FAST NON-LINEAR METHODS FOR DYNAMIC TEXTURE PREDICTION

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MOTIVATION

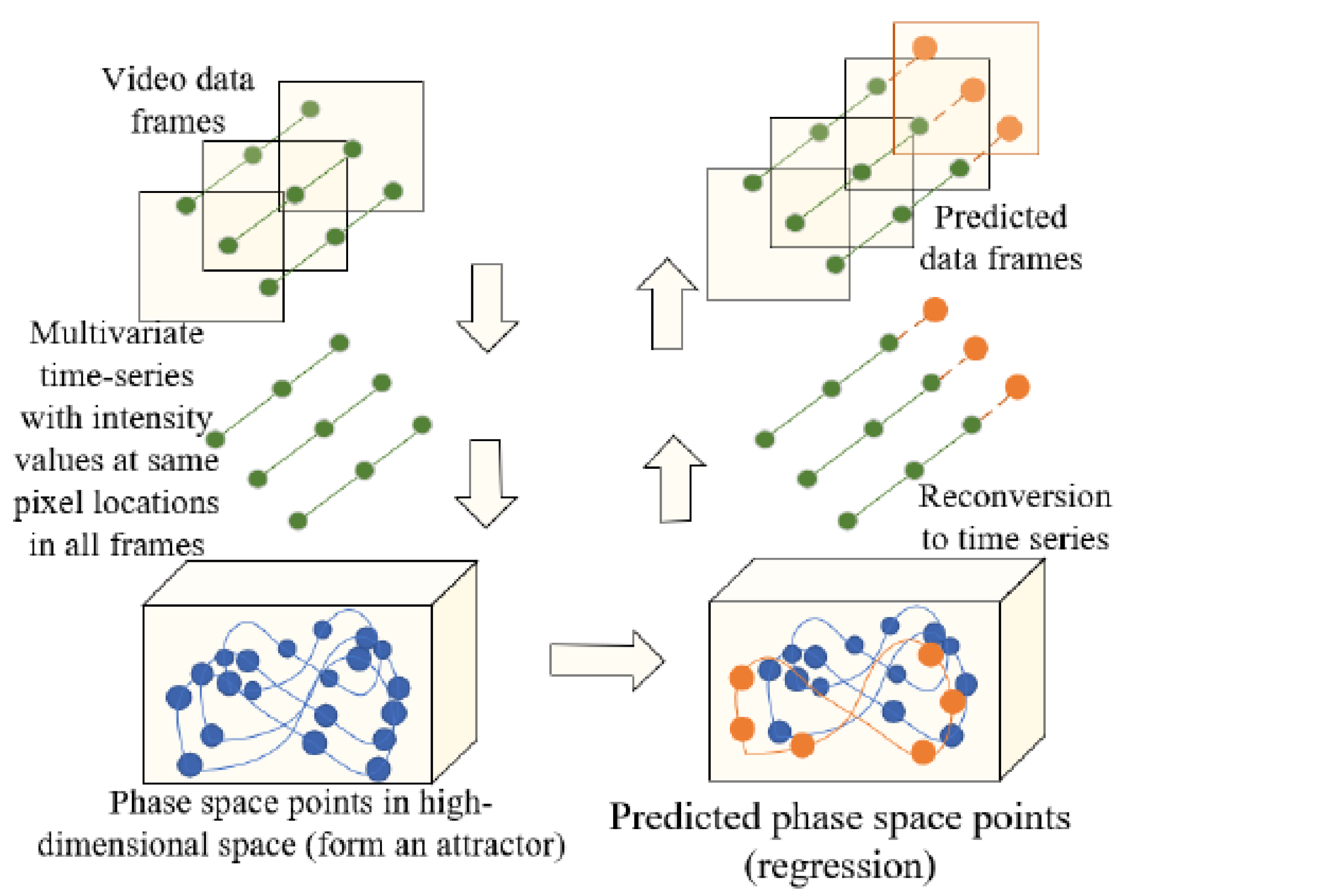
Open problems in Dynamic Texture Synthesis

- **Improved Computation Efficiency in Prediction;**
- **High Prediction Fidelity of the Predicted Frames;**
- **Avoiding residual parametric error;**
- **Applications in surveillance and weather prediction.**

PROJECT AIM

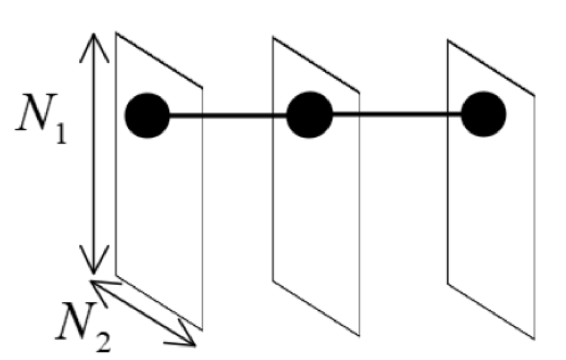
- **Fast Dynamic Texture Prediction with improved/same visual quality.**
- **Using ML techniques with Dynamic Texture Videos.**

PROPOSED ALGORITHM



Proposed Approach For Dynamic Texture Prediction

METHOD



- **I(x, y, t) represents a video.**

$$p_t = [p_{1,t}, p_{2,t}, \ldots . p_{M,t}]^T \in R^M$$
$$P = [p_1, p_2, \ldots . p_T] \in R^{M \times T}$$

- **Phase Space Matrix.**

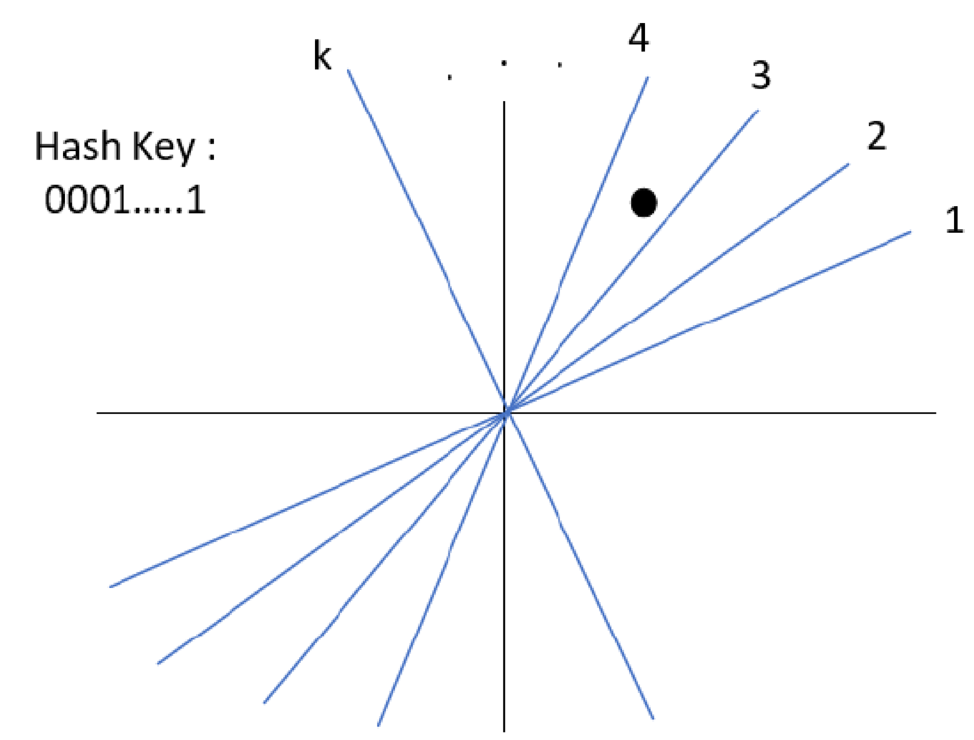
$E = [e_1, e_2, \ldots . e_N] \in R^{M \times \sum_{i=1}^{M} d_i}$ **where each e_t is a phase space point.**

- **Kernel Regression for Prediction.**

$$e_{t+1} = F(e_t) = \sum_{k=1}^{N(e_t)} (x_{k+1} - x_k + e_t) w_k(e_t, x_k)$$

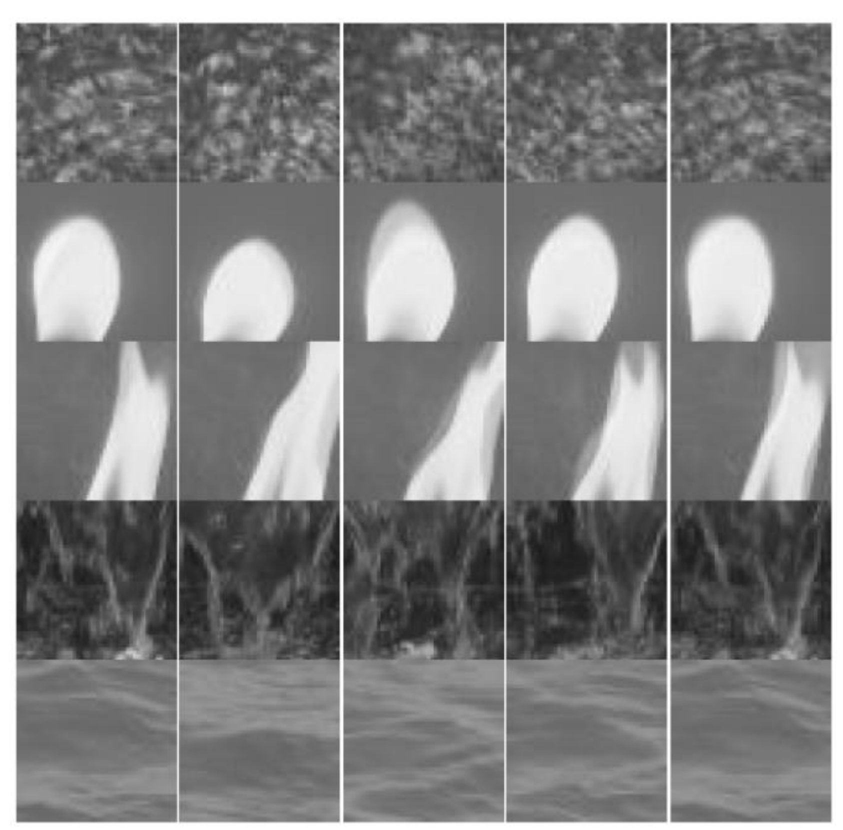
where $x_k \in E$ is the k^{th} nearest neighbor of e_t and $w_k(e_t, x_k)$ are Nadaraya Watson weights [1,2].

- **Locality Sensitive Hashing Method is used to improve the computation efficiency compared to Exhaustive Nearest Neighbor Methods [3,4].**



Brief Overview of Locality Sensitive Hashing

PRELIMINARY RESULTS



- **Predicted Frame Numbers : 100, 250, 400, 550 and 700 (horizontally)**
- **Classes: Boiling Water, Candle, Fire, Fountain, Sea (vertically)**
- **Around 780 frames predicted using 75 frames.**

	K-NN	LSH ($k = 5$)	LSH ($k = 10$)	LSH ($k = 15$)	LSH ($k = 20$)	LSH ($k = 25$)
Boiling Water	511.36	161.69 ±6.77	160.88 ±5.83	139.08 ±6.72	121.73 ±6.67	**115.26 ±7.73**
Candle	497.71	162.04 ±4.83	148.35 ±4.89	116.85 ±6.15	96.99 ±6.07	**97.83 ±6.47**
Fire	548.39	158.18 ±3.51	162.96 ±3.77	142.47 ±5.70	113.70 ±6.02	**103.76 ±5.73**
Fountain	484.48	160.10 ±2.08	154.77 ±4.60	148.71 ±4.99	112.72 ±6.34	**110.57 ±5.45**
Sea	413.18	147.84 ±2.49	149.89 ±3.54	141.90 ±6.34	132.56 ±6.34	**125.65 ±5.63**

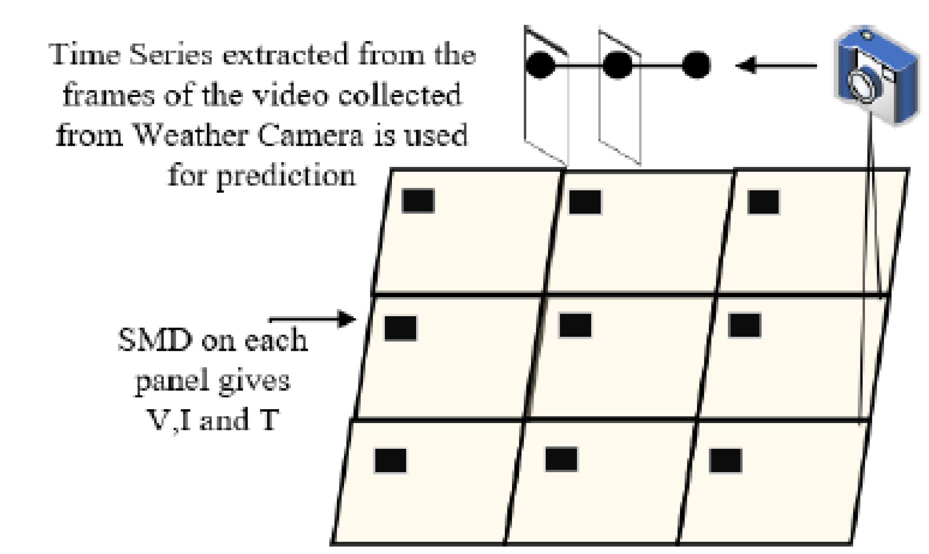
Computation Time (in seconds) for 7 Hash Tables. Number of bits (k) = 25 gave the optimal computation time.

	K-NN (PSNR)	LSH (PSNR)	K-NN (FSIM)	LSH (FSIM)
Boiling Water	17.57	17.61	0.75	0.746
Candle	13.37	13.33	0.79	0.79
Fire	15.39	15.38	0.777	0.7772
Fountain	18.64	18.66	0.745	0.741
Sea	23.15	23.15	0.767	0.768

Columns 1 and 2 represent PSNR and Columns 3 and 4 represent FSIM for 75 frames generated by Exhaustive K-NN method and LSH with k = 25 respectively.

APPLICATIONS

- **Cloud Movement Prediction in Solar.**
- **Illustration on the left shows how the weather cam data can be used in Cloud Movement Prediction.**
- **Monitoring Traffic/Crowds in Surveillance.**



ONGOING & PLANNED WORK

- **Use LSTMs for bigger dynamic texture videos for learning Long Term Dependencies.**
- **Apply the proof-of-concept method to cloud movement prediction application.**

REFERENCES

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[2] Nadaraya, Elizbar A. "On estimating regression." *Theory of Probability & Its Applications* 9.1, 141-142, 1964.

[3]Datar, M., Immorlica, N., Indyk, P., & Mirrokni, V. S. Locality-sensitive hashing scheme based on p-stable distributions. In *Proceedings of the twentieth annual symposium on Computational geometry* (pp. 253-262). ACM, June, 2004.

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