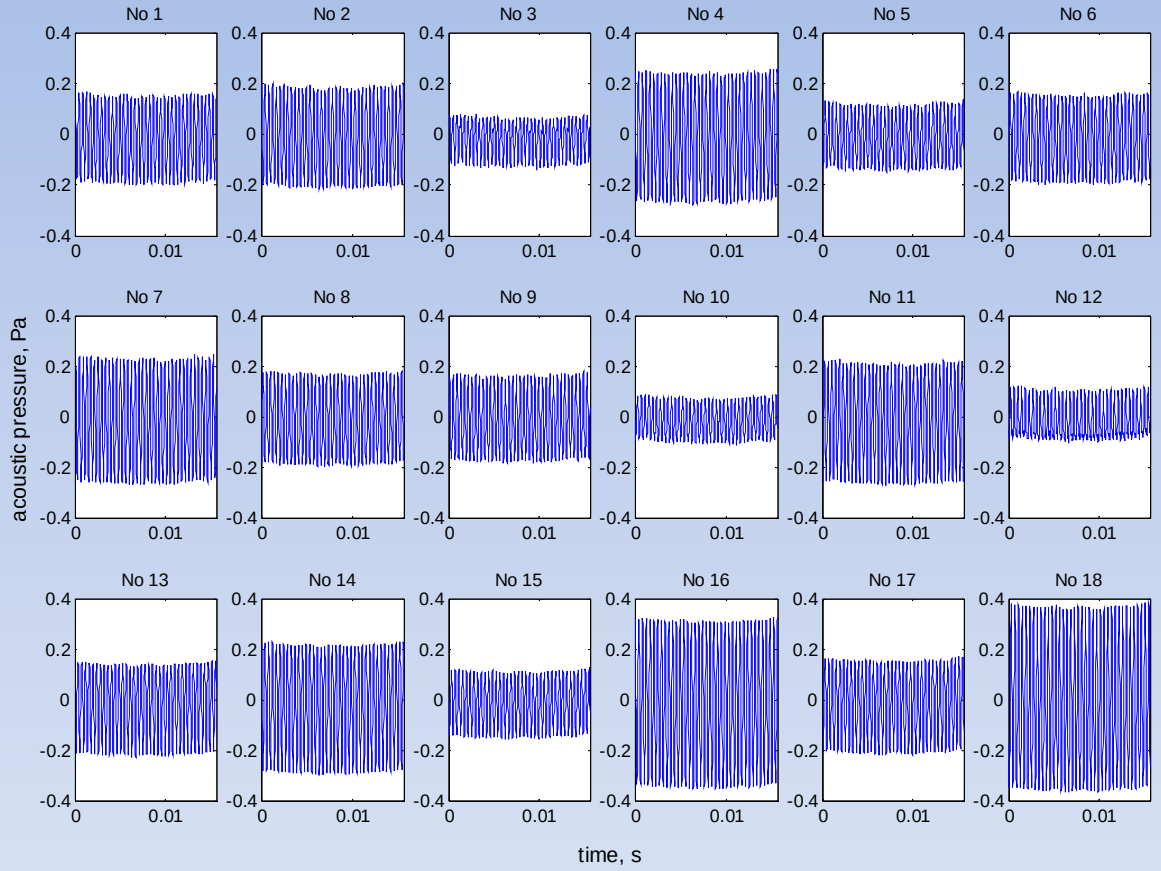
Brüel & Kjær sound analysis system



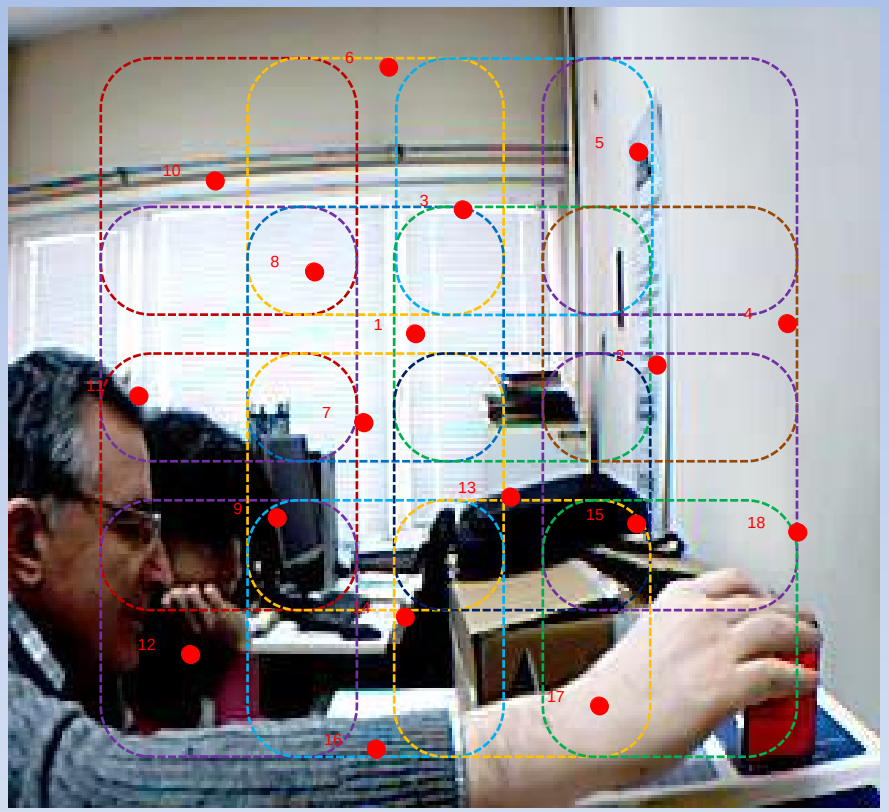
Experimental set-up

our experiment





Proposed algorithm



collect microphone signals

↓

preprocess collected signals using MT receptive fields

features I ↓

preprocess obtained features using ESN

features II ↓

obtain 2D projections

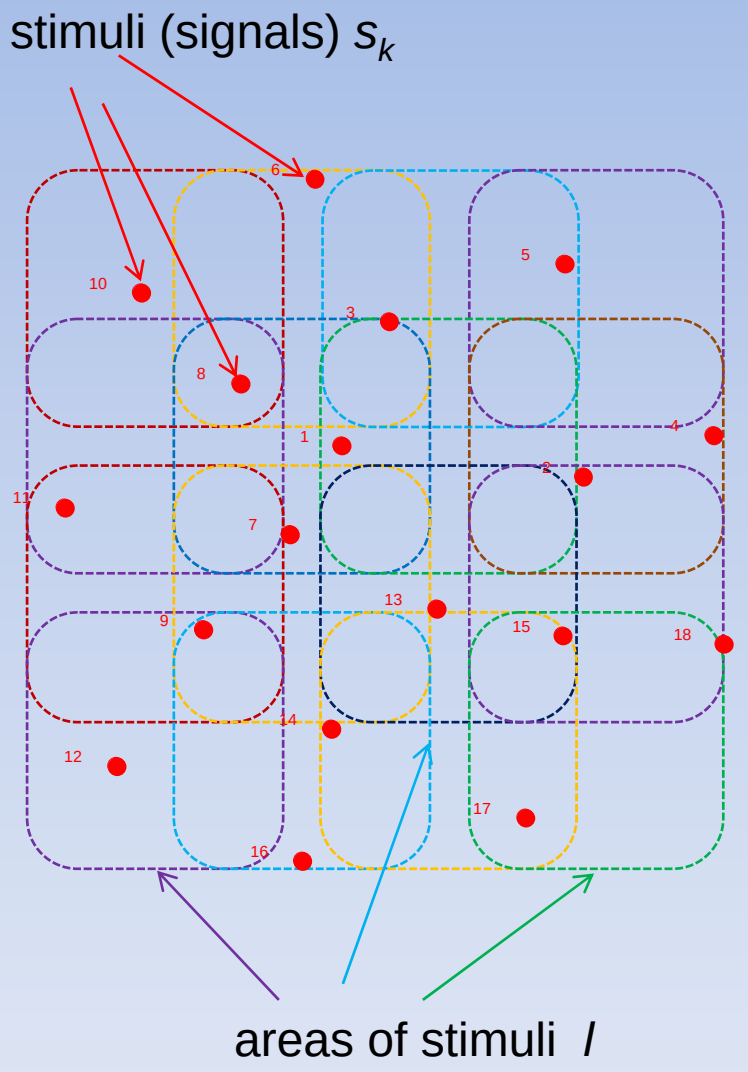
↓

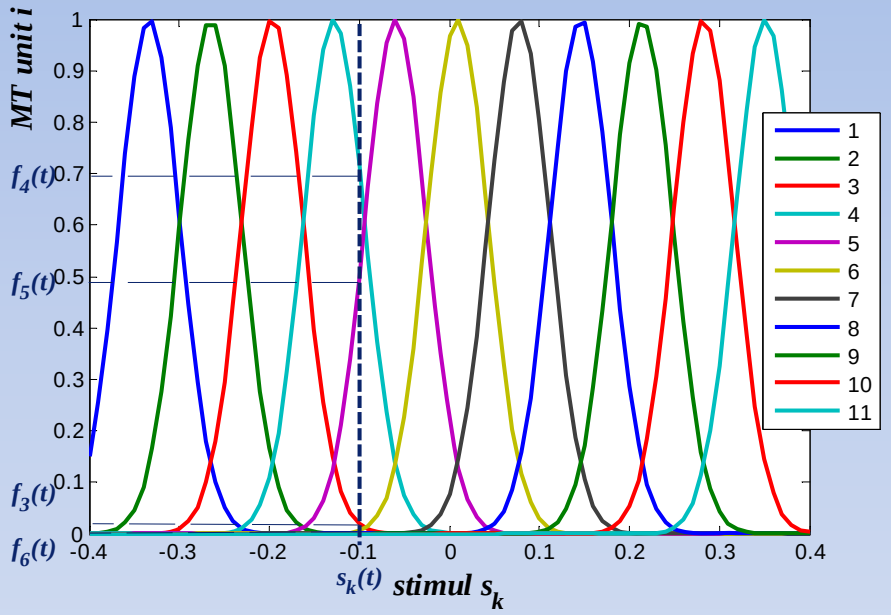
apply subtractive clustering to all projections

↓

choose a projection with maximum clusters

Receptive fields for signal preprocessing



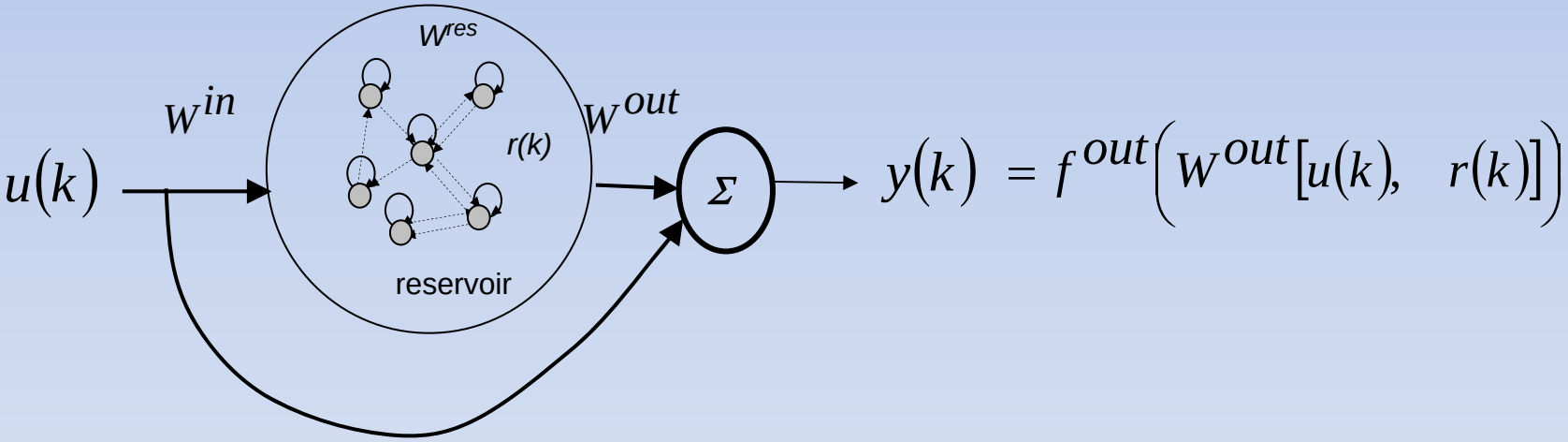


$$f_{il}(t) = \frac{1}{N} \sum_{k=1}^{N} MT_i\left(s_k(t)\right)$$

$$MT_i\left(s_k(t)\right) = \exp\left(\frac{-\left(\mu_i - s_k(t)\right)^2}{2\sigma^2}\right)$$

Echo state networks basics

$$r(k) = f^{res}\left(W^{in}u(k) + W^{res}r(k-1)\right)$$



IP improvement of reservoir

(Schrauwen, B. et al., 2008)

Kullback-Leibler divergence:

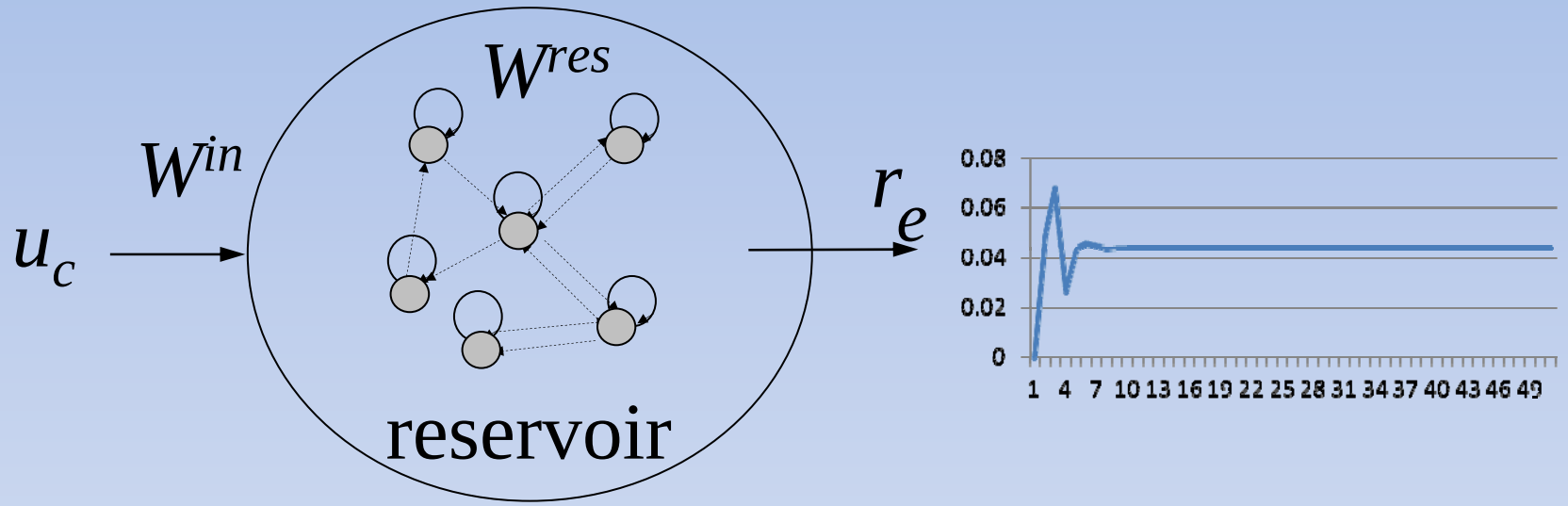
$$D_{KL}(p(r), p_d(r)) = \int p(r) \log\left(\frac{p(r)}{p_d(r)}\right) =$$

$$= -H(r) + \frac{1}{2\sigma^2} E\left((r-\mu)^2\right) + \log \frac{1}{\sigma\sqrt{2\pi}} \rightarrow \min$$

If $f^{res} = \tanh$ then $p_d(r) = \frac{1}{\sigma\sqrt{2\pi}} \exp\left(-\frac{(r-\mu)^2}{2\sigma^2}\right)$

$$r(k) = f^{res}\left(diag(a)W^{in}u(k) + diag(a)W^{res}r(k-1) + b\right)$$

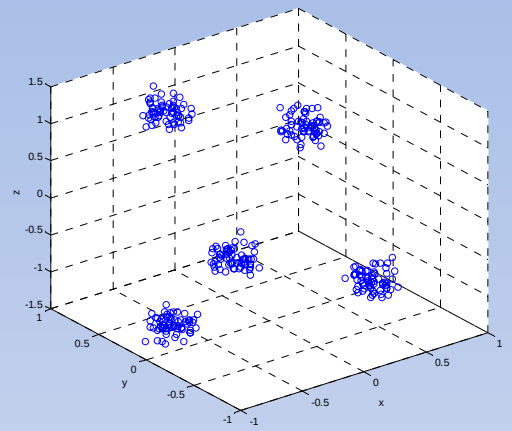
IP Improvement for clustering (Koprinkova-Hristova, P., Tontchev, N., ICANN'2012)

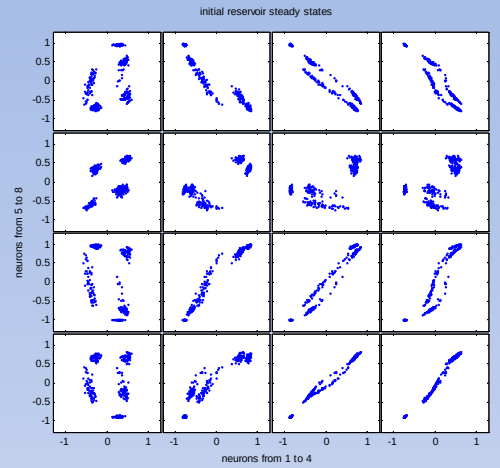


$$r_e = \tanh\left(diag(a) W^{res} r_e + diag(a) W^{in} u_c + b \right), \quad u_c = const.$$

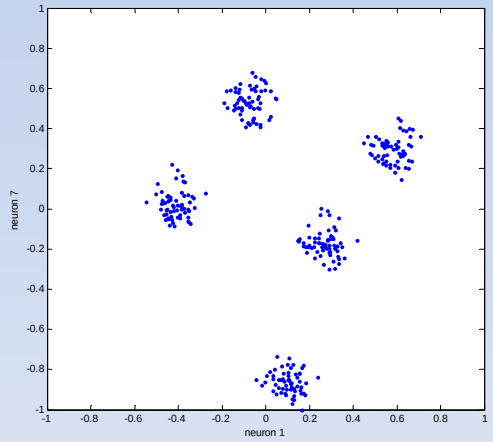
IP improvement for clustering

(Koprinkova-Hristova, P., Tontchev, N., ICANN'2012)

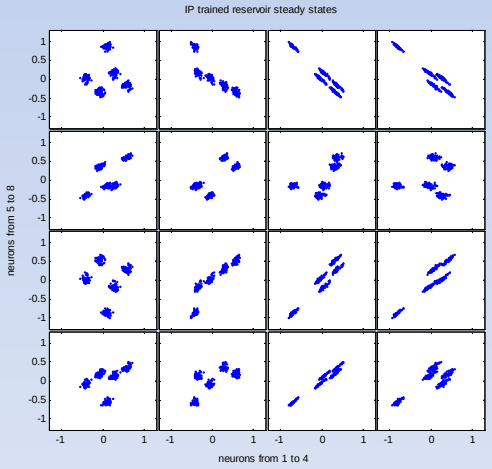




before IP training

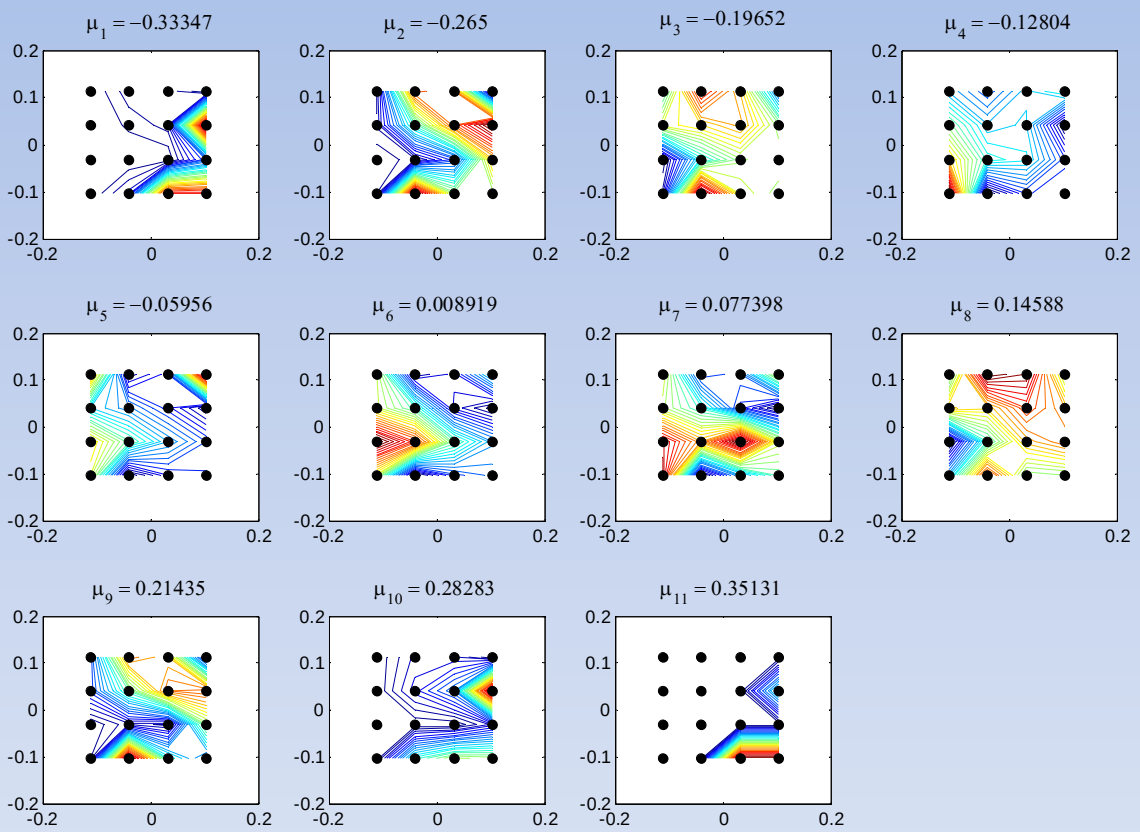


chosen projection

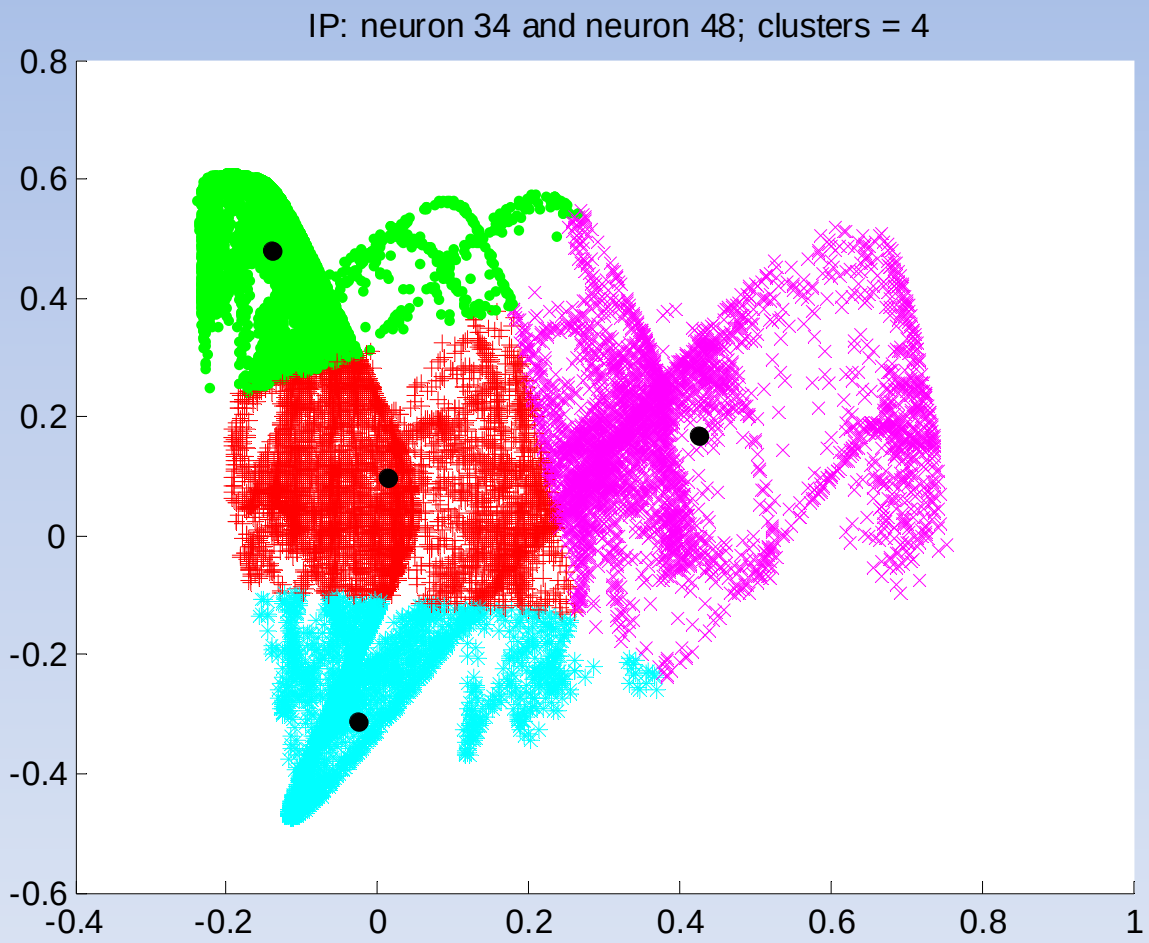


after IP training

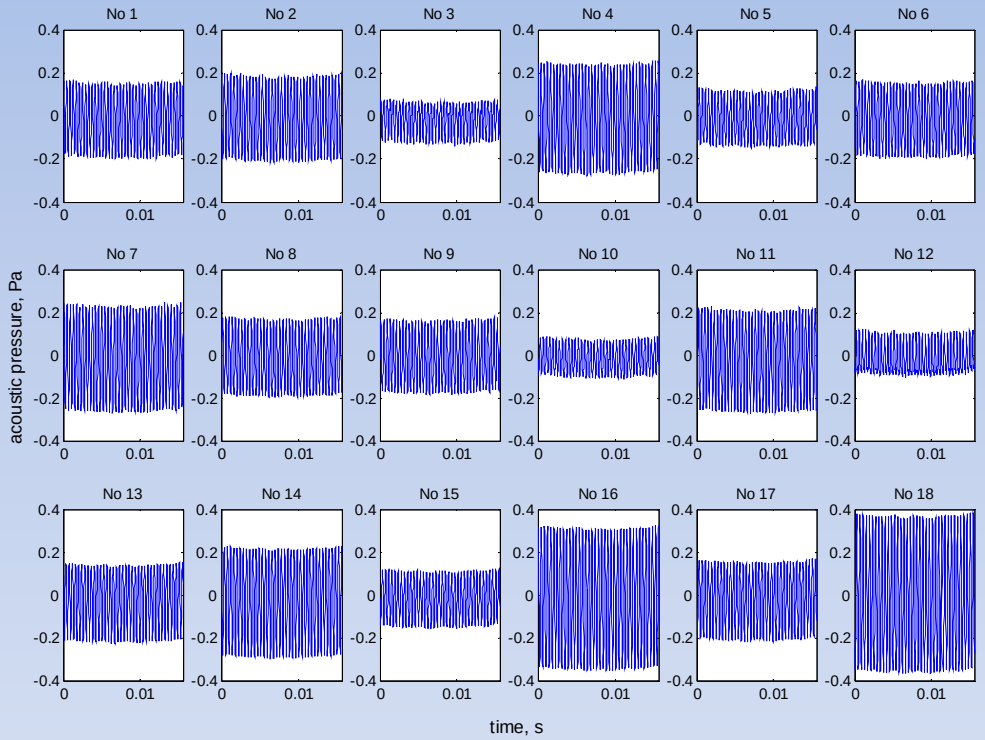
Results
features I



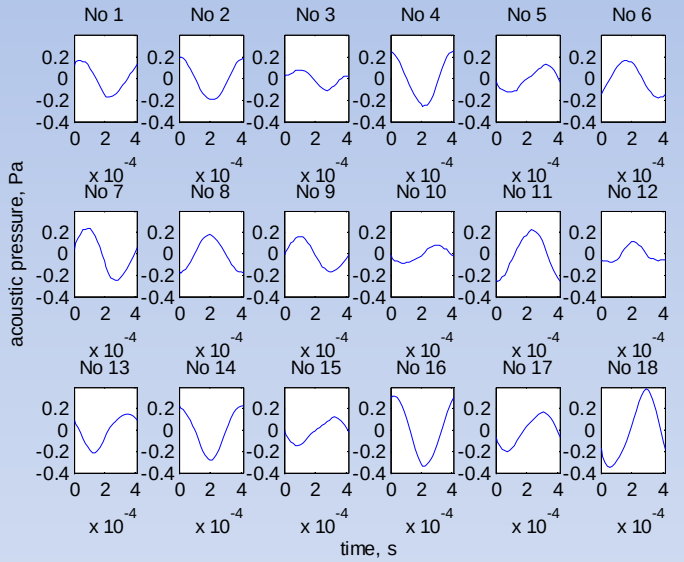
Results
features II & clusters



Results & discussion

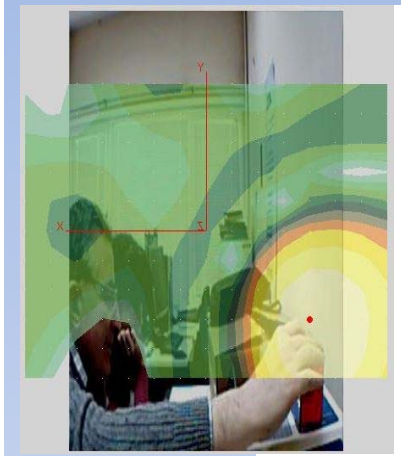


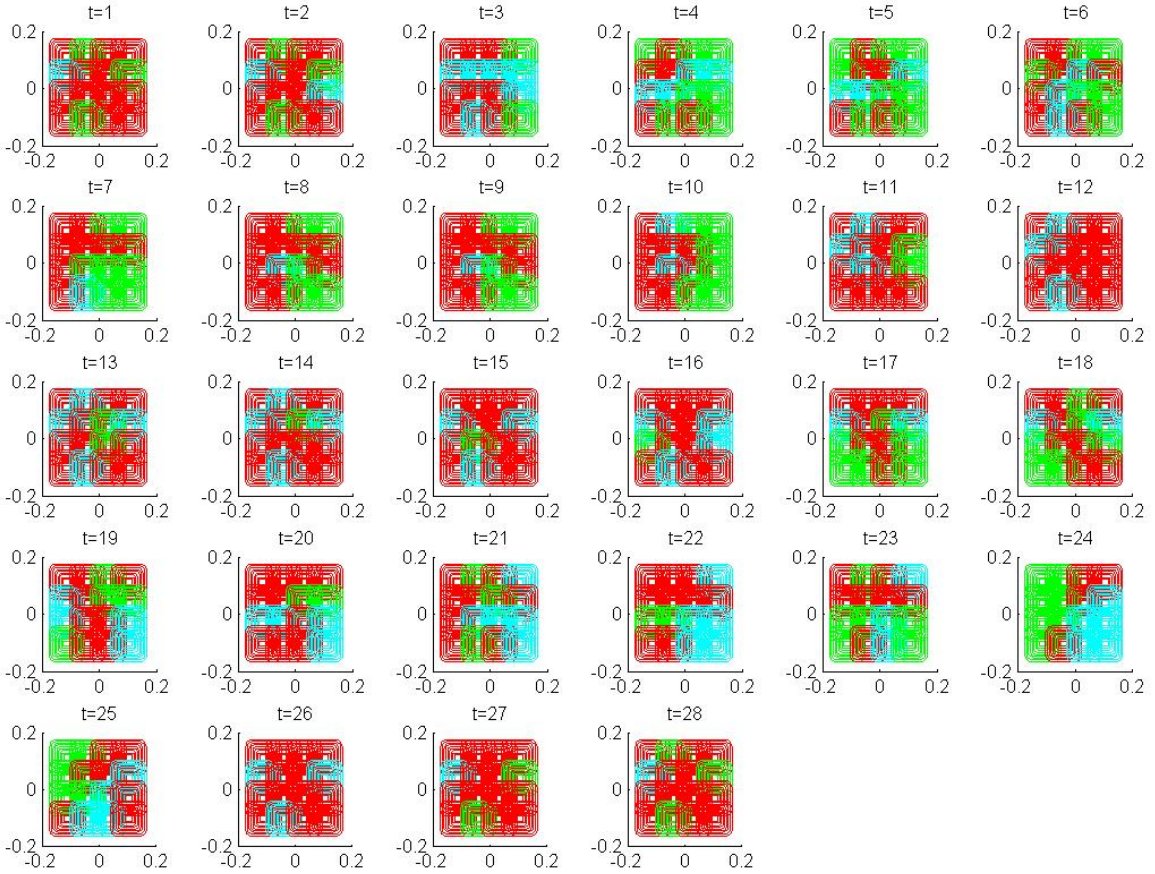
Microphone signals for all period of measurements.



Microphone signals for the first period of approximately 28 time steps.

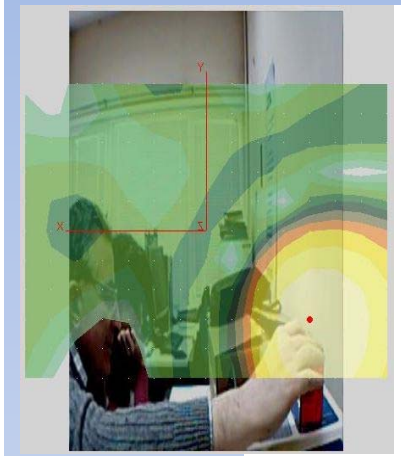
Results & discussions

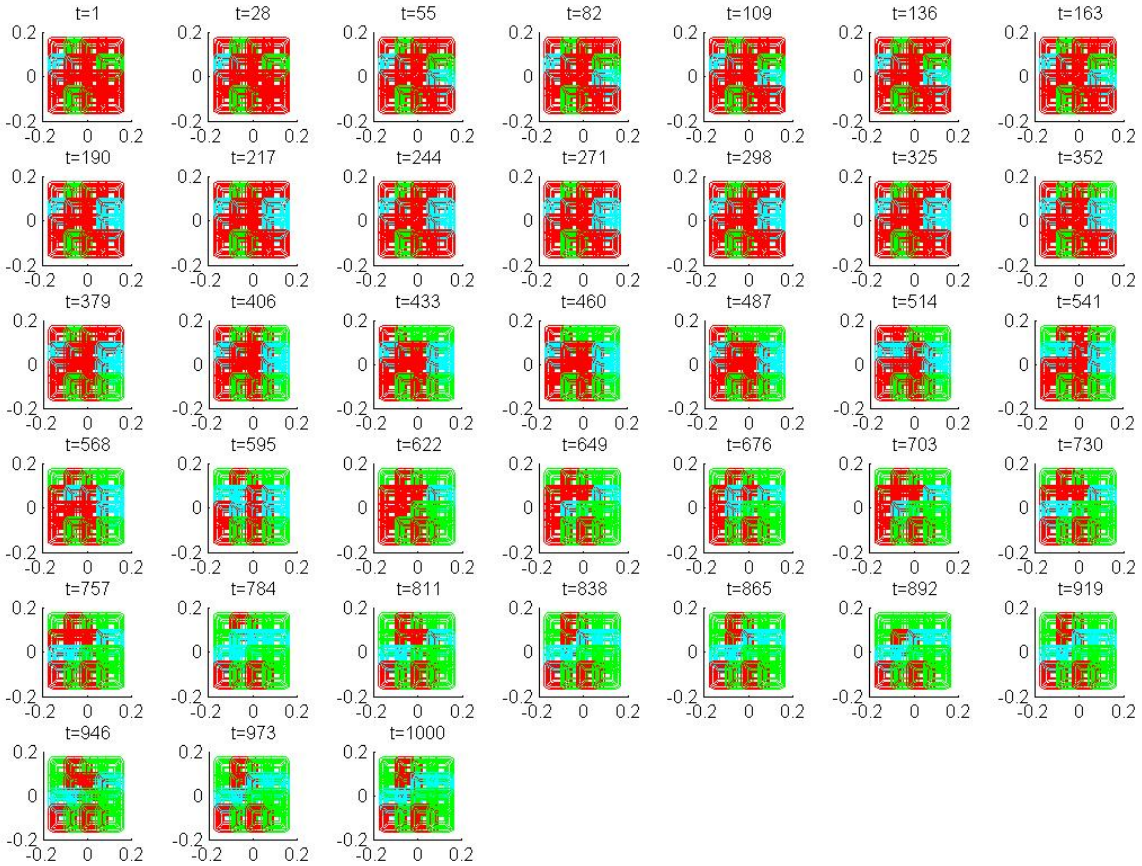




Clusters obtained with 10 neurons for the first period of measurements

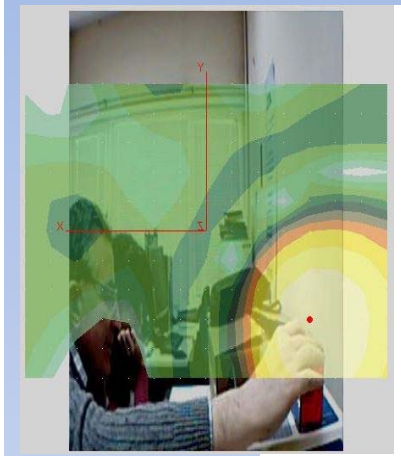
Results & discussion

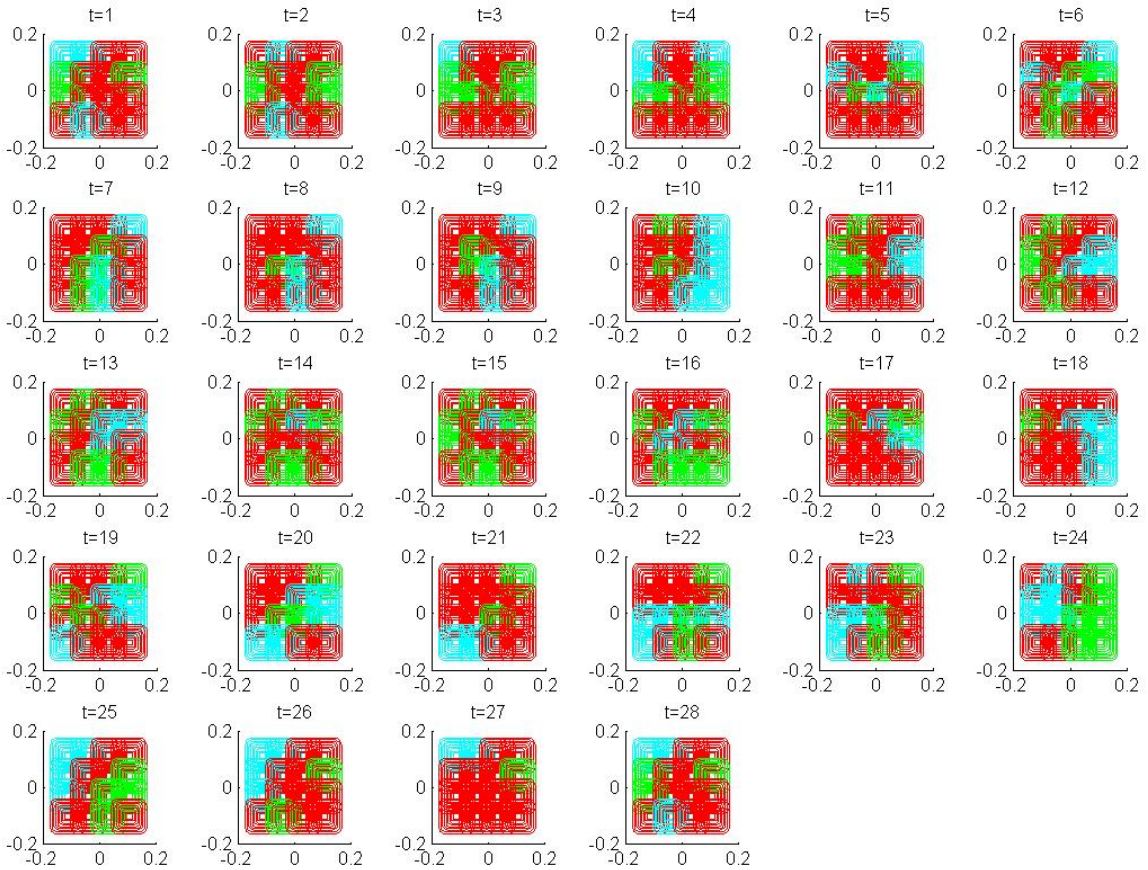




Clusters obtained with 10 neurons for all the time with step 0.412 ms

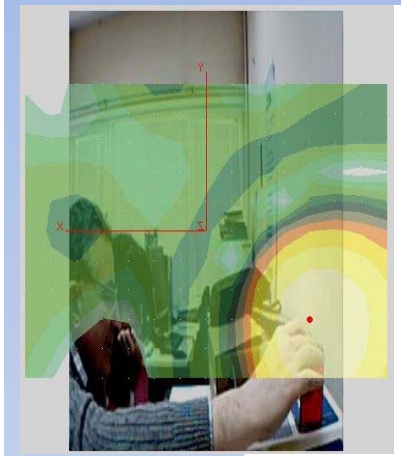
Results & discussions

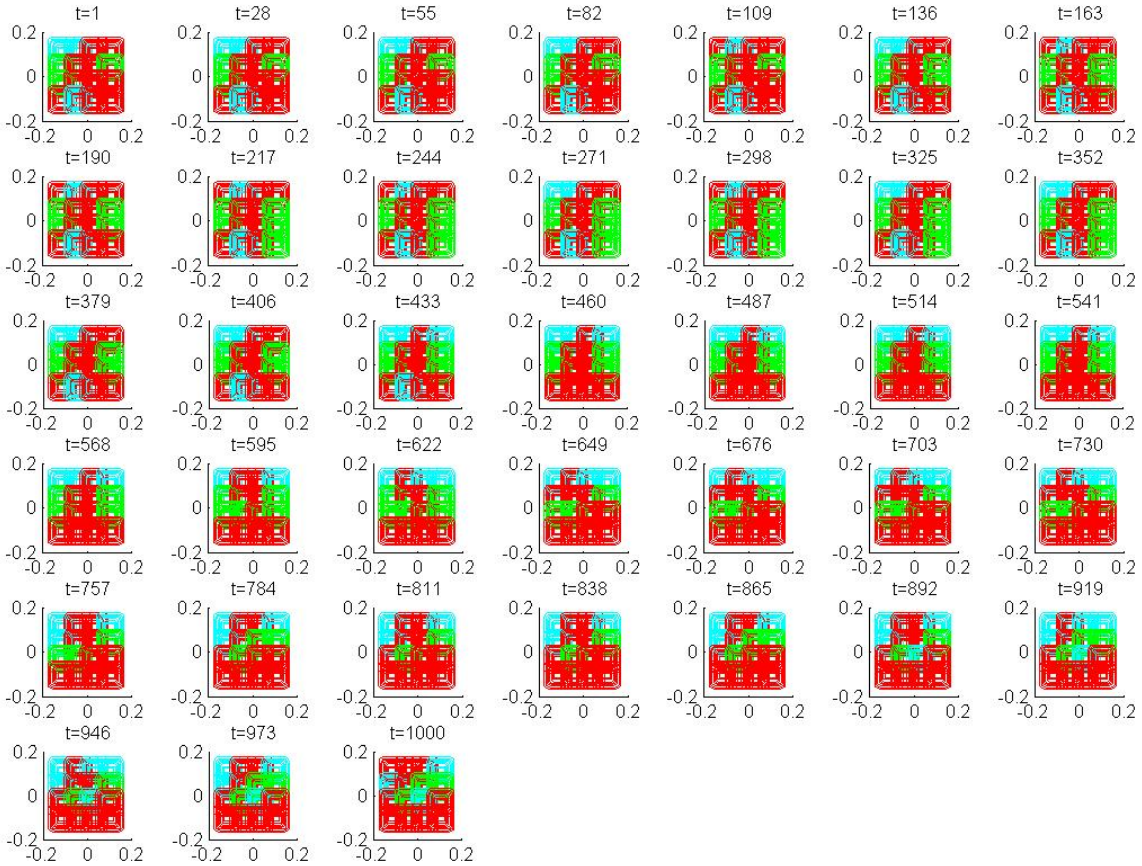




Clusters obtained with 30 neurons for the first period of measurements

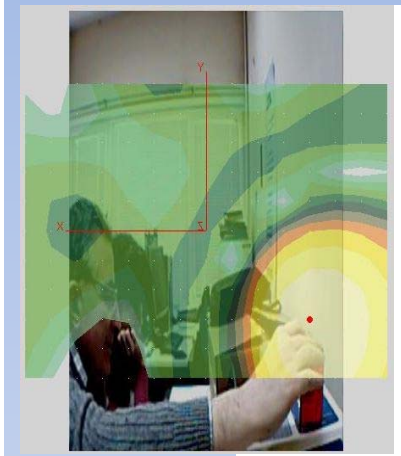
Results & discussion

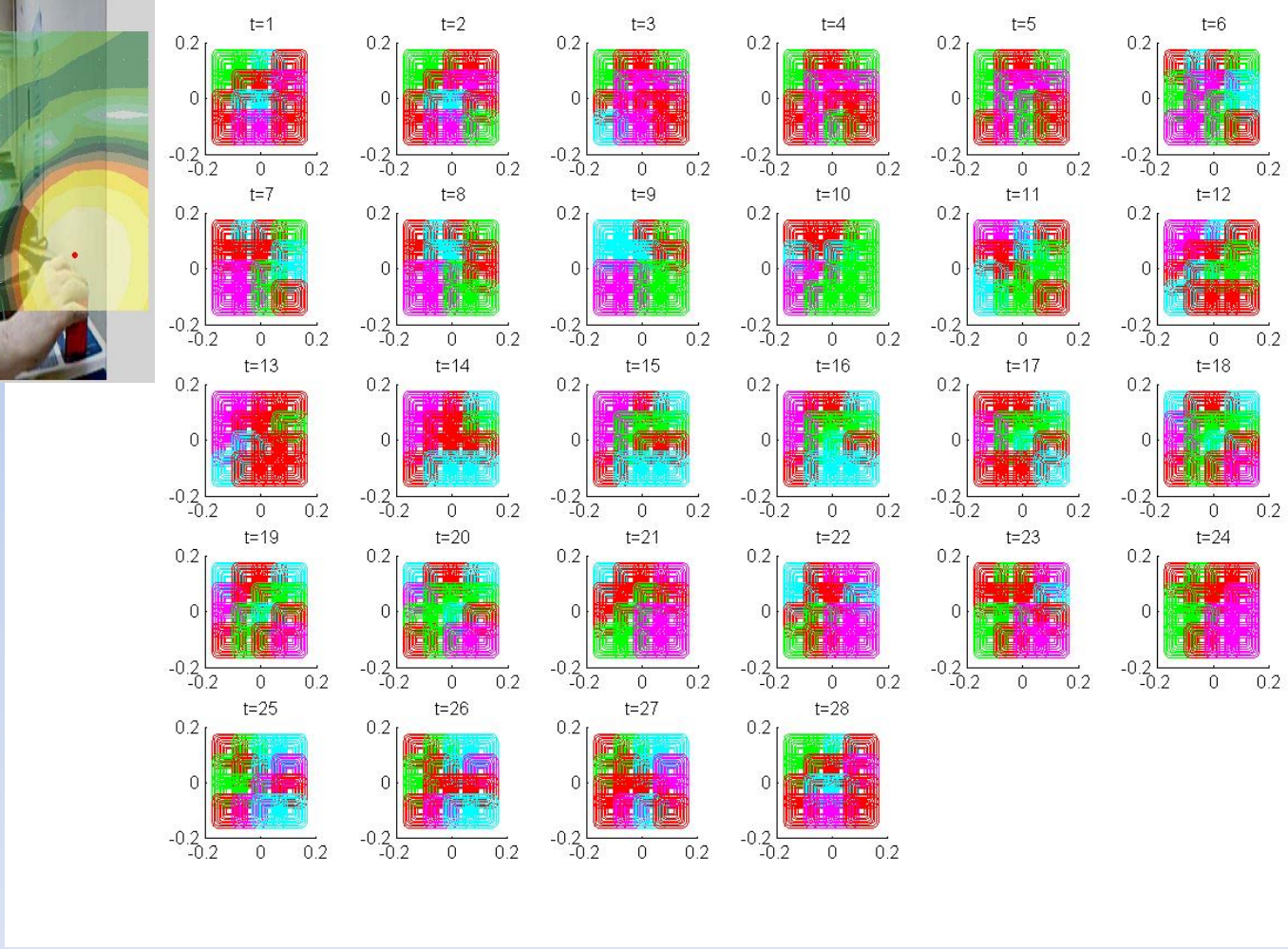




Clusters obtained with 30 neurons for all the time with step 0.412 ms

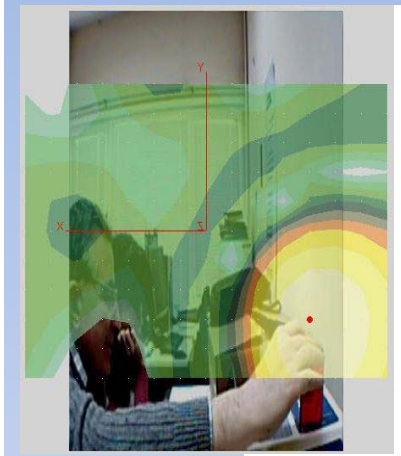
Results & discussions

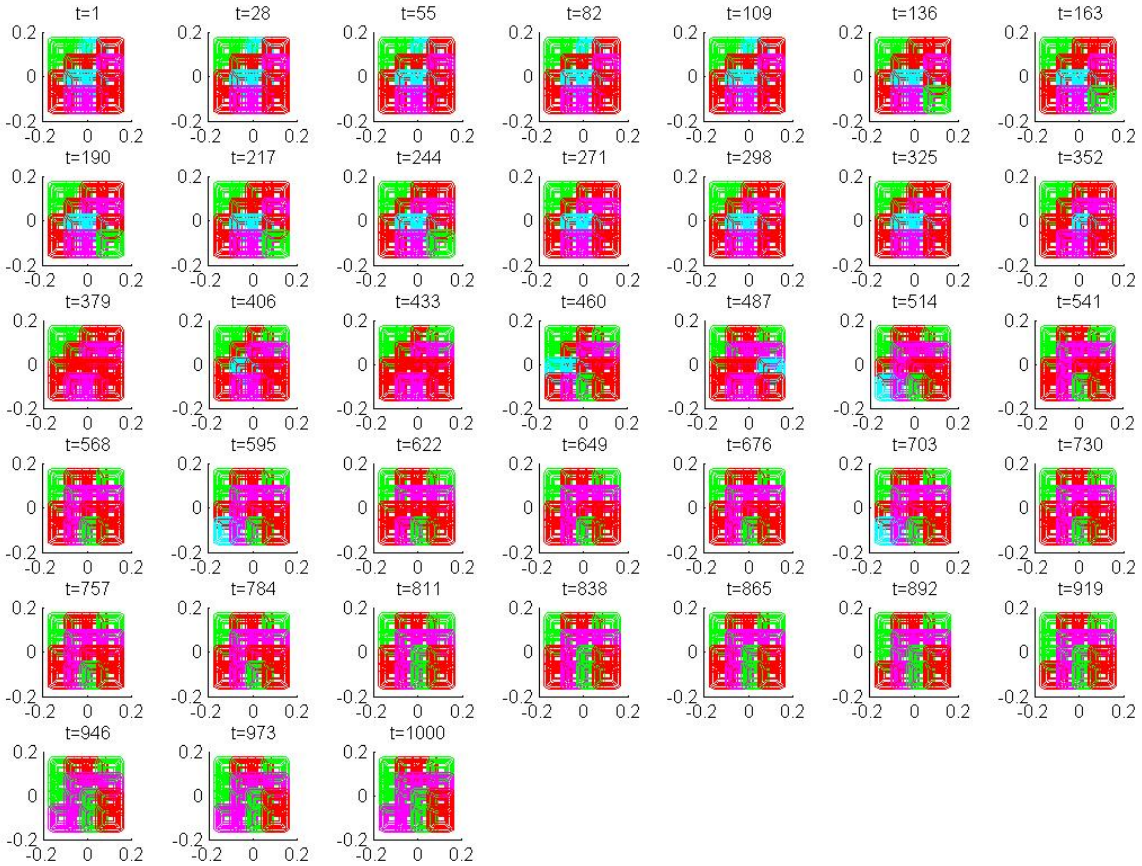




Clusters obtained with 50 neurons for the first period of measurements

Results & discussion





Clusters obtained with 50 neurons for all the with step 0.412 ms

Acknowledgments

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Thank you for attention!

Questions?