AI VIETNAM
All-in-One Course

How to do Research

(Performance Evaluation, Journal/Conference Selection, Plan to write a Scientific Research Paper)

Vinh Dinh Nguyen
PhD in Computer Science

Year 2023

Schedule

Week 1
How to read Research Paper

Week 2
How to find Research Topic and Develop Research Questions

Week 3
Research Plan: Study and Implement Existing Algorithms

Week 4
Research Plan: *Brainstorming Idea and Implementation*

This Week
Performance Evaluation and Journal/Conference Selection, Plan to Write a Research Paper

Group Presentation
(23/12/2023 & 30/12/2023)

How to write a Scientific Research Paper
(4 weeks)

Performance Evaluation Strategy

Evaluating the performance of a proposed method in research is a ***crucial step to assess its effectiveness, robustness, and generalizability***. The specific strategy you adopt will depend on the *nature of your research*, *the problem* you are *addressing*, and *the type of method* you have developed

- Define Clear Objectives and Metrics
- Dataset Selection
- Baseline Comparison
- Cross-Validation
- Parameter Tuning
- Visualization and Analysis
- Peer Review
- Robust Testing
- Real-world Validation
- Documentation and Reproducibility

Outline

- Performance Evaluation in Detail
- Enough Contributions for Submission
- How to Find Suitable Journal/Conference
- Plan to Write a Scientific Research Paper
- Assignment

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Research Questions: Stereo Matching

RQ1: How to improve the performance of existing stereo matching methods under various lighting conditions and complex material properties?

RQ2: How to obtain a real-time processing for current state-of-the-art stereo matching-based deep learning methods?

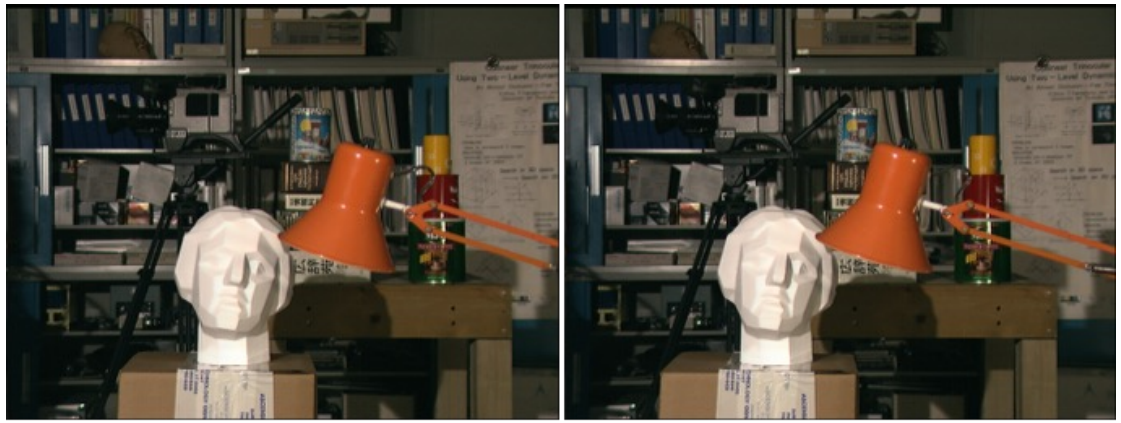
RQ3: How to design an automatically learning the network architecture, its activation functions, and its parameters from data ?

Please select the simplest question to solve

In this module

Stereo Matching

❖Normal



Left Image | Right Image

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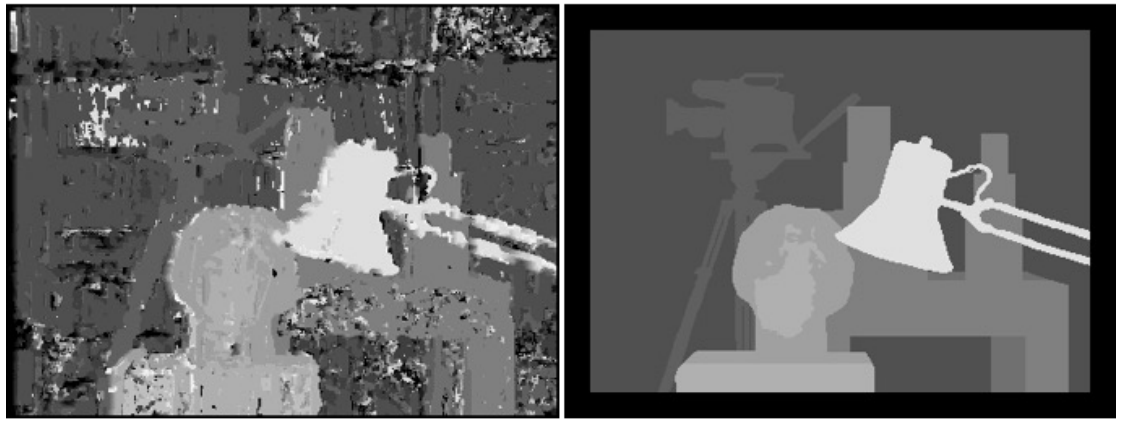
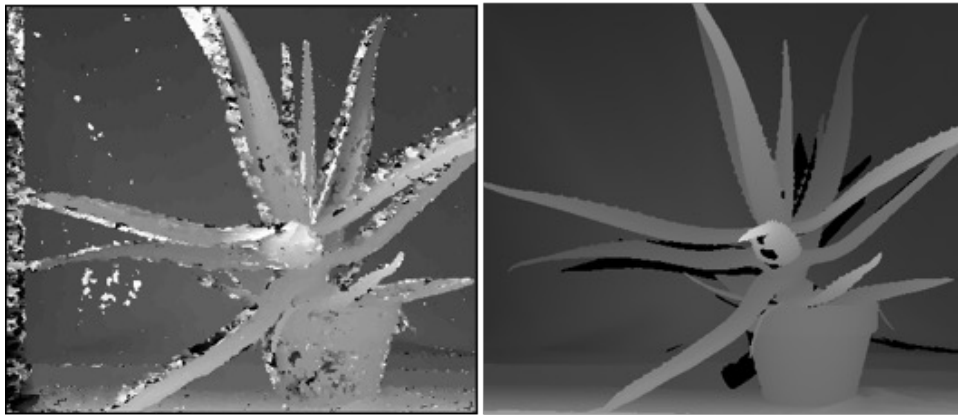


Disparity Map | Ground Truth

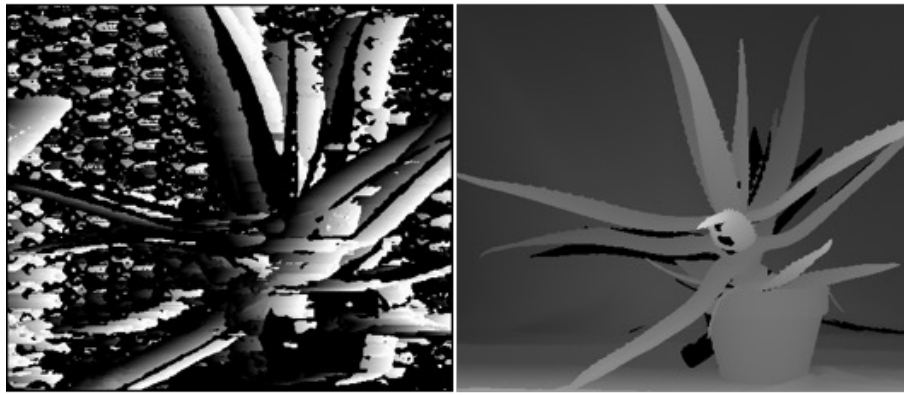


Disparity Map | Ground Truth

Stereo Matching

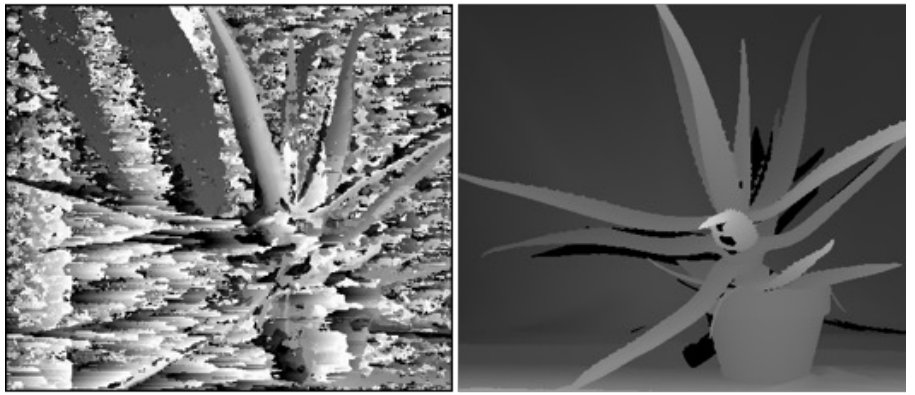
❖Challenges

Left Image | Right Image



Disparity Map | Ground Truth

Left Image | Right Image



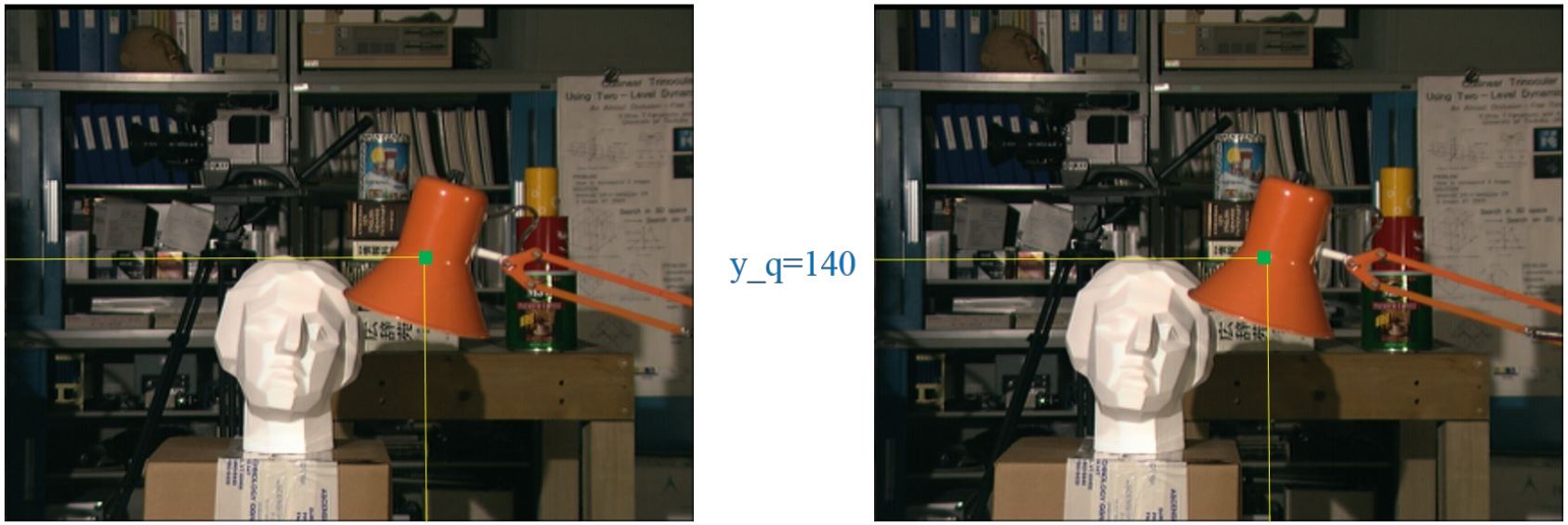
Disparity Map | Ground Truth

Challenges in Stereo Matching

RQ1: How to improve the performance of existing stereo matching methods under various lighting conditions and complex material properties?

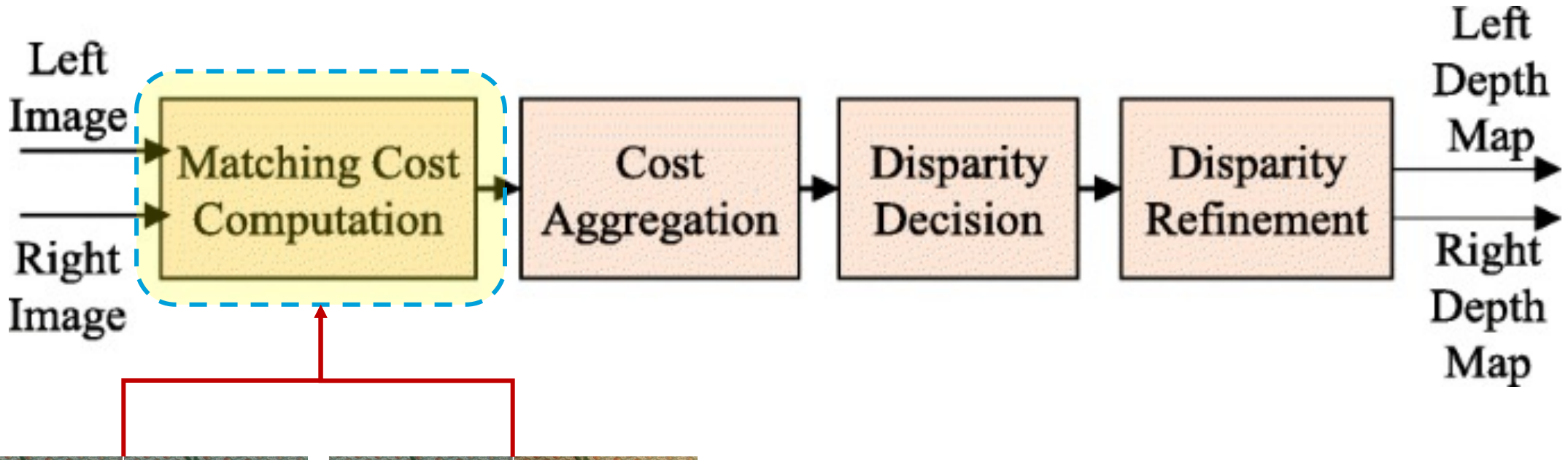
p = (234, 140)

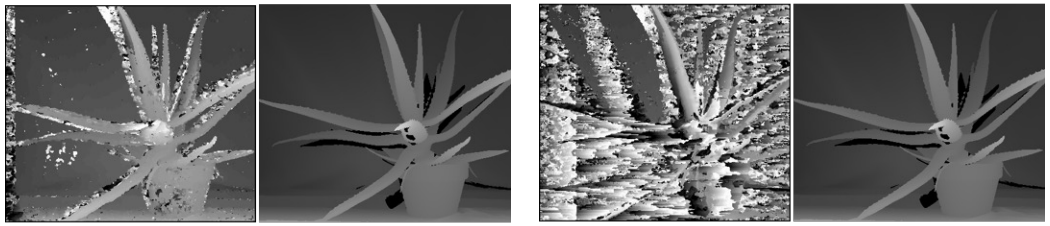
q = (220, 140)



disparity_q = x_p – x_q = 14

Your Proposed Solution





Indentify where you can improve the performance of existing algorithms?

Stereo Matching Cost

Parametric Matching Costs

$$C_{AD}(\mathbf{p}, \mathbf{d}) = |I_L(\mathbf{p}) - I_R(\mathbf{p} - \mathbf{d})|, \quad (1)$$

$$C_{SAD}(\mathbf{p}, \mathbf{d}) = \sum_{\mathbf{q} \in N_\mathbf{p}} |I_L(\mathbf{q}) - I_R(\mathbf{q} - \mathbf{d})|. \quad (2)$$

Sampling-insensitive absolute difference of Birchfield and Tomasi

$$\begin{aligned}
C_{BT}(\mathbf{p}, \mathbf{d}) &= \min(A, B), \\
A &= \max(0, I_L(\mathbf{p}) - I_R^{max}(\mathbf{p} - \mathbf{d}), I_R^{min}(\mathbf{p} - \mathbf{d}) - I_L(\mathbf{p})), \\
B &= \max(0, I_R(\mathbf{p} - \mathbf{d}) - I_L^{max}(\mathbf{p}), I_L^{min}(\mathbf{p}) - I_R(\mathbf{p} - \mathbf{d})), \\
I^{min}(\mathbf{p}) &= \min(I^-(\mathbf{p}), I(\mathbf{p}), I^+(\mathbf{p})) \\
I^{max}(\mathbf{p}) &= \max(I^-(\mathbf{p}), I(\mathbf{p}), I^+(\mathbf{p})) \\
I^-(\mathbf{p}) &= (I(\mathbf{p} - [1 \;\; 0]^T) + I(\mathbf{p}))/2, \\
I^+(\mathbf{p}) &= (I(\mathbf{p} + [1 \;\; 0]^T) + I(\mathbf{p}))/2.
\end{aligned}$$

Stereo Matching Cost

Parametric Matching Costs

The zeromean sum of absolute differences (ZSAD) s

$$C_{ZSAD}(\mathbf{p},\mathbf{d}) = \sum_{\mathbf{q}\in N_\mathbf{p}} |I_L(\mathbf{q}) - \bar{I}_L(\mathbf{p}) - I_R(\mathbf{q}-\mathbf{d}) + \bar{I}_R(\mathbf{p}-\mathbf{d})|$$

$$\bar{I}(\mathbf{p}) = \frac{1}{|N_\mathbf{p}|}\sum_{\mathbf{q}\in N_\mathbf{p}} I(\mathbf{q}).$$

Normalized cross-correlation

$$C_{NCC}(\mathbf{p},\mathbf{d}) = \frac{\sum_{\mathbf{q}\in N_\mathbf{p}} I_L(\mathbf{q}) I_R(\mathbf{q}-\mathbf{d})}{\sqrt{\sum_{\mathbf{q}\in N_\mathbf{p}} I_L(\mathbf{q})^2 \sum_{\mathbf{q}\in N_\mathbf{p}} I_R(\mathbf{q}-\mathbf{d})^2}}.$$

NCC is another window-based matching technique that is commonly used. NCC compensates for gain changes and is statistically the optimal method for dealing with Gaussian noise. However, NCC tends to blur depth discontinuities more than many other matching costs because outliers lead to high errors within the NCC calculation

Stereo Matching Cost

Parametric Matching Costs

Zero-mean variant ZNCC

$$C_{ZNCC}(\mathbf{p},\mathbf{d}) = \frac{\sum_{\mathbf{q}\in N_\mathbf{p}}(I_L(\mathbf{q})-\bar{I}_L(\mathbf{p}))(I_R(\mathbf{q}-\mathbf{d})-\bar{I}_R(\mathbf{p}-\mathbf{d}))}{\sqrt{\sum_{\mathbf{q}\in N_\mathbf{p}}(I_L(\mathbf{q})-\bar{I}_L(\mathbf{p}))^2 \sum_{\mathbf{q}\in N_\mathbf{p}}(I_R(\mathbf{q}-\mathbf{d})-\bar{I}_R(\mathbf{p}-\mathbf{d}))^2}}.$$

Non-parametric Matching Costs

Rank Filter

$$I_{Rank}(\mathbf{p}) = \sum_{\mathbf{q}\in N_\mathbf{p}} T[I(\mathbf{q}) < I(\mathbf{p})].$$

The function T[] is defined to return 1 if its argument is true and 0 otherwise. The transformed images are matched with the absolute difference. The Rank filter is known to be susceptible to noise in textureless areas.

Stereo Matching Cost

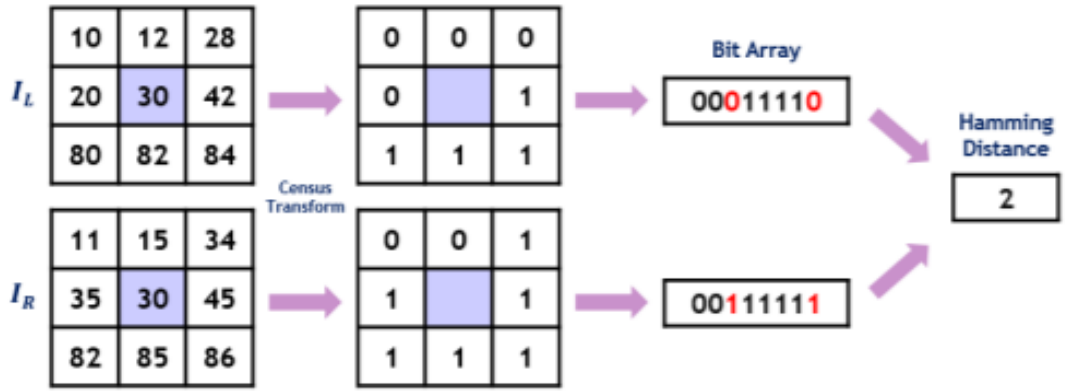
Non-parametric Matching Costs

Soft Rank filter

$$I_{SoftRank}(\mathbf{p}) = \sum_{\mathbf{q} \in N_\mathbf{p}} \min\left(1, \max\left(0, \frac{I(\mathbf{p}) - I(\mathbf{q})}{2t} + \frac{1}{2}\right)\right).$$

The Soft Rank filter was proposed by Zitnick to reduce the problem of Rank filter by defining a linear, soft transition zone between 0 and 1 for values that are close together

Census Filter



Cosine similarity

Cosine similarity (cs) được dùng để đo mức độ giống nhau/tương đồng giữa hai vector

Gọi $\vec{x}$ và $\vec{y}$ là hai vector, cs được tính như sau

$$\text{cs}(\vec{x},\vec{y}) = \frac{\vec{x}.\vec{y}}{\|\vec{x}\|\|\vec{y}\|} = \frac{\sum_1^n x_i y_i}{\sqrt{\sum_1^n x_i^2}\sqrt{\sum_1^n y_i^2}}$$

Tính chất 1: $\text{cs}(\vec{x},\vec{y}) = \text{cs}(a\vec{x}, b\vec{y})$

$$\text{cs}(a\vec{x}, b\vec{y}) = \frac{a\vec{x}.b\vec{y}}{\|a\vec{x}\|\|b\vec{y}\|} = \frac{\sum_1^n a x_i b y_i}{\sqrt{\sum_1^n a^2 x_i^2}\sqrt{\sum_1^n b^2 y_i^2}}$$

$$= \frac{ab\sum_1^n x_i y_i}{\sqrt{a^2\sum_1^n x_i^2}\sqrt{b^2\sum_1^n y_i^2}}$$

$$= \frac{\sum_1^n x_i y_i}{\sqrt{\sum_1^n x_i^2}\sqrt{\sum_1^n y_i^2}} = \text{cs}(\vec{x},\vec{y})$$

Tính chất 2: $\text{cs}(\vec{x},\vec{y}) \neq \text{cs}(\vec{x}+c, \vec{y}+d)$

Ví dụ:

$$\vec{x} = [4,2,1,2]^T$$

$$\vec{y} = [1,2,2,0]^T$$

$$\vec{u} = 2\vec{x} = [8,4,2,4]^T$$

$$\vec{v} = 3\vec{y} = [3,6,6,0]^T$$

$$\text{cs}(\vec{x},\vec{y}) = \frac{4*1+2*2+1*2+2*0}{\sqrt{4^2+2^2+1^2+2^2}\sqrt{1^2+2^2+2^2+0}}$$

$$= \frac{10}{\sqrt{25}\sqrt{9}} = \frac{10}{15} = 0.67$$

$$\text{cs}(\vec{u},\vec{v}) = \frac{8*3+4*6+2*6+4*0}{\sqrt{8^2+4^2+2^2+4^2}\sqrt{3^2+6^2+6^2+0}}$$

$$= \frac{60}{\sqrt{100}\sqrt{81}} = \frac{60}{90} = 0.67$$

$$= \text{cs}(\vec{x},\vec{y})$$

Cosine Similarity for Matching Cost

Cosine similarity (cs) is used to measure the similarity between two vectors

Let $\vec{x}$ and $\vec{y}$ be two vectors, cs is defined as

$$cs(\vec{x},\vec{y}) = \frac{\vec{x}.\vec{y}}{\|\vec{x}\|\|\vec{y}\|} = \frac{\sum_1^n x_i y_i}{\sqrt{\sum_1^n x_i^2}\sqrt{\sum_1^n y_i^2}}$$

Property 1: $cs(\vec{x},\vec{y}) = cs(a\vec{x}, b\vec{y})$; $ab > 0$

$$cs(a\vec{x}, b\vec{y}) = \frac{a\vec{x}.b\vec{y}}{\|a\vec{x}\|\|b\vec{y}\|} = \frac{\sum_1^n a x_i b y_i}{\sqrt{\sum_1^n a^2 x_i^2}\sqrt{\sum_1^n b^2 y_i^2}}$$

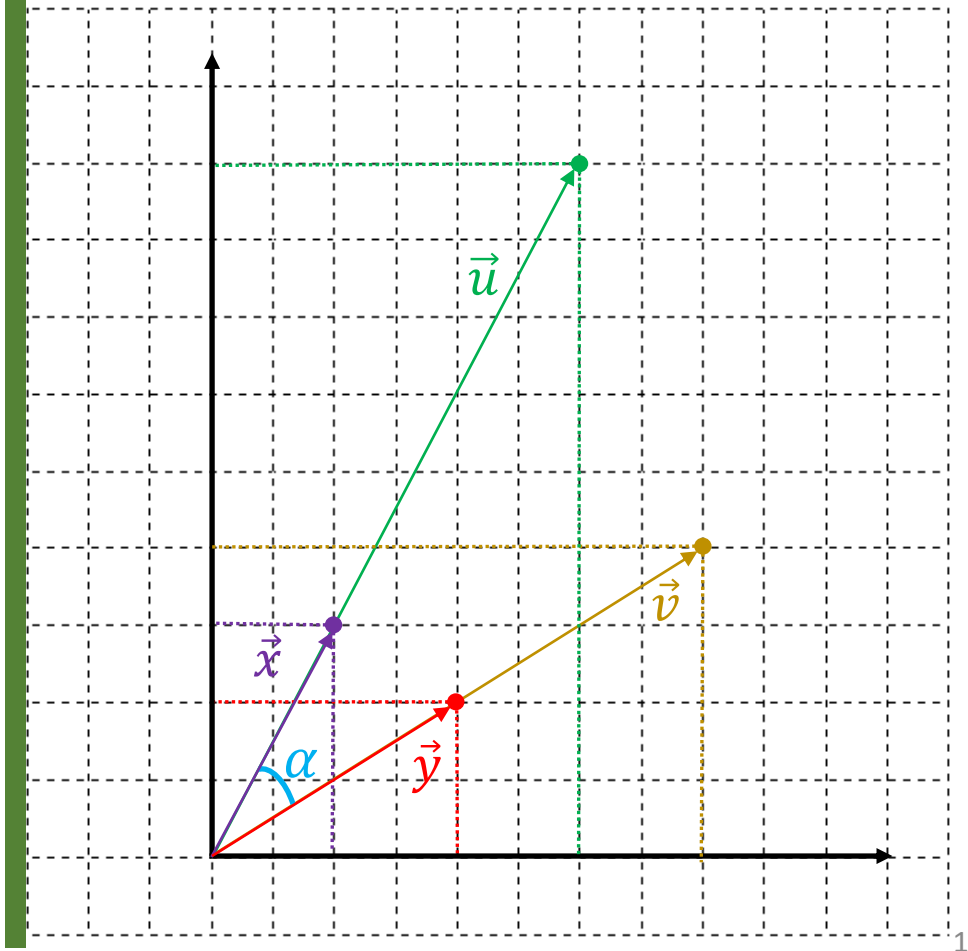
$$= \frac{ab\sum_1^n x_i y_i}{\sqrt{a^2\sum_1^n x_i^2}\sqrt{b^2\sum_1^n y_i^2}}$$

$$= \frac{\sum_1^n x_i y_i}{\sqrt{\sum_1^n x_i^2}\sqrt{\sum_1^n y_i^2}} = cs(\vec{x},\vec{y})$$

Property 2: $cs(\vec{x},\vec{y}) \neq cs(\vec{x}+c, \vec{y}+d)$

$\vec{x} = \begin{pmatrix}2\\3\end{pmatrix}$ $\quad \vec{u} = 3 * \vec{x} = \begin{pmatrix}6\\9\end{pmatrix}$

$\vec{y} = \begin{pmatrix}4\\2\end{pmatrix}$ $\quad \vec{v} = 2 * \vec{y} = \begin{pmatrix}8\\4\end{pmatrix}$



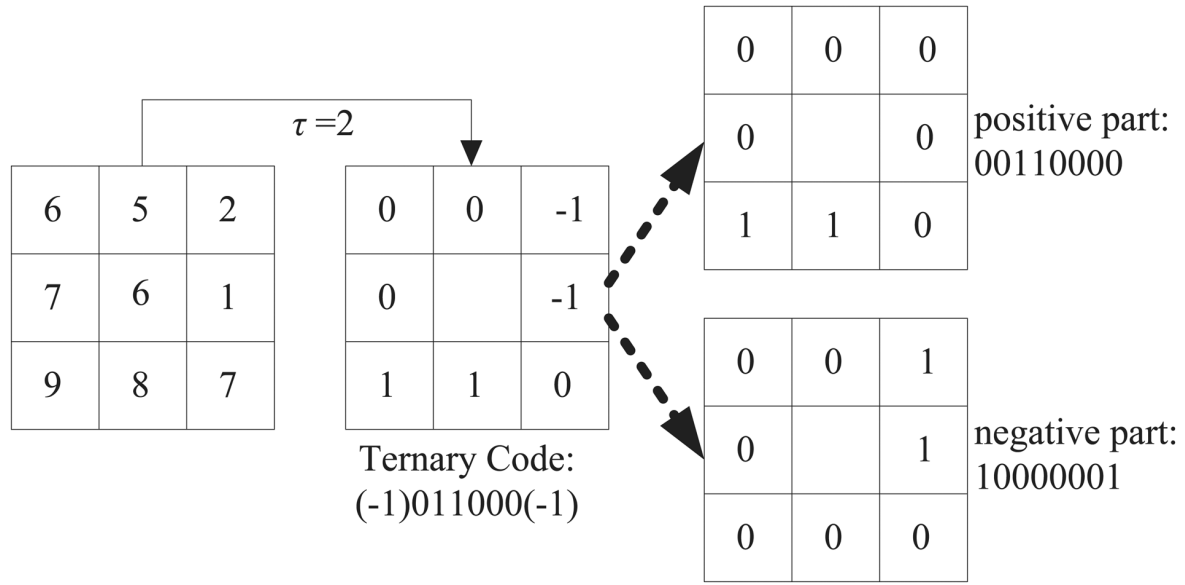
LTP Matching Cost

$$LTP_{S,P} = \sum_{y=0}^{S-1} 2^y h(i_y - i_c)$$

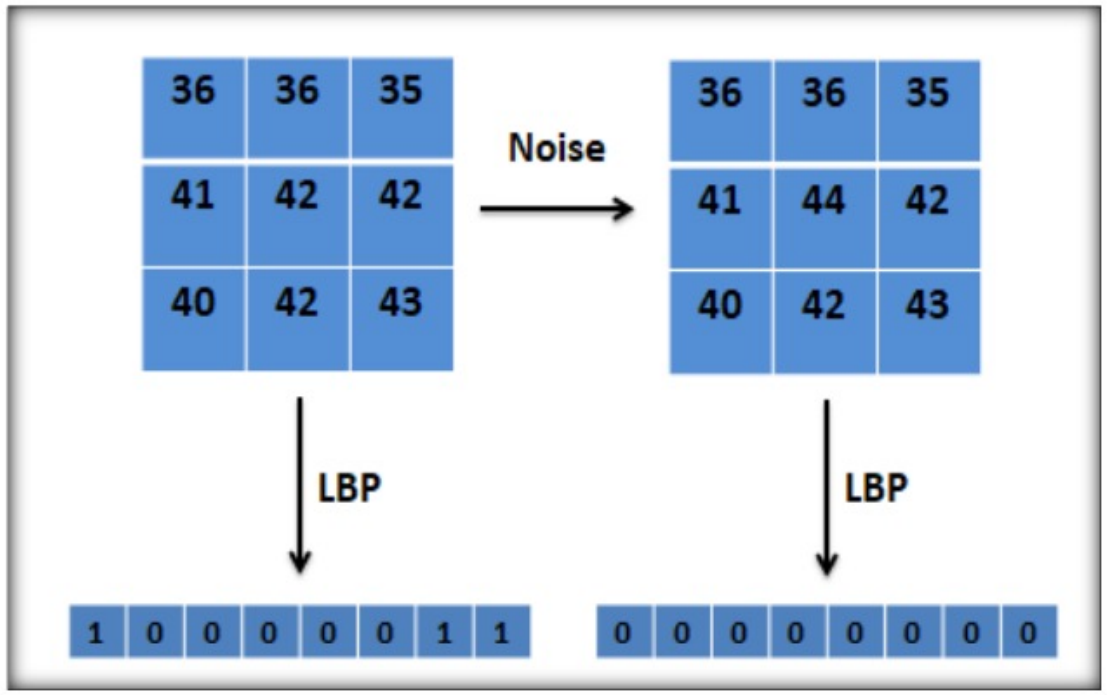
$$\text{Where} \quad h(i_y - i_c) = \begin{cases} 1 & i_y - i_c \geq t \\ 0 & -t < i_y - i_c < t \\ -1 & i_y - i_c < -t \end{cases}$$

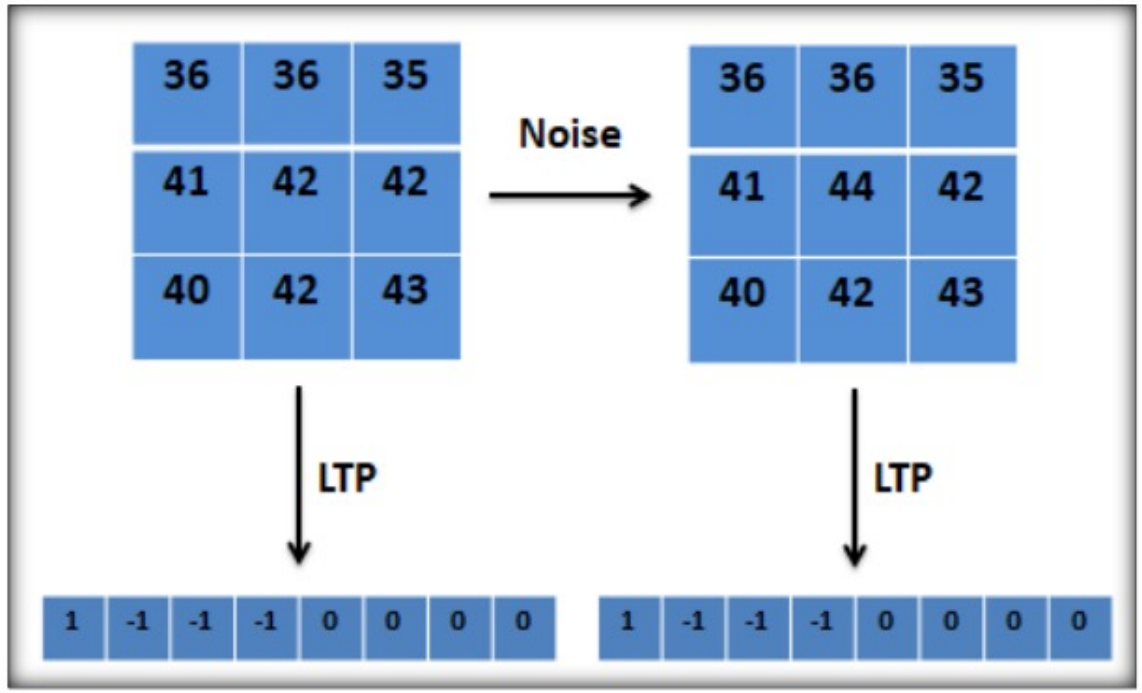
$$LBP_{S,P} = \sum_{y=0}^{S-1} 2^y h(i_y - i_c)$$

$$\text{Where,} \quad h(i_y - i_c) = \begin{cases} 1 & i_y - i_c \geq 0 \\ 0 & i_y - i_c < 0 \end{cases}$$

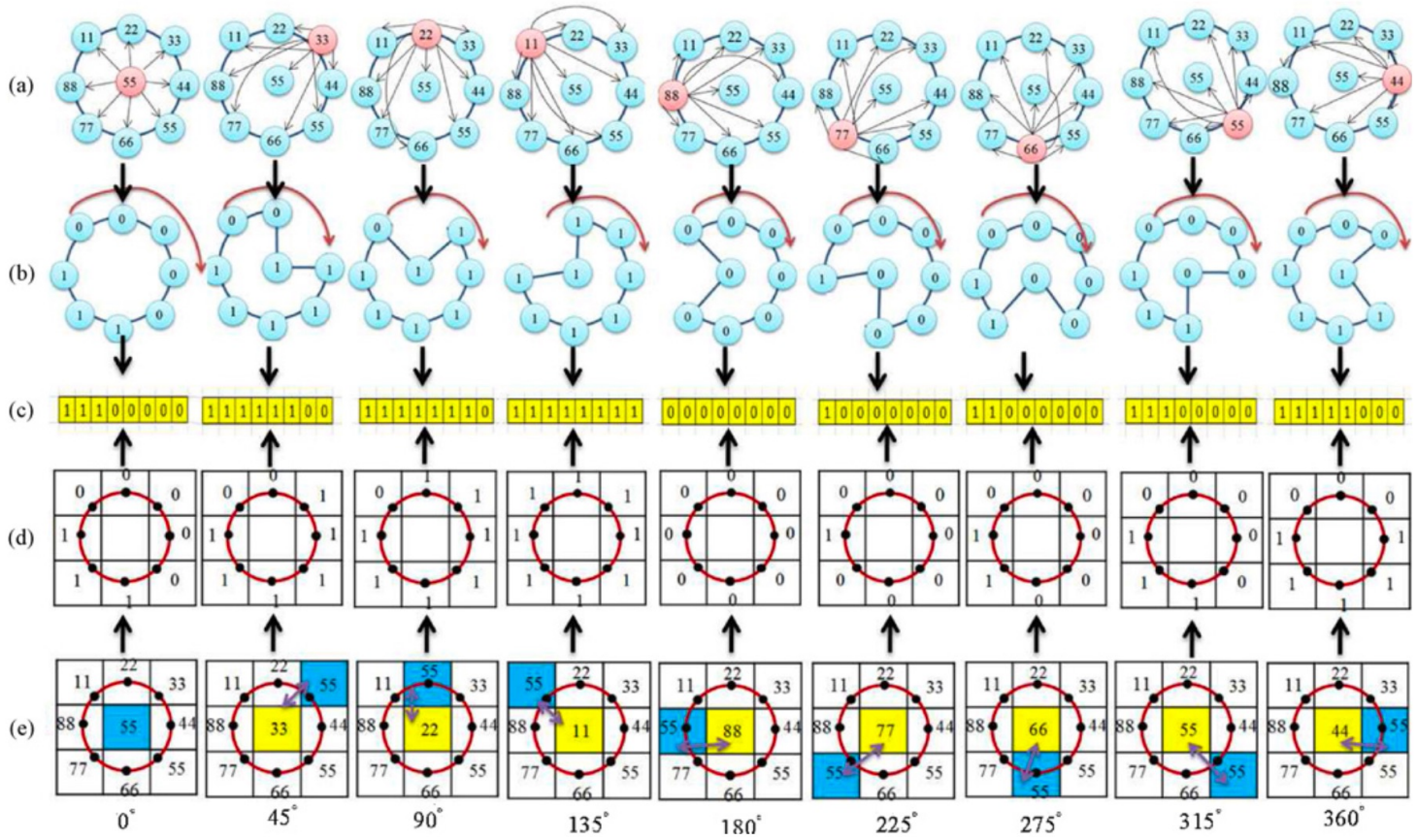


LTP Matching Cost



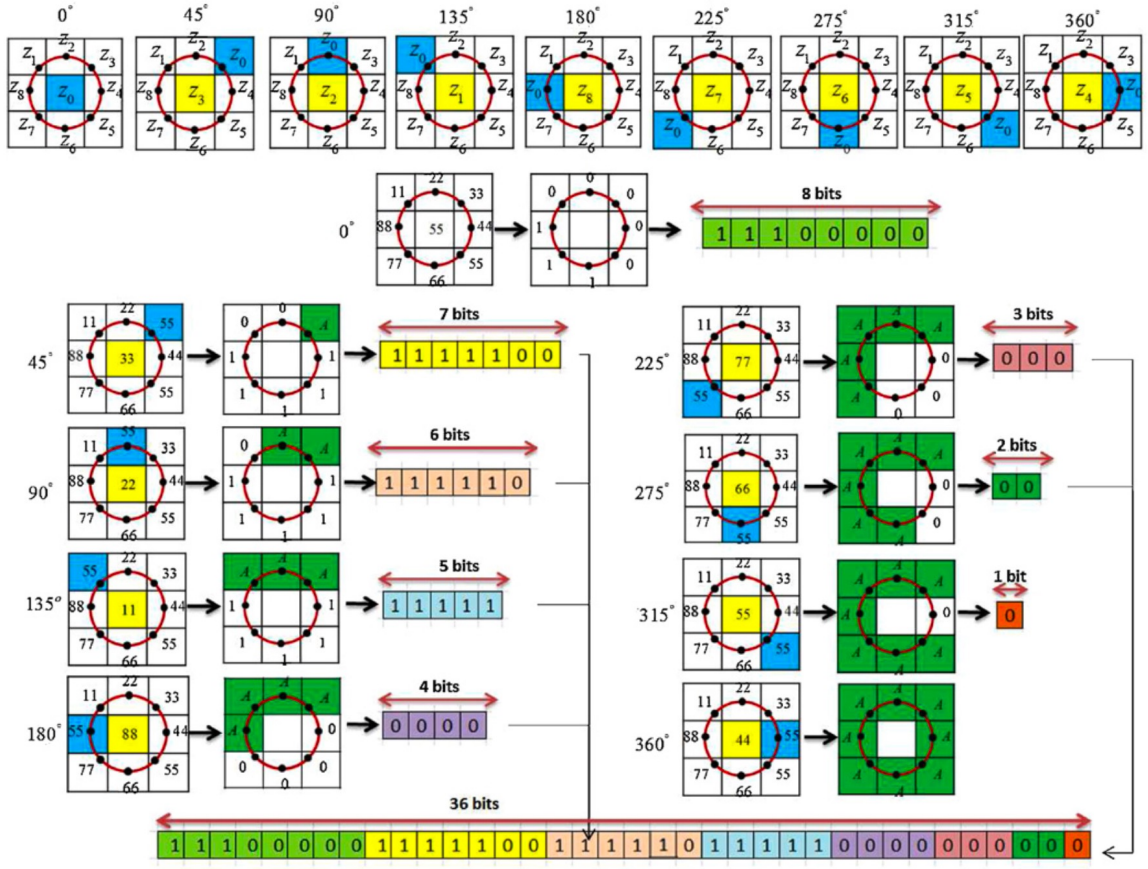


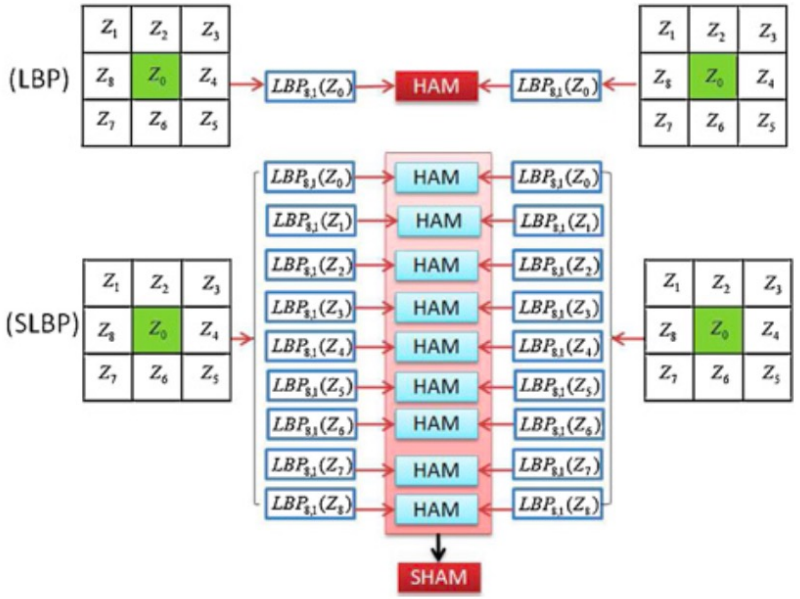
Stereo Matching Cost



V. D. Nguyen, D. D. Nguyen, T. T. Nguyen, V. Q. Dinh and J. W. Jeon, "Support Local Pattern and its Application to Disparity Improvement and Texture Classification," in IEEE Transactions on Circuits and Systems for Video Technology, vol. 24, no. 2, pp. 263-276, Feb. 2014, doi: 10.1109/TCSVT.2013.2254898.

Stereo Matching Cost





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Define Clear Objectives and Metrics

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Cross-Validation

Parameter Tuning

Visualization and Analysis

Peer Review

Robust Testing

Real-world Validation

Documentation and Reproducibility

Define Clear Objectives and Metrics

Evaluation Metric: Stereo Matching

- Clearly articulate the objectives of your proposed method. What problem is it solving, and what are the desired outcomes?
- Define appropriate evaluation metrics that align with your objectives. Common metrics include accuracy, precision, recall, F1 score, mean squared error, etc.

	Method	Setting	Code	D1-bg	D1-fg	D1-all	Density	Runtime	Environment
1	MoCha-Stereo			1.36 %	2.43 %	**1.53 %**	100.00 %	0.27 s	NVIDIA Tesla A6000 (PyTorch)
2	DiffuVolume			1.35 %	2.51 %	1.54 %	100.00 %	0.36 s	GPU @ 2.5 Ghz (Python)
3	GANet+ADL			1.38 %	2.38 %	1.55 %	100.00 %	0.67s	NVIDIA RTX 3090 (PyTorch)
4	Selective-IGEV			1.33 %	2.61 %	1.55 %	100.00 %	0.24 s	1 core @ 2.5 Ghz (Python)
5	MC-Stereo			1.36 %	2.51 %	1.55 %	100.00 %	0.40 s	1 core @ 2.5 Ghz (Python)
6	IGEV-ICGNet			1.38 %	2.55 %	1.57 %	100.00 %	0.18 s	NVIDIA Tesla A5000 (Pytorch)
7	yjlig			1.37 %	2.62 %	1.58 %	100.00 %	0.35 s	1 core @ 2.5 Ghz (C/C++)
8	MDA			1.37 %	2.64 %	1.58 %	100.00 %	0.32 s	1 core @ 2.5 Ghz (Python)
9	UGNet			1.34 %	2.77 %	1.58 %	100.00 %	0.2 s	GPU @ 3.0 Ghz (Python)
10	Any-IGEV			1.43 %	2.35 %	1.58 %	100.00 %	0.32 s	GPU @ 2.5 Ghz (Python)
11	OpenStereo-IGEV		code	1.44 %	**2.31 %**	1.59 %	100.00 %	0.18 s	NVIDIA-3090

The KITTI Vision Benchmark Suite

Define Clear Objectives and Metrics

Percentage of Bad Pixels: Measures the percentage of pixels with disparity errors exceeding a specified threshold. Common thresholds include 1, 2, or 3 pixels.

$$BP = \frac{\text{Number of Bad Pixels}}{\text{Total Number of Pixels}} \times 100\%$$

Root Mean Squared Error (RMSE): Calculates the square root of the average squared disparity errors across all pixels. It provides a measure of the overall accuracy.

$$RMSE = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(D_i - \hat{D}_i)^2}$$

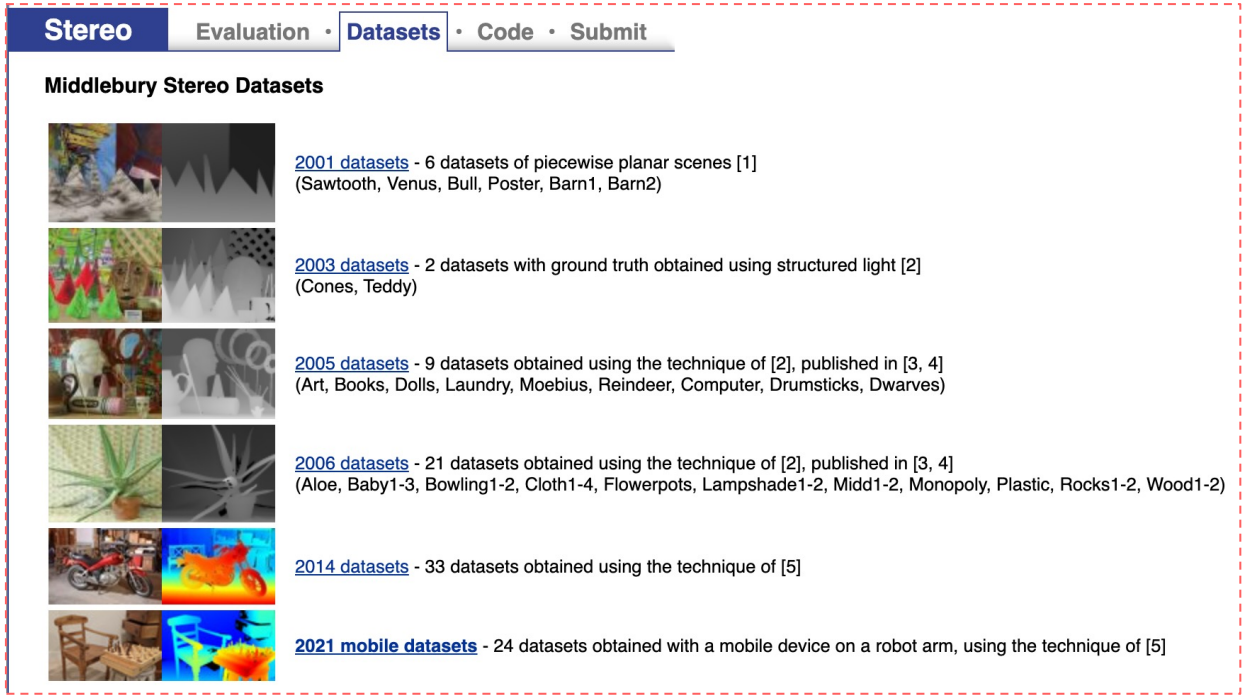
Mean Absolute Error (MAE): Computes the average absolute disparity errors. It is less sensitive to outliers than RMSE.

$$MAE = \frac{1}{N}\sum_{i=1}^{N}|D_i - \hat{D}_i|$$

The "d1-bg" error is specifically defined as the percentage of disparity errors (in pixels) where the absolute disparity error is less than 1 pixel and the error occurs in regions classified as foreground or background

$$\text{d1-bg} = \frac{\text{Number of pixels with disparity error} < 1 \text{ pixel and in fg/bg}}{\text{Total number of pixels in fg/bg}} \times 100\%$$

Dataset Selection



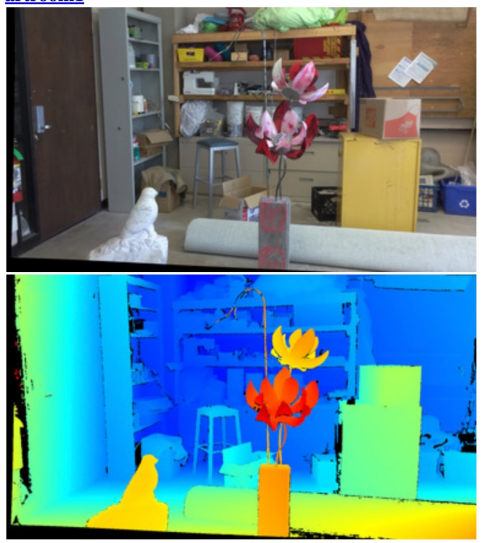
- Choose relevant and diverse datasets to evaluate your method. The datasets should be representative of the real-world scenarios your method is intended to address.
- Split the dataset into training, validation, and test sets. Ensure that the distribution of data in each set reflects the real-world scenario to avoid biased evaluations.

Dataset Selection

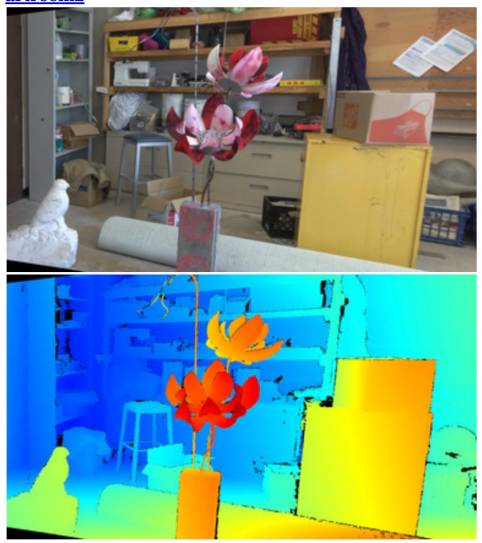
Ground Truth Data: Stereo Matching

Obtain or create a ground truth dataset with accurate depth information. This dataset should include stereo image pairs along with corresponding depth maps acquired from a reliable source (e.g., depth sensors or manually annotated).

artroom1



artroom2

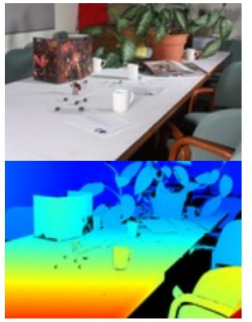


Australia

Bicycle2

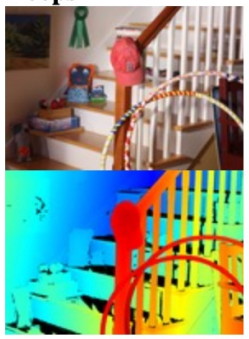
Classroom2

Crusade

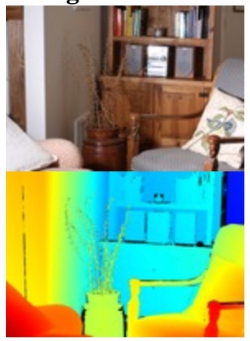


Djembe

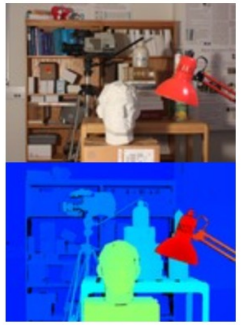
Hoops



Livingroom

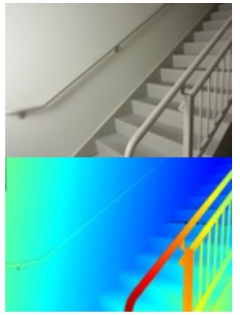


Newkuba



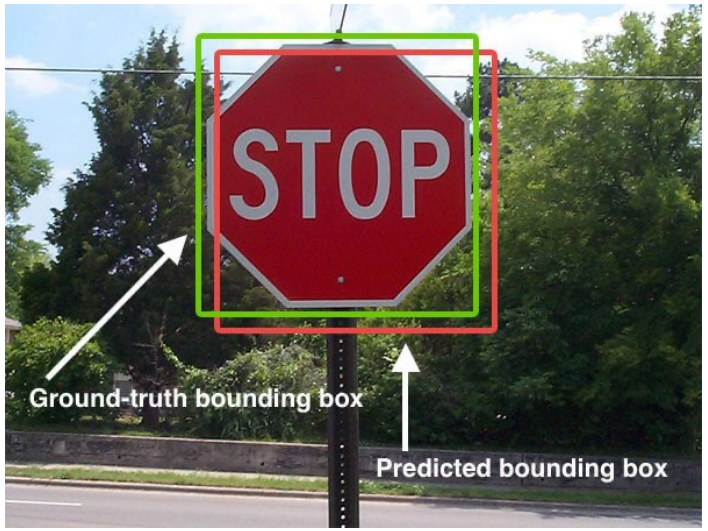
Plants

Staircase

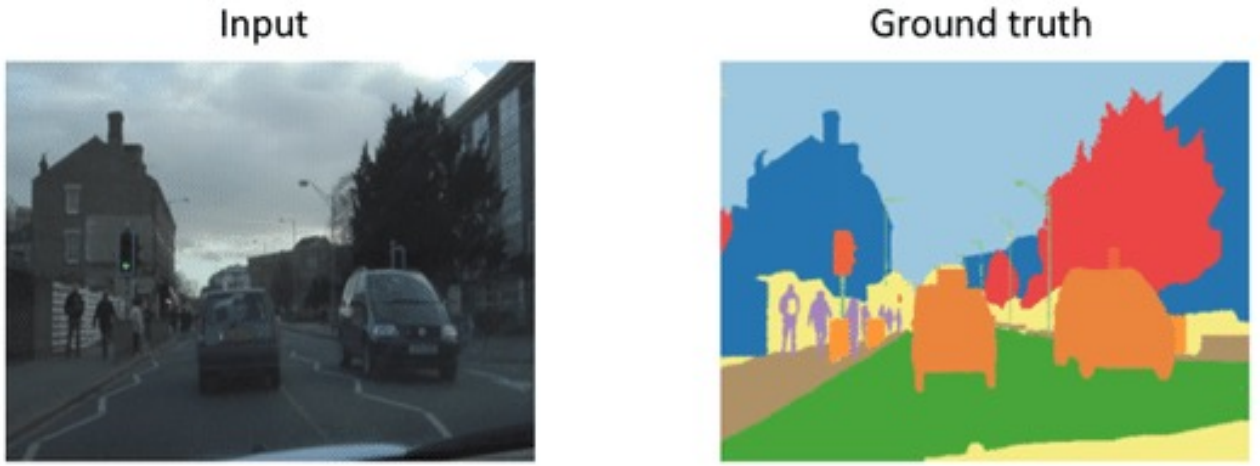


Dataset Selection

Ground Truth Data: Other research topics



Object Detection



Object Segmentation

Baseline Comparison

Establish a baseline performance by comparing your method against existing or well-known methods in the field. This provides context for understanding the relative improvement of your proposed method.

	Method	Setting	Code	D1-bg	D1-fg	D1-all	Density	Runtime	Environment
1	MoCha-Stereo			1.36 %	2.43 %	**1.53 %**	100.00 %	0.27 s	NVIDIA Tesla A6000 (PyTorch)
2	DiffuVolume			1.35 %	2.51 %	1.54 %	100.00 %	0.36 s	GPU @ 2.5 Ghz (Python)
3	GANet+ADL			1.38 %	2.38 %	1.55 %	100.00 %	0.67s	NVIDIA RTX 3090 (PyTorch)
4	Selective-IGEV			1.33 %	2.61 %	1.55 %	100.00 %	0.24 s	1 core @ 2.5 Ghz (Python)
5	MC-Stereo			1.36 %	2.51 %	1.55 %	100.00 %	0.40 s	1 core @ 2.5 Ghz (Python)
6	IGEV-ICGNet			1.38 %	2.55 %	1.57 %	100.00 %	0.18 s	NVIDIA Tesla A5000 (Pytorch)
7	yjlig			1.37 %	2.62 %	1.58 %	100.00 %	0.35 s	1 core @ 2.5 Ghz (C/C++)
8	MDA			1.37 %	2.64 %	1.58 %	100.00 %	0.32 s	1 core @ 2.5 Ghz (Python)
9	UGNet			1.34 %	2.77 %	1.58 %	100.00 %	0.2 s	GPU @ 3.0 Ghz (Python)
10	Any-IGEV			1.43 %	2.35 %	1.58 %	100.00 %	0.32 s	GPU @ 2.5 Ghz (Python)
11	OpenStereo-IGEV		code	1.44 %	**2.31 %**	1.59 %	100.00 %	0.18 s	NVIDIA-3090

The KITTI Vision Benchmark Suite

Baseline Comparison

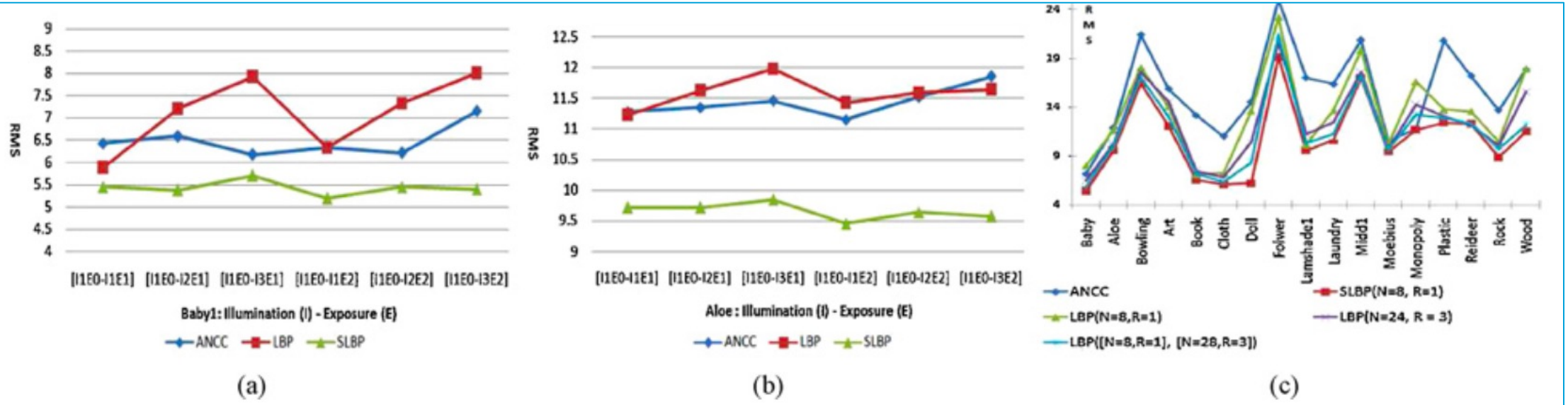
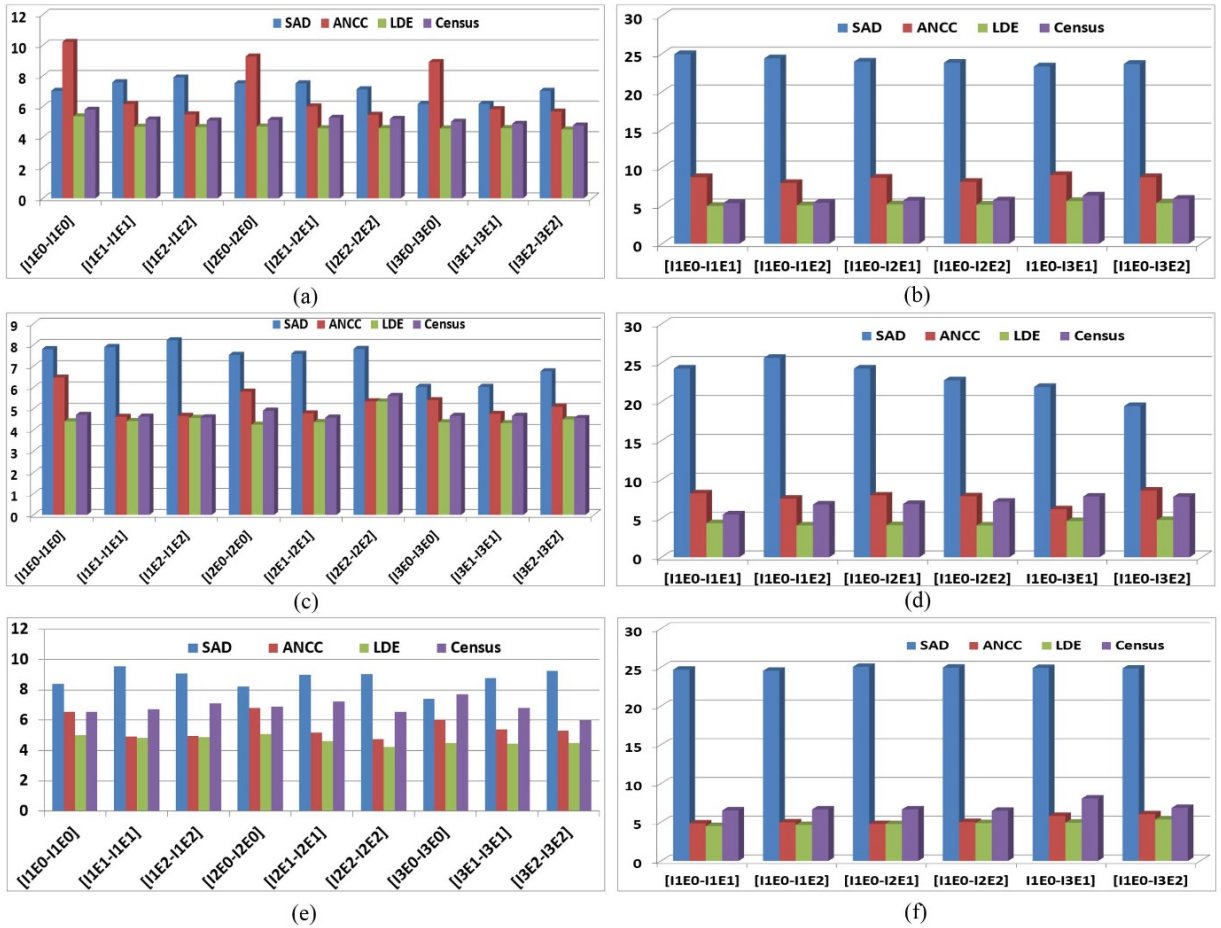


Fig. 12. RMS error of various stereo methods using the (a) Baby, (b) Aloe, and (c) 17 subdatasets under different illuminations and exposures.

V. D. Nguyen, D. D. Nguyen, T. T. Nguyen, V. Q. Dinh and J. W. Jeon, "Support Local Pattern and its Application to Disparity Improvement and Texture Classification," in IEEE Transactions on Circuits and Systems for Video Technology, vol. 24, no. 2, pp. 263-276, Feb. 2014, doi: 10.1109/TCSVT.2013.2254898.

Baseline Comparison



V. D. Nguyen, D. D. Nguyen, S. J. Lee and J. W. Jeon, "Local Density Encoding for Robust Stereo Matching," in IEEE Transactions on Circuits and Systems for Video Technology, vol. 24, no. 12, pp. 2049-2062, Dec. 2014, doi: 10.1109/TCSVT.2014.2334053.

Fig. 11. Comparison of the RMS of the proposed data cost and other data costs with SGM, BP, and GC using the baby data set. (a) and (b) Performances of various data costs with SGM under normal and different illuminations, respectively. (c) and (d) Performances of various data costs with BP under normal and different illuminations, respectively. (e) and (f) Performances of various data costs with GC under normal and different illuminations, respectively.

Cross-Validation

•Implement cross-validation to ensure robustness of your results. This helps in assessing the model's performance across different subsets of the data and reduces the impact of dataset-specific characteristics.

1. Split the dataset into k equal (if possible) parts (they are called folds)

2.Choose k – 1 folds as the training set. The remaining fold will be the test set

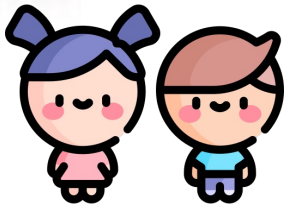
3.Train the model on the training set. On each iteration of cross-validation, you must train a new model independently of the model trained on the previous iteration

4.Validate on the test set

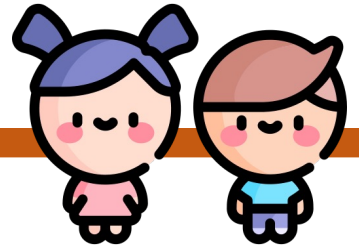
5.Save the result of the validation

6.Repeat steps 3 – 6 k times. Each time use the remaining fold as the test set. In the end, you should have validated the model on every fold that you have.

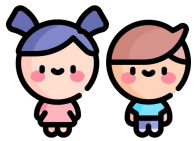
7.To get the final score average the results that you got on step 6.



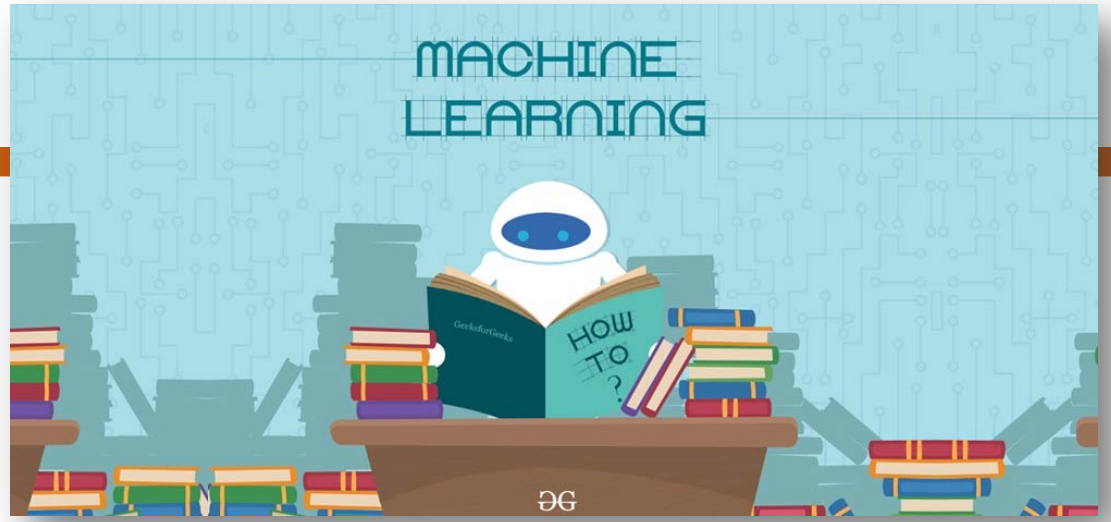
Have seen these cars



Never seen.
But, still know it is a car



For human beings **generalization** is the most natural thing possible. For example, we would definitely recognize a car even if we didn't see this car before



It might be quite a challenge for an ML model

→

That's why checking the algorithm's ability to **generalize** is an important task that requires a lot of attention when building the model.

↓

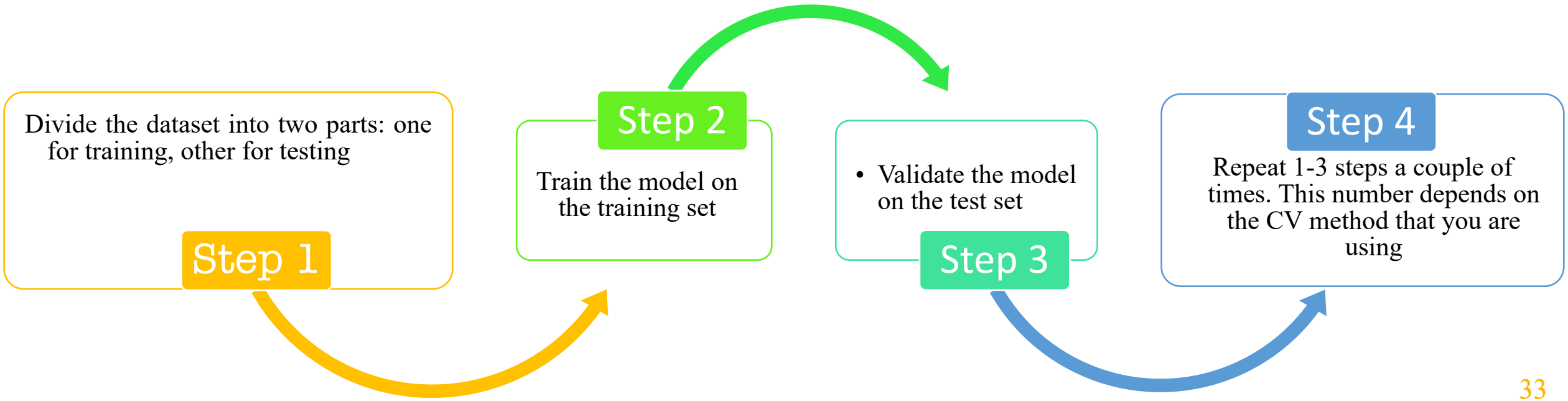
To do that, we use **Cross-Validation** (**CV**)

What is Cross-Validation?

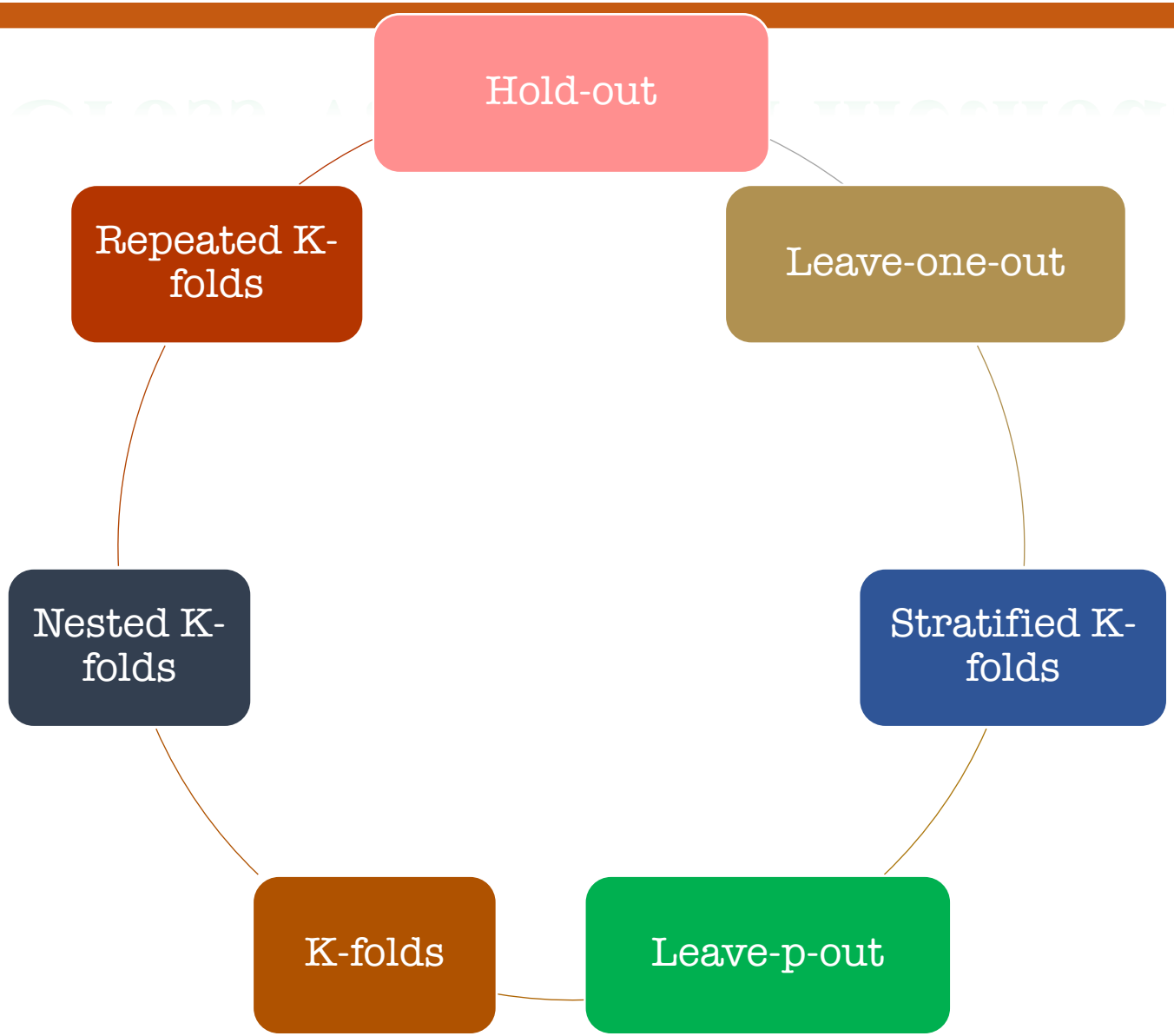
Cross-validation is a technique for evaluating a machine learning model and testing its performance.

Cross-validation a powerful tool for selecting the best model for the specific task.

Common actions of cross-validation algorithms



Cross-validation methods



Parameter Tuning

If your method has hyperparameters, perform a thorough parameter tuning process using techniques such as grid search or random search. This ensures that your model is optimized for performance.

A model hyperparameter is a characteristic of a model that is external to the model and whose value cannot be estimated from data. The value of the hyperparameter has to be set before the learning process begins. For example, c in Support Vector Machines, k in k-Nearest Neighbors, the number of hidden layers in Neural Networks.

- **Random Search**. Define a search space as a bounded domain of hyperparameter values and randomly sample points in that domain.

- **Grid Search**. Define a search space as a grid of hyperparameter values and evaluate every position in the grid.

More advanced methods are sometimes used, such as Bayesian Optimization and Evolutionary Optimization.

Visualization and Analysis

Disparity Map Visualization

Visualize the generated disparity maps to qualitatively assess the method's performance. Compare them against the ground truth disparity maps to identify regions of accurate and inaccurate depth estimation.

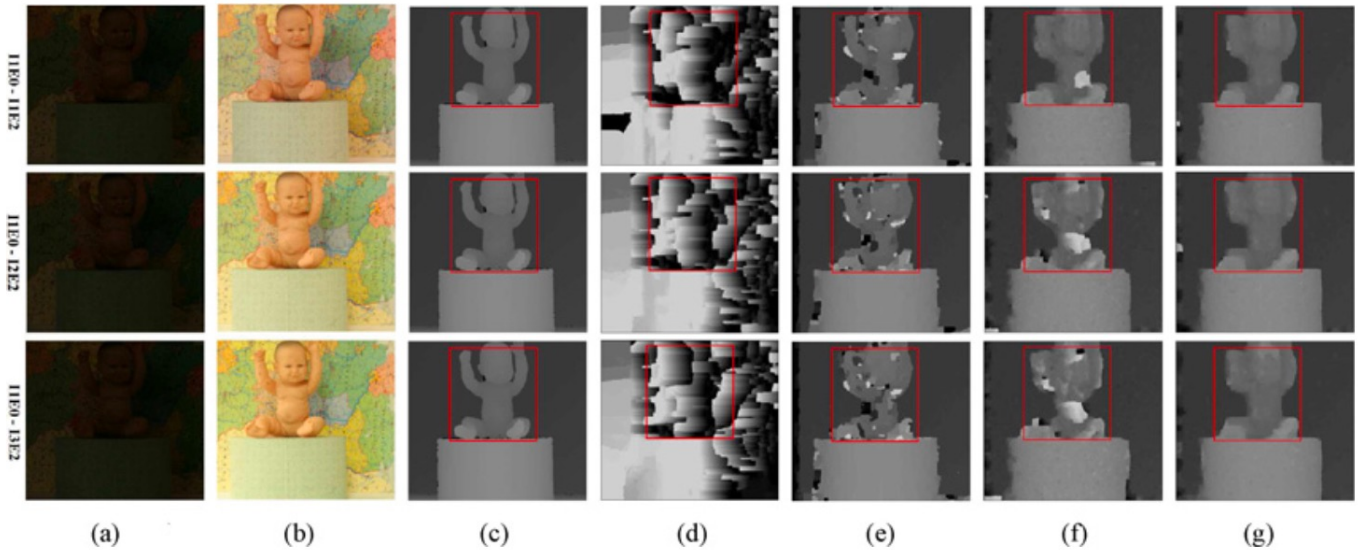
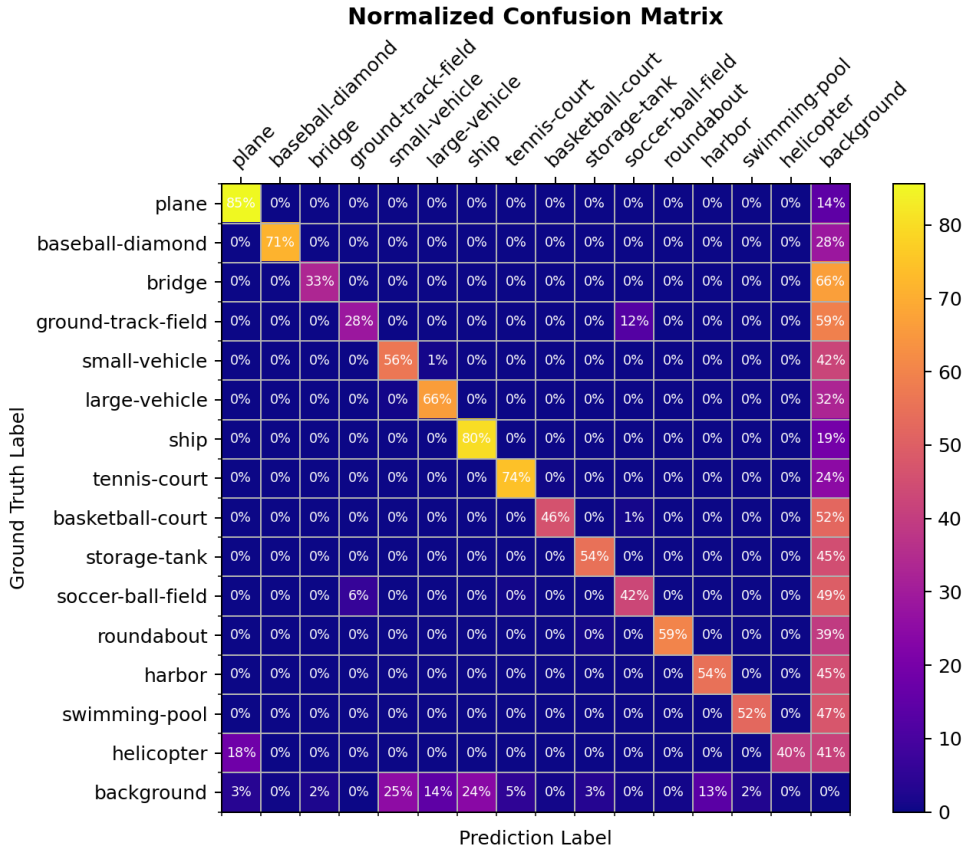


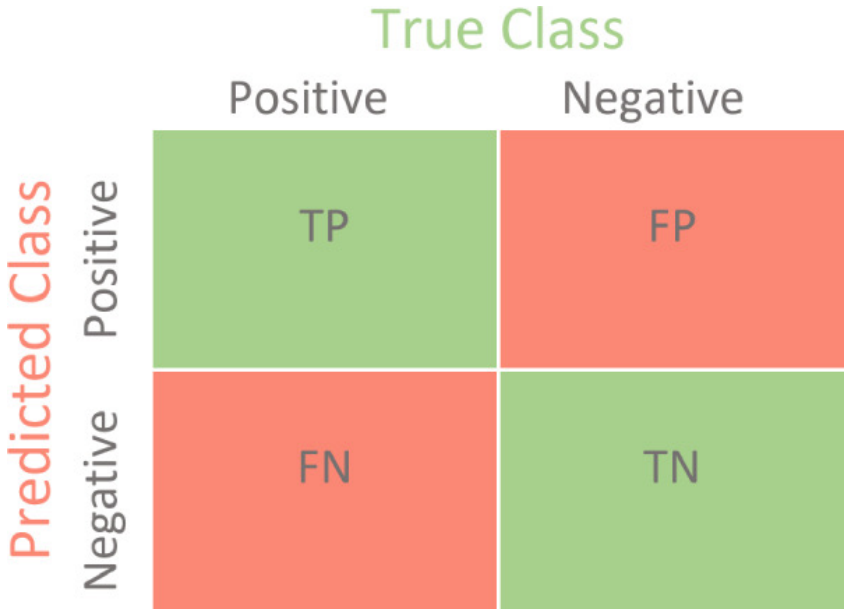
Fig. 10. Result of various stereo methods on Baby1 image pairs under various illuminations and exposures. (a) Left image. (b) Right image. (c) Ground truth. (d) AD. (e) ANCC. (f) LBP. (g) SLBP.

V. D. Nguyen, D. D. Nguyen, T. T. Nguyen, V. Q. Dinh and J. W. Jeon, "Support Local Pattern and its Application to Disparity Improvement and Texture Classification," in IEEE Transactions on Circuits and Systems for Video Technology, vol. 24, no. 2, pp. 263-276, Feb. 2014, doi: 10.1109/TCSVT.2013.2254898.

Visualization and Analysis

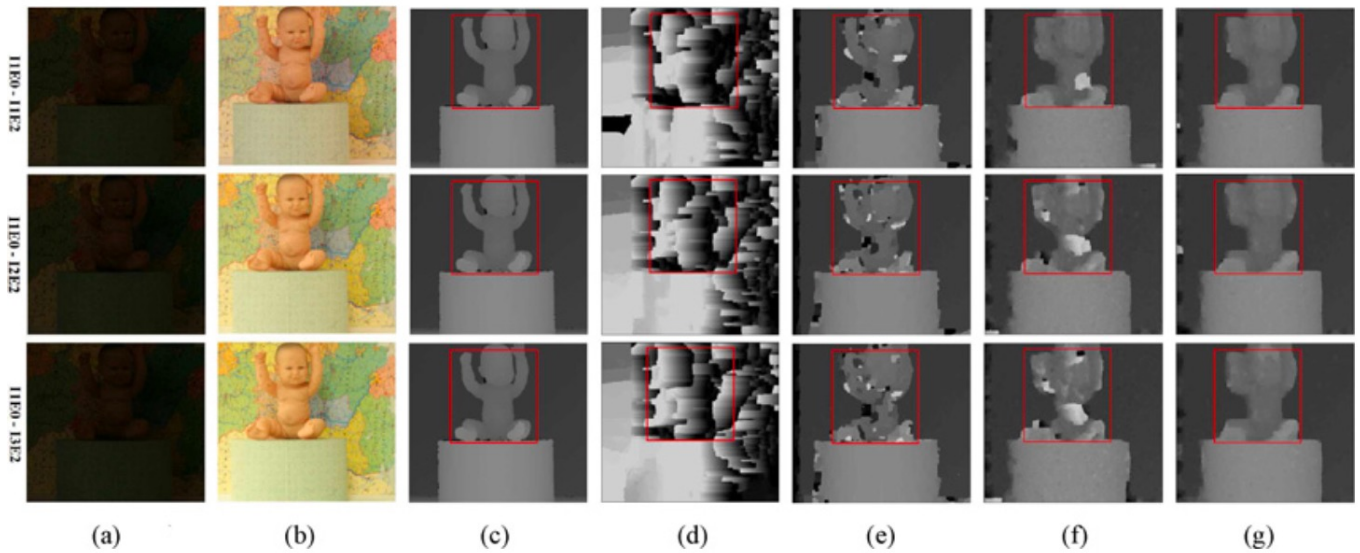
- Use visualizations to understand the behavior of your method. This could include confusion matrices, ROC curves, learning curves, etc.
- Conduct a detailed analysis of model errors to identify patterns or trends that may indicate areas for improvement.





Robustness Testing

•Evaluate the robustness of your method by testing it under various conditions, such as different input data distributions, noise levels, or adversarial attacks.



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V. D. Nguyen, D. D. Nguyen, T. T. Nguyen, V. Q. Dinh and J. W. Jeon, "Support Local Pattern and its Application to Disparity Improvement and Texture Classification," in IEEE Transactions on Circuits and Systems for Video Technology, vol. 24, no. 2, pp. 263-276, Feb. 2014, doi: 10.1109/TCSVT.2013.2254898.

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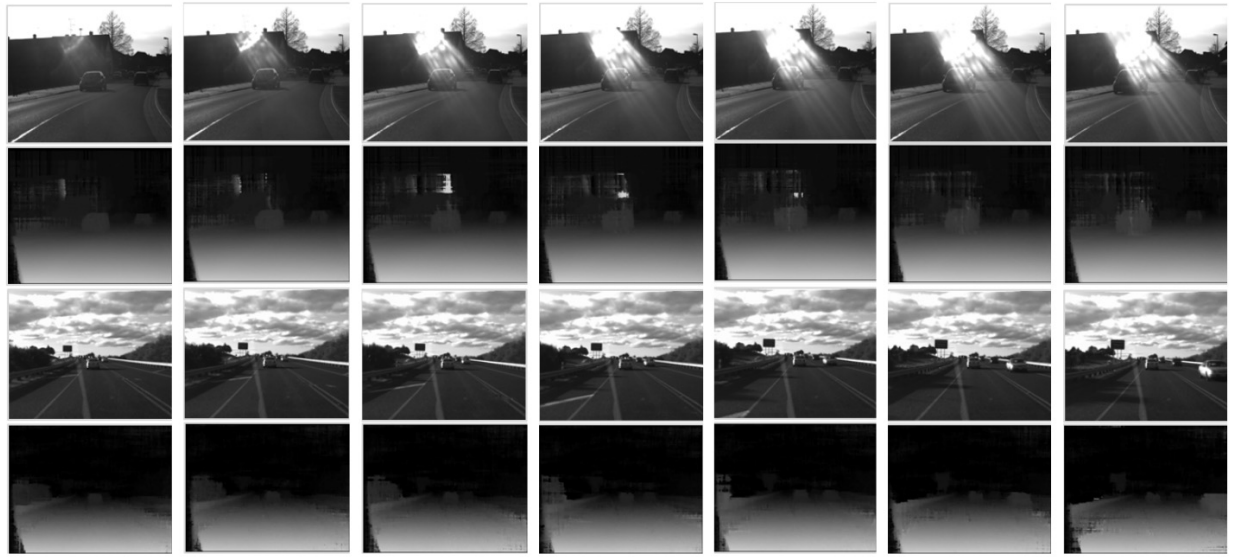


Fig. 16. First and second rows show sun flare sequences (frames #000003–#000008) in the HCI data set and corresponding disparity results of SGM+LDE, respectively. The third and fourth rows are brightness difference sequences (frames #134–#140) in the EISAT data set and corresponding disparity results of SGM+LDE, respectively.

V. D. Nguyen, D. D. Nguyen, S. J. Lee and J. W. Jeon, "Local Density Encoding for Robust Stereo Matching," in IEEE Transactions on Circuits and Systems for Video Technology, vol. 24, no. 12, pp. 2049-2062, Dec. 2014, doi: 10.1109/TCSVT.2014.2334053.

Real-world Validation

•If possible, validate your method in a real-world setting. This might involve deploying your model in a relevant environment and monitoring its performance over time.

Fig. 8. Configuration of the proposed system, which includes a stereo camera, FPGA, PC, and monitor, which are attached to the experiment vehicle.

Fig. 10. Experimental results of the proposed system-based ZF basenet under various road conditions using the extended CCD stereo dataset.

V. D. Nguyen, D. T. Tran, J. Y. Byun and J. W. Jeon, "Real-Time Vehicle Detection Using an Effective Region Proposal-Based Depth and 3-Channel Pattern," in IEEE Transactions on Intelligent Transportation Systems, vol. 20, no. 10, pp. 3634-3646, Oct. 2019, doi: 10.1109/TITS.2018.2877200.

Computational Efficiency

Consider the computational efficiency of the stereo matching method. Evaluate the processing time and resource requirements, especially if the method is intended for real-time applications.

	Method	Setting	Code	D1-bg	D1-fg	D1-all	Density	Runtime	Environment
1	MoCha-Stereo			1.36 %	2.43 %	**1.53 %**	100.00 %	0.27 s	NVIDIA Tesla A6000 (PyTorch)
2	DiffuVolume			1.35 %	2.51 %	1.54 %	100.00 %	0.36 s	GPU @ 2.5 Ghz (Python)
3	GANet+ADL			1.38 %	2.38 %	1.55 %	100.00 %	0.67s	NVIDIA RTX 3090 (PyTorch)
4	Selective-IGEV			1.33 %	2.61 %	1.55 %	100.00 %	0.24 s	1 core @ 2.5 Ghz (Python)
5	MC-Stereo			1.36 %	2.51 %	1.55 %	100.00 %	0.40 s	1 core @ 2.5 Ghz (Python)
6	IGEV-ICGNet			1.38 %	2.55 %	1.57 %	100.00 %	0.18 s	NVIDIA Tesla A5000 (Pytorch)
7	yjlig			1.37 %	2.62 %	1.58 %	100.00 %	0.35 s	1 core @ 2.5 Ghz (C/C++)
8	MDA			1.37 %	2.64 %	1.58 %	100.00 %	0.32 s	1 core @ 2.5 Ghz (Python)
9	UGNet			1.34 %	2.77 %	1.58 %	100.00 %	0.2 s	GPU @ 3.0 Ghz (Python)
10	Any-IGEV			1.43 %	2.35 %	1.58 %	100.00 %	0.32 s	GPU @ 2.5 Ghz (Python)
11	OpenStereo-IGEV		code	1.44 %	**2.31 %**	1.59 %	100.00 %	0.18 s	NVIDIA-3090

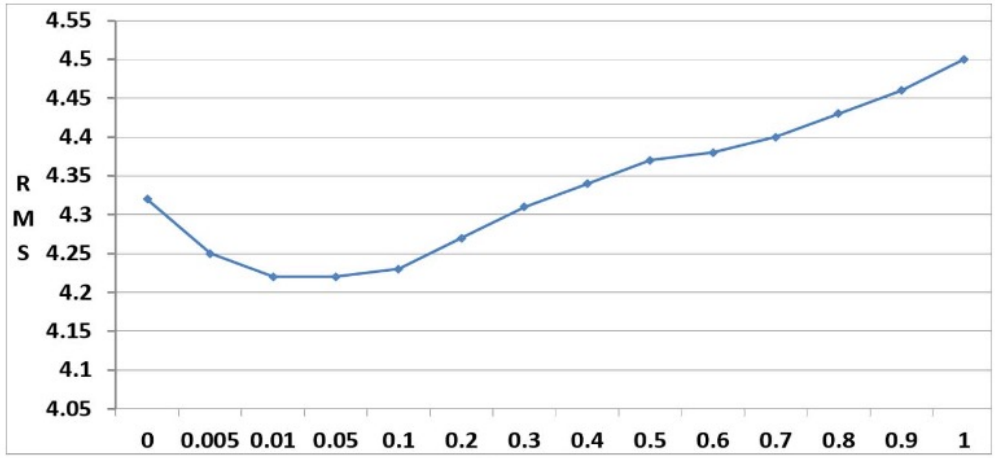
https://www.cvlibs.net/datasets/kitti/

Parameter Sensitivity Analysis

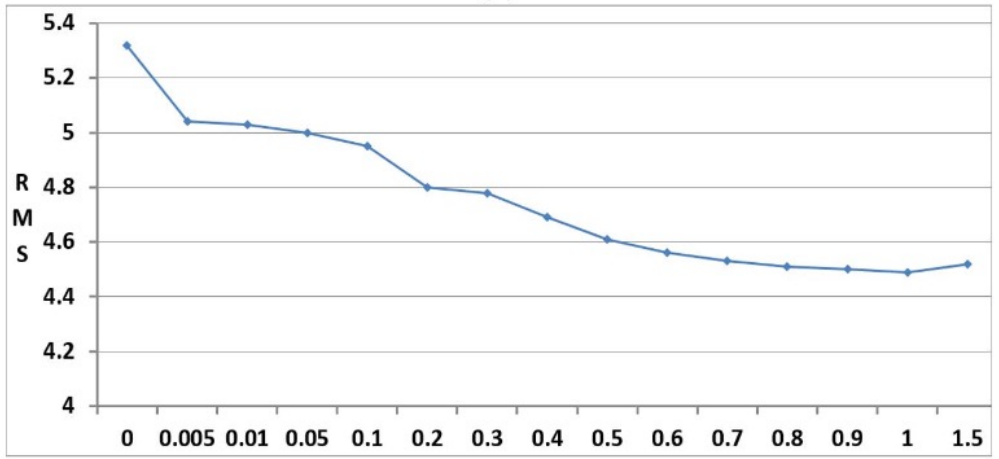
Parameter Sensitivity Analysis

Conduct a sensitivity analysis on key parameters of the stereo matching algorithm. Determine how changes in parameters affect the overall performance.

V. D. Nguyen, D. D. Nguyen, S. J. Lee and J. W. Jeon, "Local Density Encoding for Robust Stereo Matching," in IEEE Transactions on Circuits and Systems for Video Technology, vol. 24, no. 12, pp. 2049-2062, Dec. 2014, doi: 10.1109/TCSVT.2014.2334053.



(a)



(b)

Fig. 18. (a) Performance of LDE when ψ is fixed and φ varies. (b) Performance of LDE when φ is fixed and ψ varies.

Documentation and Reproducibility

Document your experimental setup, including code, parameters, and configurations, to ensure that your experiments are reproducible. This is crucial for the scientific community to validate and build upon your work.

TABLE III
AVERAGE DRS AND FA RATES OF OUR PROPOSED ALGORITHM IN COMPARISON WITH GENETIC SYSTEMS [7], FEATURE SYSTEMS [17], STIXEL SYSTEM [28], AND MOTION SYSTEMS [37]

Seq.	Configuration	Illumination	# images	Feature system		Genetic system		Motion system		Stixel System		Our system	
				DR(%)	FA(%)	DR(%)	FA(%)	DR(%)	FA(%)	DR(%)	FA(%)	DR(%)	FA(%)
SQ01	b35,f16	Normal	110	92	8	92	8	93	3	95	1	100	0
SQ02	b60,f25	Normal	310	91	5	89	7	92	5	94	2	97	3
SQ03	**b60,f25**	**Low, changed**	**76**	**78**	**7**	**75**	**5**	**82**	**6**	**85**	**6**	**90**	**3**
SQ04	b60,f25	Normal	115	89	3	80	7	95	7	98	2	100	0
SQ05	b35,f25	Low	225	80	4	85	3	94	3	95	3	96	4
SQ06	**b60,f16**	**High, changed**	**85**	**82**	**8**	**79**	**6**	**85**	**4**	**88**	**4**	**91**	**4**
SQ07	b35,f16	Normal	197	88	4	84	4	96	2	98	2	98	2
SQ08	b35,f16	Normal	126	90	6	86	9	92	3	100	3	97	5
SQ09	**b35,f16**	**Low, changed**	**597**	**79**	**7**	**89**	**11**	**92**	**5**	**93**	**2**	**98**	**2**
SQ10	b35,f16	High	754	85	5	90	8	96	2	100	4	95	3
SQ11	b35,f16	High	800	87	11	85	9	92	6	98	5	94	4
SQ12	b35,f16	High	505	82	15	79	16	92	5	97	3	97	3
Average				**85.25**	**6.92**	**84.42**	**7.75**	**91.75**	**4.25**	**95.58**	**3.08**	**96.08**	**2.75**

Parameter	Search space	Selected value
Weight decay	[0.0001, 0.001]	0.0002
Dropout	[0, 0.333]	0.15
Pool method	'max', 'average'	'max'
Kernel initializer	'glorot', 'he', 'normal', 'uniform'	'glorot'
Optimizer	'SGD', 'Adam'	'SGD'
Learning rate	[0.001, 0.1]	0.05
Learning schedule	'constant', 'step decay', 'exponential decay'	'step decay'
Epochs	[30,150]	100
Batch size	32, 64, 128, 256, 512, 1024	512

Peer Review

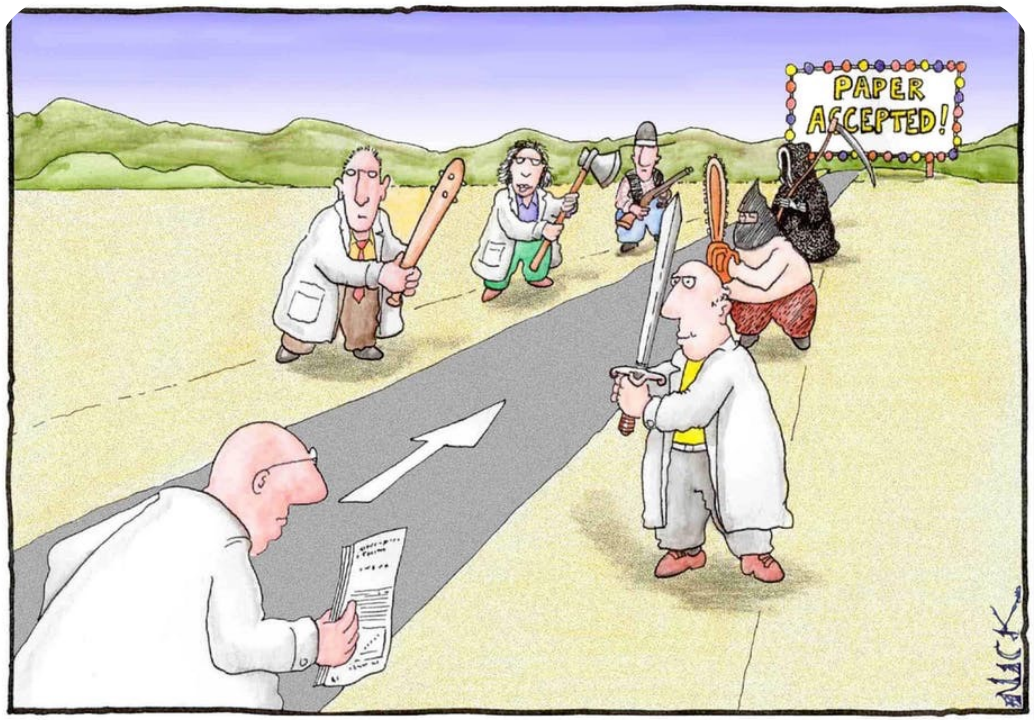
Submit your work for peer review. The feedback from experts in your field can provide valuable insights and help improve the rigor and quality of your evaluation.

Outline

- Performance Evaluation in Detail
- Enough Contributions for Submission
- How to Find Suitable Journal/Conference
- Plan to Write a Scientific Research Paper
- Assignment

Enough Contributions for Submission?

Getting your conference or journal paper accepted involves a combination of factors, including the quality of your research, writing, and presentation



Most scientists regarded the new streamlined peer-review process as "quite an improvement."

Enough Contributions for Submission?

Deciding whether a research paper represents a sufficient contribution for submission to a conference or journal involves assessing the novelty, significance, and completeness of the work

Novelty

Clearly identify and articulate the novelty of your work. Consider whether your research introduces new ideas, concepts, methods, or applications that advance the current state of knowledge in the field.

Literature Review

Ensure that your paper provides a thorough literature review that places your work in the context of existing research. Highlight the gaps in the literature that your work addresses and explain how your contribution fills these gaps.

Research Question and Objectives

Clearly state the research question or problem your paper addresses and outline the specific objectives. Ensure that the objectives align with the overall goal of making a meaningful contribution to the field.

Methodology

Detail the methodology used in your research. Explain the experimental setup, data collection process, and any novel techniques or approaches employed. This section should be comprehensive enough for others to replicate your work.

Enough Contributions for Submission?

Deciding whether a research paper represents a sufficient contribution for submission to a conference or journal involves assessing the novelty, significance, and completeness of the work

Results and Analysis

Present your results in a clear and organized manner. Include visualizations, statistical analyses, or other relevant methods to support your findings. Discuss the implications of your results and how they contribute to the field.

Comparisons and Baselines

If applicable, compare your results with existing methods, baselines, or state-of-the-art approaches. Highlight the strengths and weaknesses of your approach and explain how it advances beyond the current state of the art.

Discussion

Provide a thorough discussion of your results, drawing connections between your findings and the existing literature. Discuss any unexpected outcomes, limitations, and potential future directions for research in your area.

Adherence to Guidelines

Follow the submission guidelines provided by the conference or journal rigorously. Ensure that your paper meets all formatting and length requirements.

New and Original Contribution

In research, a new and original contribution refers to a novel idea, concept, method, insight, or discovery that advances the current state of knowledge in a particular field

Innovative Approach or Methodology

•Introducing a new and innovative research methodology or approach to solve a problem can be a significant contribution. This could involve developing a new experimental technique, data analysis method, or computational algorithm.

Novel Insights or Observations

•Providing new insights or observations that challenge existing theories or expand our understanding of a phenomenon is a valuable contribution. This might involve *uncovering unexpected patterns, relationships, or trends in data*.

Development of New Theories or Models

•Proposing a *new theoretical framework* or model that *explains phenomena more accurately* or comprehensively than existing models contributes to the theoretical foundation of a field.

New and Original Contribution

In research, a new and original contribution refers to a novel idea, concept, method, insight, or discovery that advances the current state of knowledge in a particular field

Creation of New Tools or Technologies

•Developing *new tools, technologies, or instruments* that enable researchers to *explore, measure, or analyze phenomena* in ways not previously possible can be a groundbreaking contribution.

Synthesis of Existing Knowledge

•*Integrating* and *synthesizing existing knowledge from disparate sources to generate a new conceptual framework* or theory can be a valuable contribution. This involves bringing together diverse ideas in a coherent and meaningful way.

Application in a Novel Context

•Applying *existing theories, methods, or technologies to a new and unexplored context can be considered a contribution*, especially if it yields insights that were not apparent in the original context.

New and Original Contribution

In research, a new and original contribution refers to a novel idea, concept, method, insight, or discovery that advances the current state of knowledge in a particular field

Addressing an Unmet Need or Problem

•*Identifying and addressing a previously unmet need or problem in a field can be a significant contribution*. This might involve solving practical challenges, *improving efficiency*, or addressing gaps in current knowledge.

Verification or Refutation of Existing Findings

•Conducting rigorous experiments or studies to verify or refute existing findings is a valuable contribution. This adds to the reliability and robustness of knowledge in a given area.

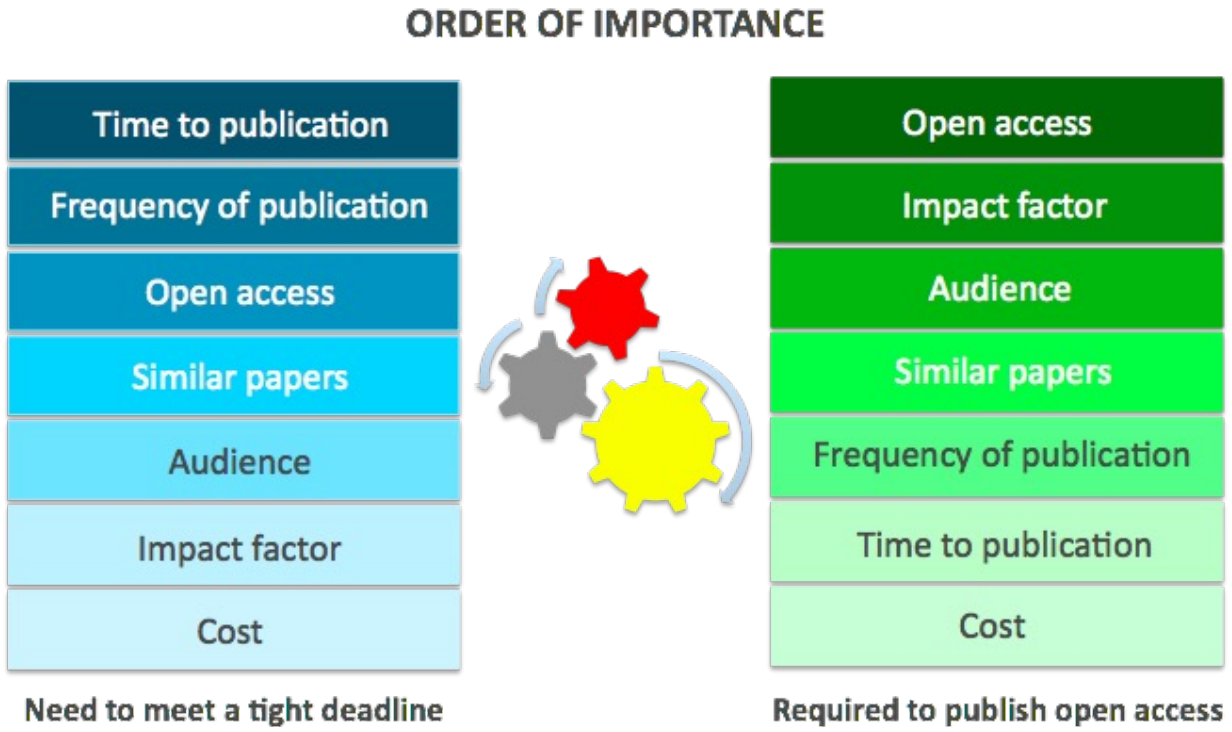
Cross-Disciplinary Connections

•Making connections between seemingly unrelated fields and applying concepts or methods from one discipline to another can lead to innovative solutions and contribute to the advancement of both fields.

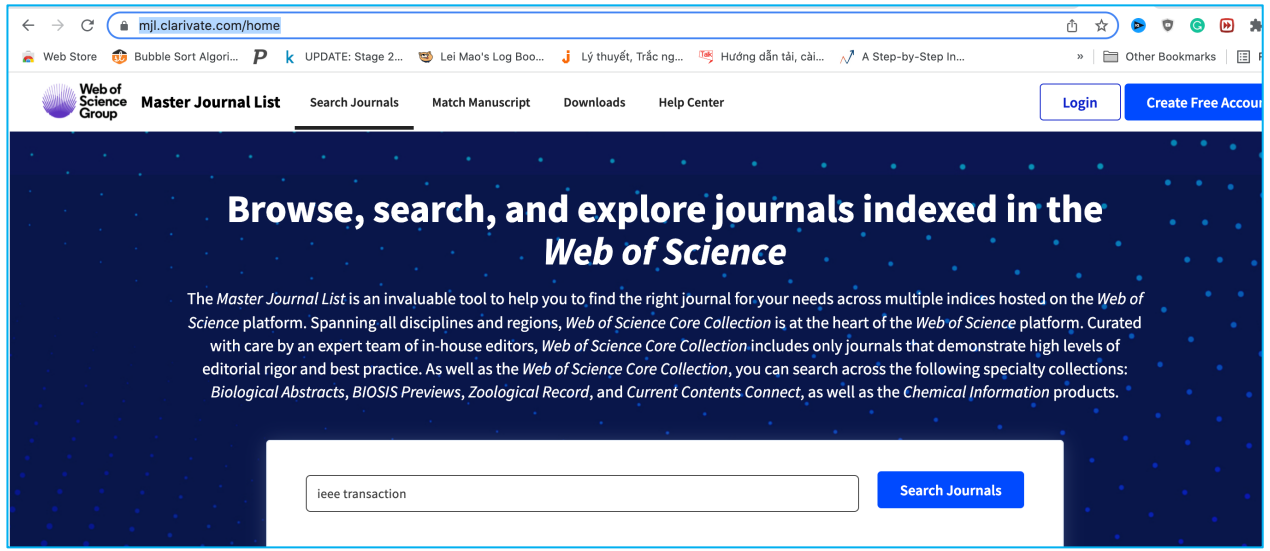
Outline

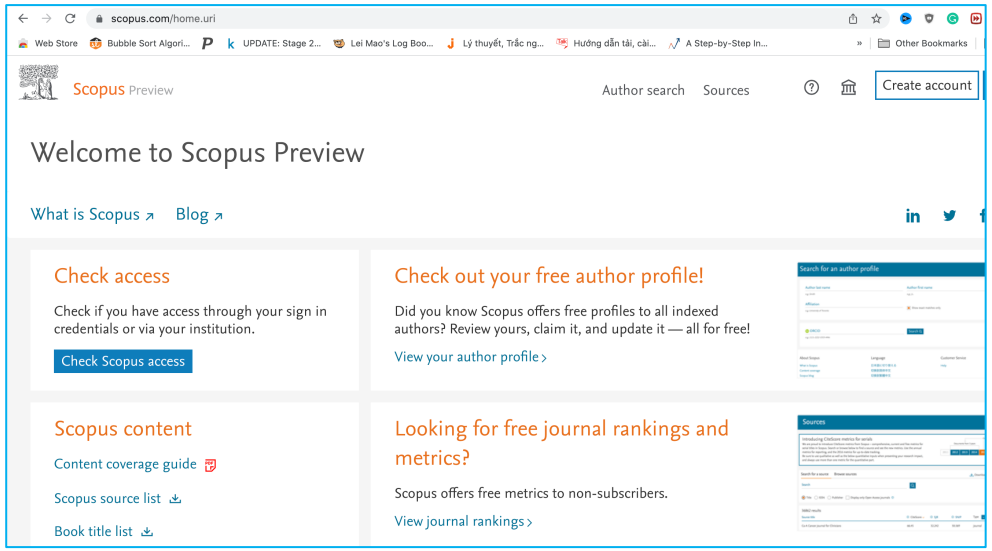
- Performance Evaluation in Detail
- Enough Contributions for Submission
- How to Find Suitable Journal/Conference
- Plan to Write a Scientific Research Paper
- Assignment

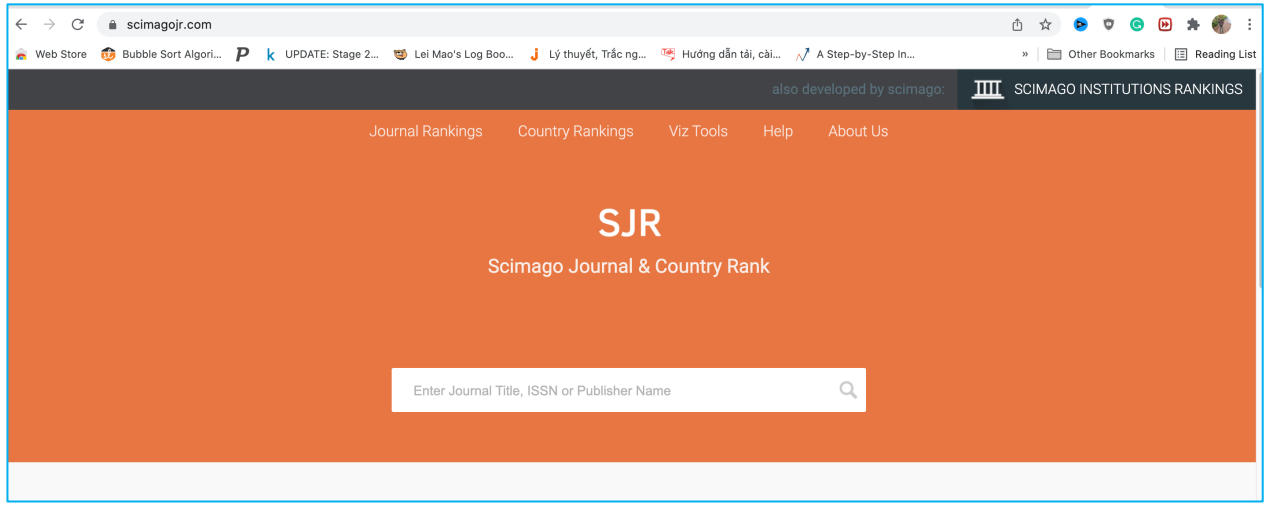
How to select a good conf./journal

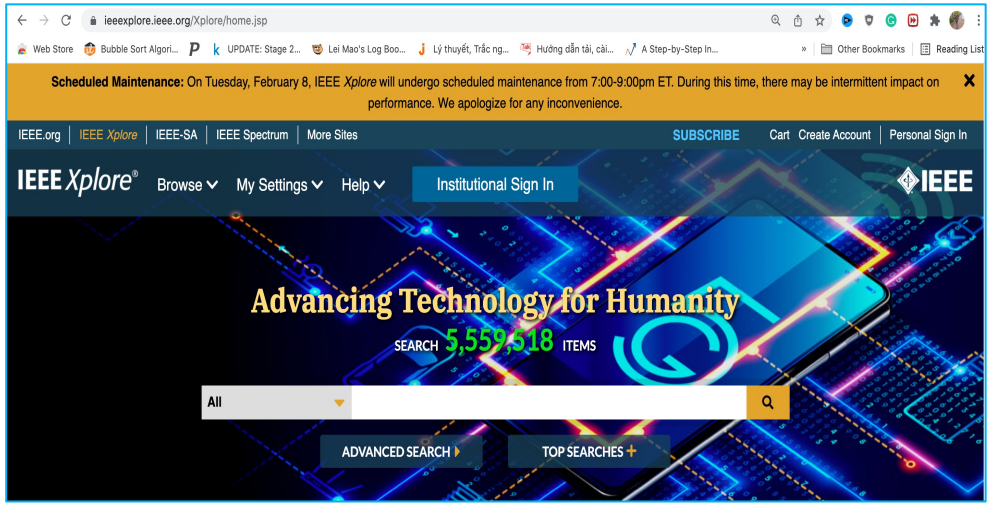


How to select a good conf./journal









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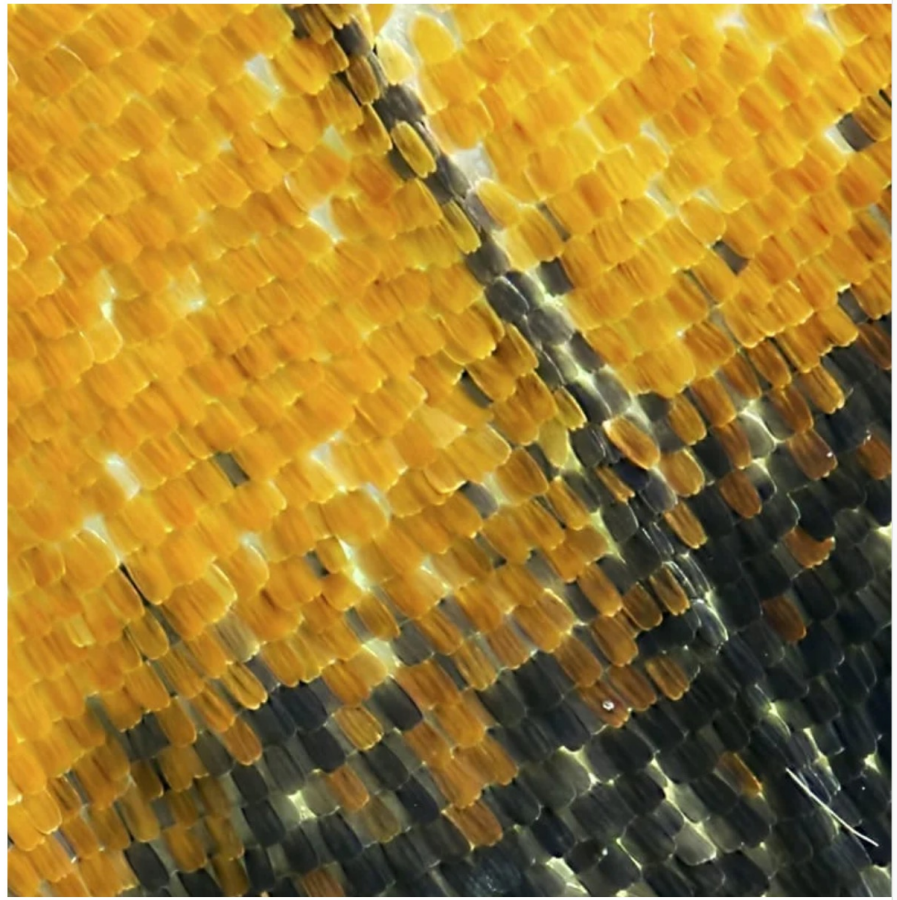

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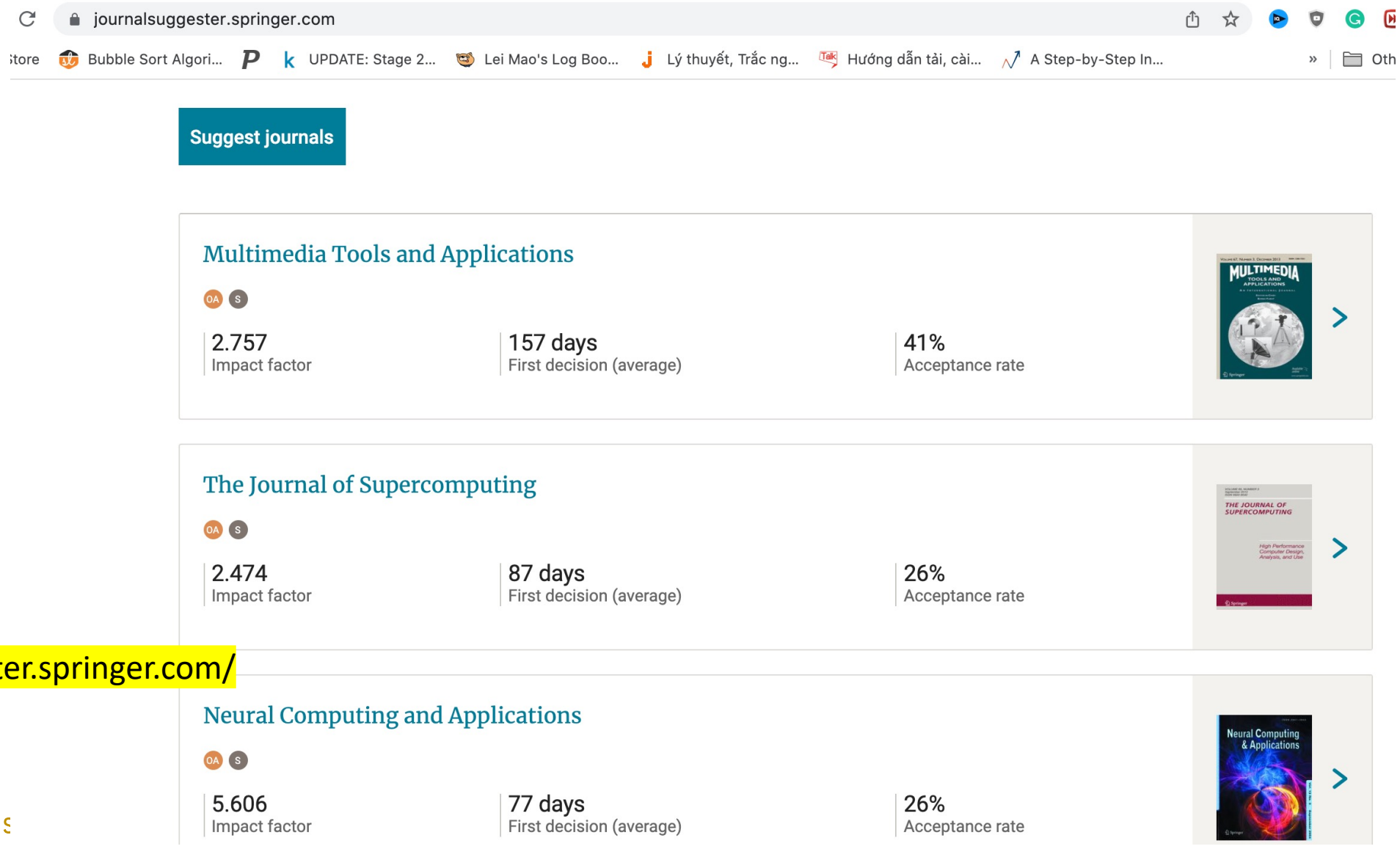

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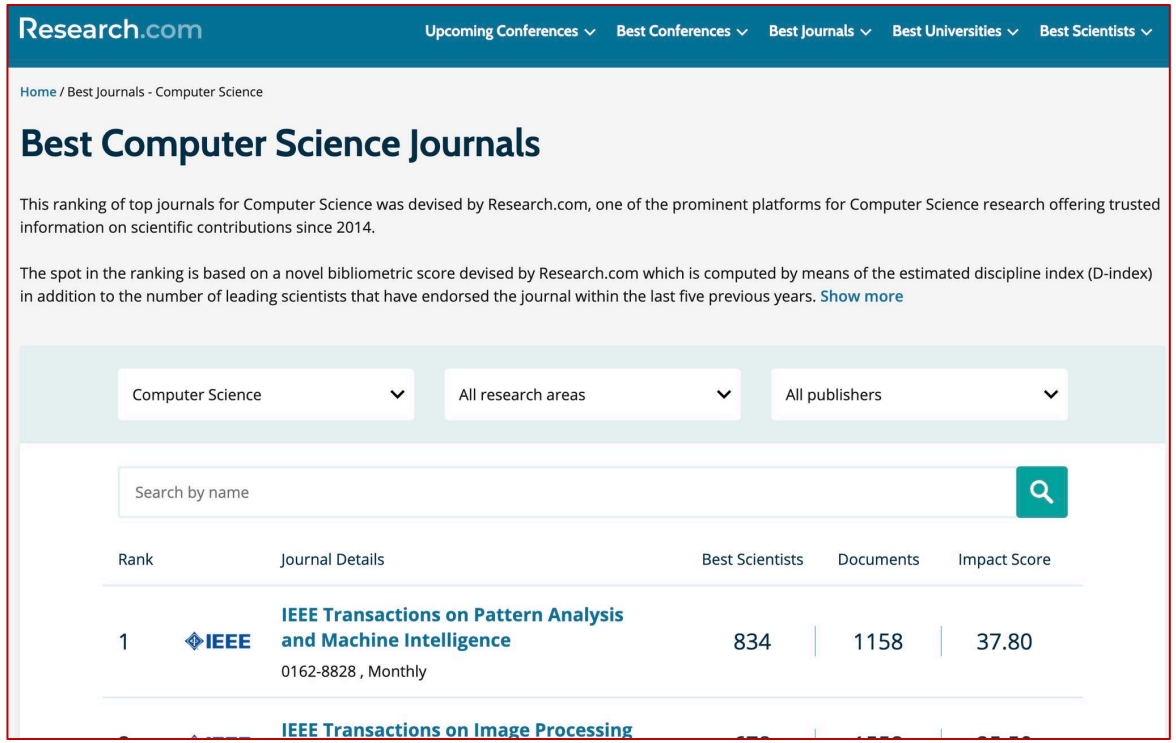

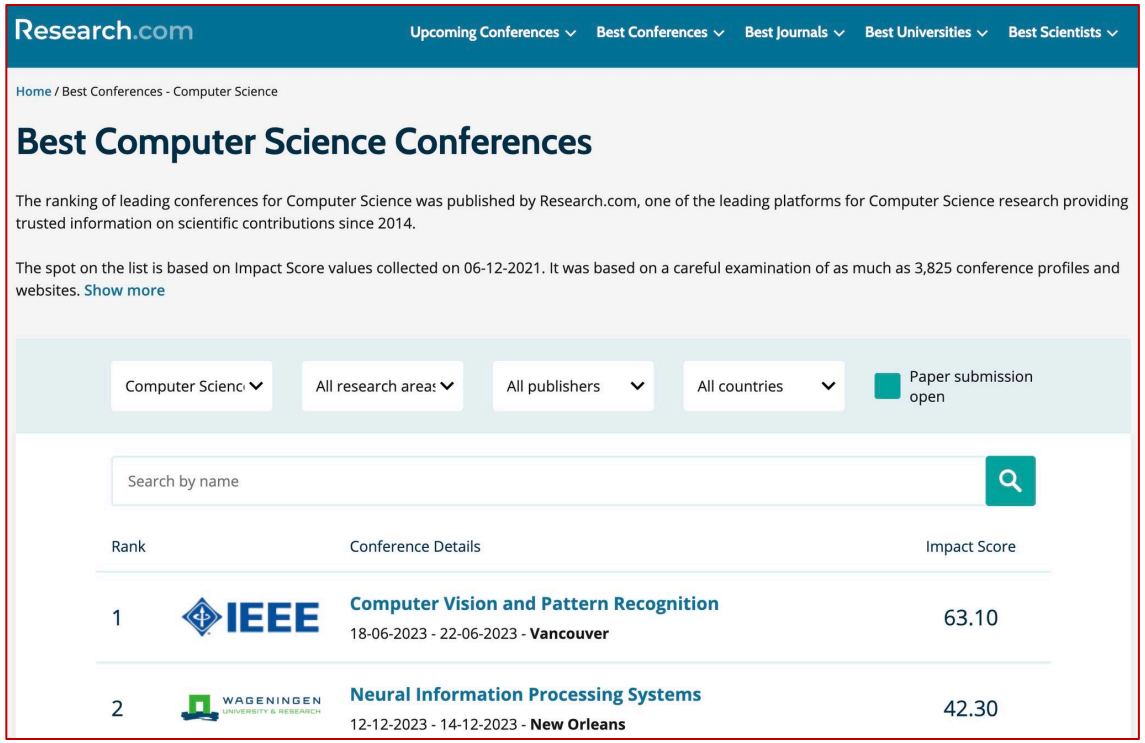

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- How to Find Suitable Journal/Conference
- Plan to Write a Scientific Research Paper
- Assignment

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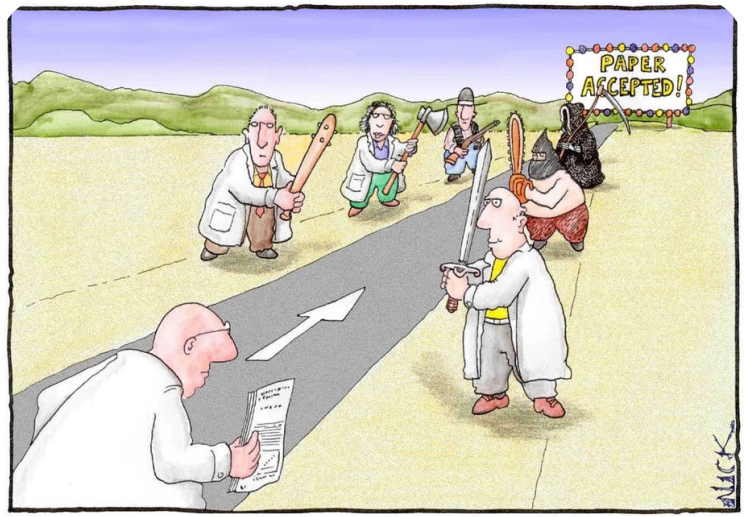

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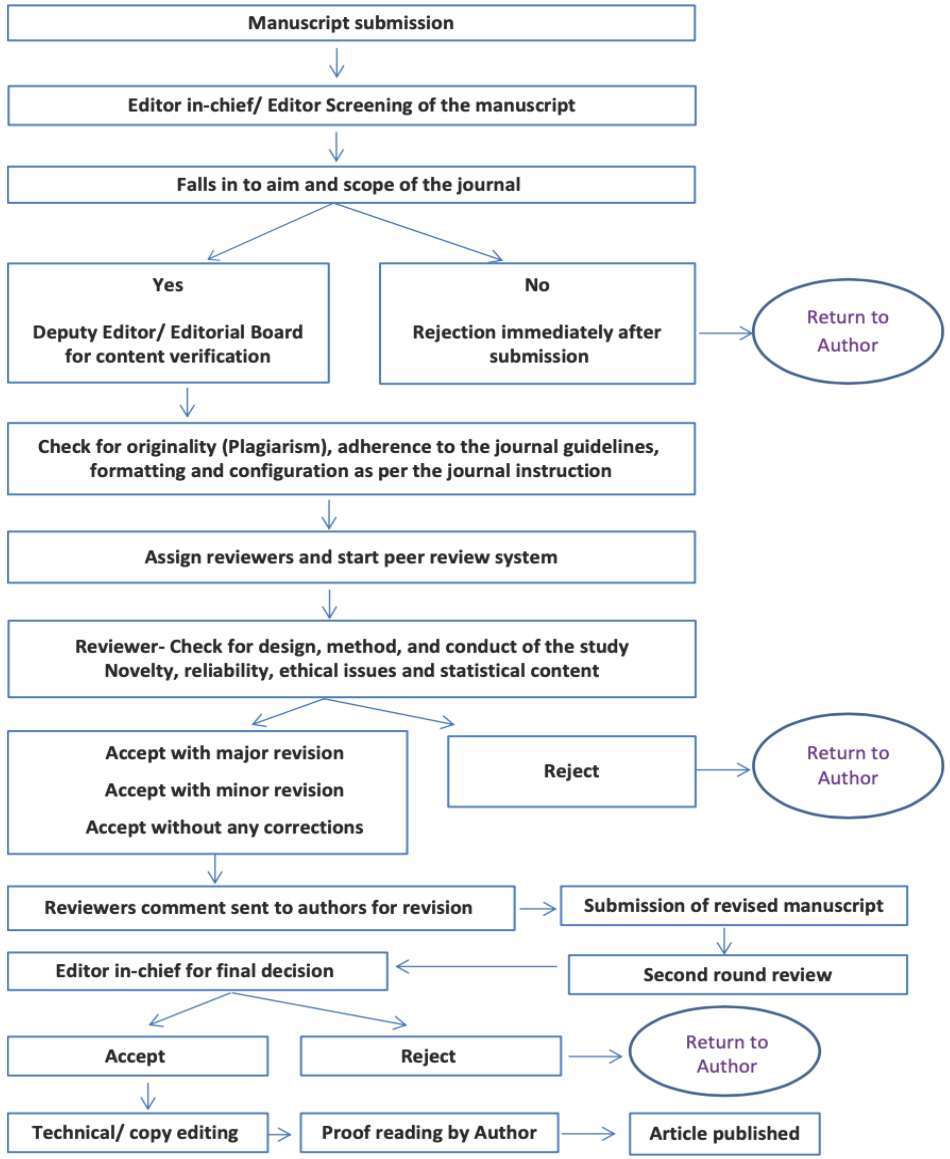

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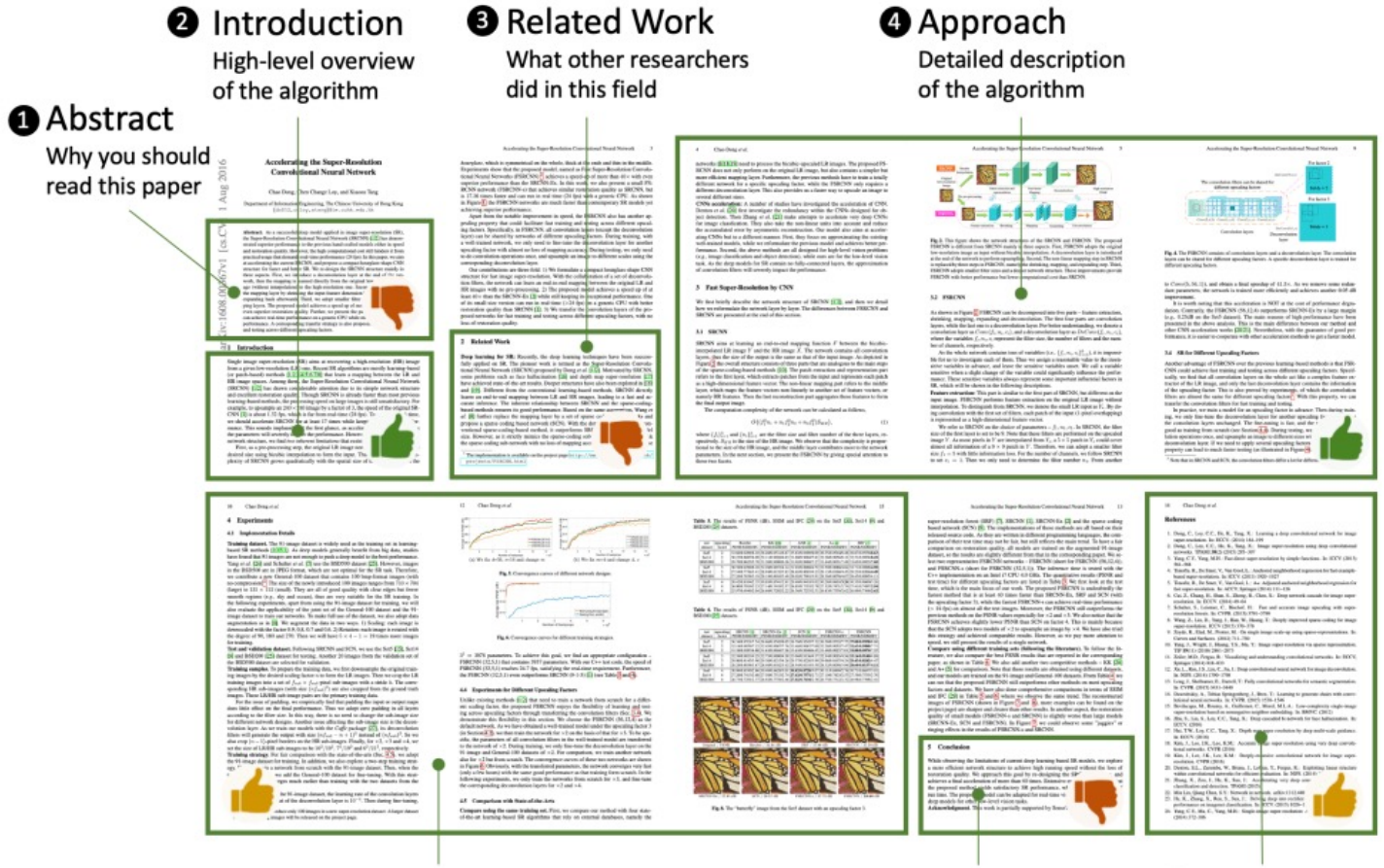

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Michael Shell, *Member, IEEE,* John Doe, *Fellow, OSA,* and Jane Doe, *Life Fellow, IEEE*

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II. Conclusion

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Proof of the First Zonklar Equation

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Appendix B

Appendix two text goes here.

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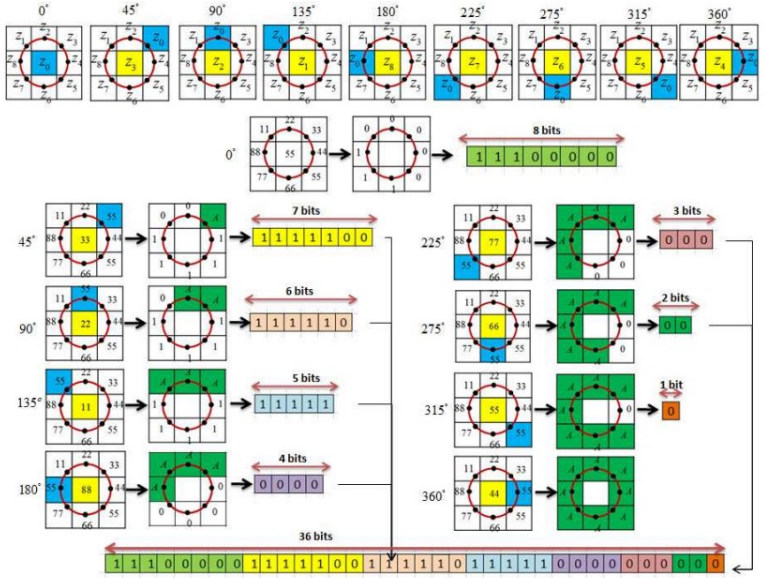

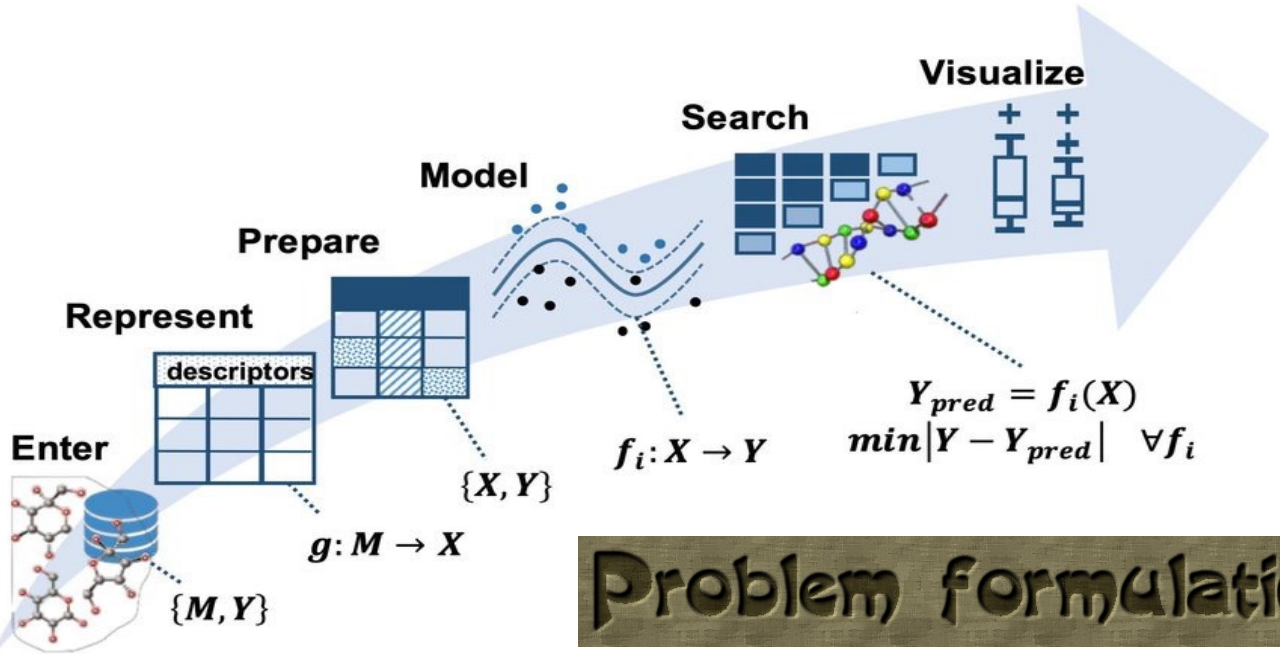

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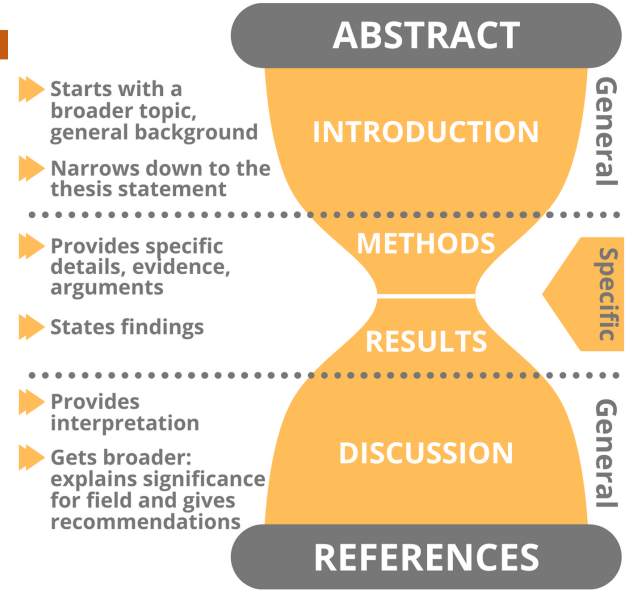


$$
\begin{cases}
F^{(1)} = -C_{\mathrm{de}} G_{\mathrm{de}}^{(1)} + C_l G_l^{(1)} + C_r G_r^{(1)} + C_{\mathrm{to}} G_{\mathrm{to}}^{(1)} + C_b G_b^{(1)} \\
\qquad + C_d G_d^{(1)} + C_{\mathrm{rd}} G_{\mathrm{rd}}^{(1)} + C_m G_m^{(1)} + C_{\mathrm{pos}} G_{\mathrm{pos}}^{(1)} \\
\cdots \\
F^{(k)} = -C_{\mathrm{de}} G_{\mathrm{de}}^{(k)} + C_l G_l^{(k)} + C_r G_r^{(k)} + C_{\mathrm{to}} G_{\mathrm{to}}^{(k)} + C_b G_b^{(k)} \\
\qquad + C_d G_d^{(k)} + C_{\mathrm{rd}} G_{\mathrm{rd}}^{(k)} + C_m G_m^{(k)} + C_{\mathrm{pos}} G_{\mathrm{pos}}^{(k)} \\
\cdots \\
F^{(N)} = -C_{\mathrm{de}} G_{\mathrm{de}}^{(N)} + C_l G_l^{(N)} + C_r G_r^{(N)} + C_{\mathrm{to}} G_{\mathrm{to}}^{(N)} + C_b G_b^{(N)} \\
\qquad + C_d G_d^{(N)} + C_{\mathrm{rd}} G_{\mathrm{rd}}^{(N)} + C_m G_m^{(N)} + C_{\mathrm{pos}} G_{\mathrm{pos}}^{(N)} .
\end{cases}
\tag{18}
$$

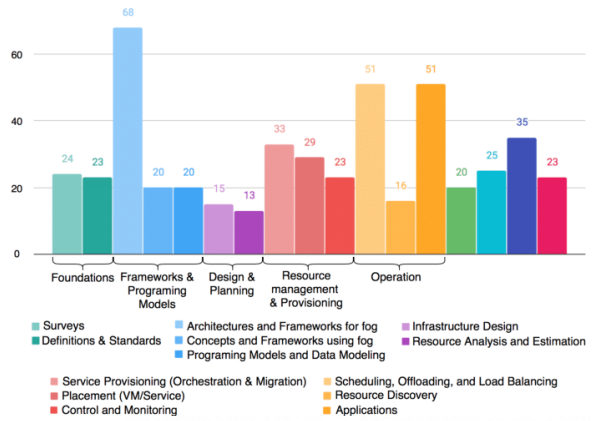
Problem formulation

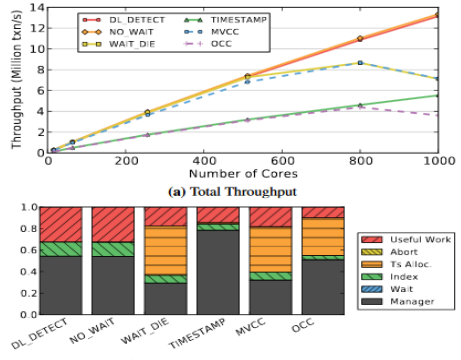
Solution formulation

How to write Experimental result

TABLE II
BENCHMARK OF STATE-OF-THE-ART AND PROPOSED METHODS (DR AND MDD)

Author	DR %	Detection direction	Processing time(ms)	MDD (m)
Nedevschi [3]	94	Front and rear	100	90
Yi-Min Tsai [10]	97.1	Rear	970	140
Toulminet [17]	90	Rear	95	100
[illegible]	[illegible]	Front and rear	50	105
[illegible]	[illegible]	Front and rear	155.5	70.58
Nedevschi [34]	98.89	Front and rear	23	N/A
[illegible] [47]	93.75	Rear	57	88
[illegible]	95.6	Rear	510	89
[illegible]	85	Front and rear	47	105
[illegible]	93	Rear	96.9	90
[illegible]	98.5	Rear	2150.5	110
[illegible]	**96.08**	**Front and rear**	**48**	**140**

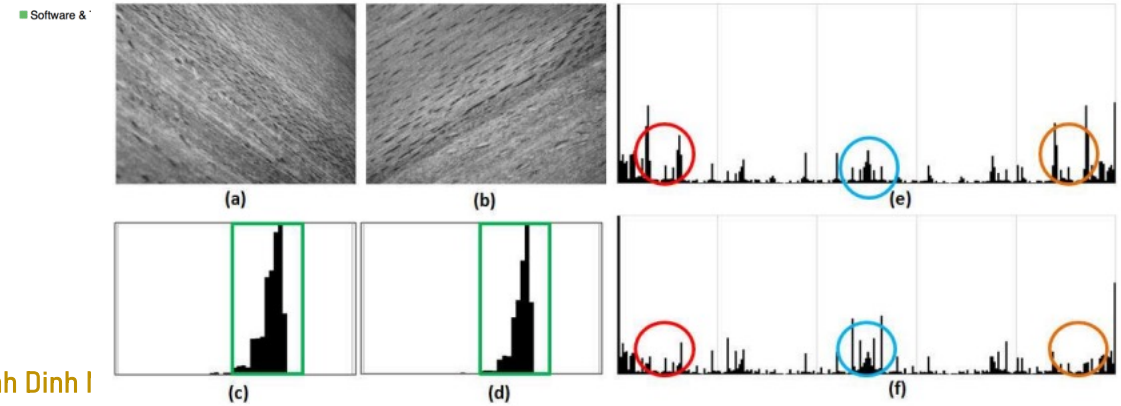




(a) Total Throughput

(b) Runtime Breakdown (1024 cores)

Figure 8: Read-only Workload – Results for a read-only YCSB workload.



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ABSTRACT

INTRODUCTION (General)
- Starts with a broader topic, general background
- Narrows down to the thesis statement

METHODS (Specific)
- Provides specific details, evidence, arguments
- States findings

RESULTS (Specific)

DISCUSSION (General)
- Provides interpretation
- Gets broader: explains significance for field and gives recommendations

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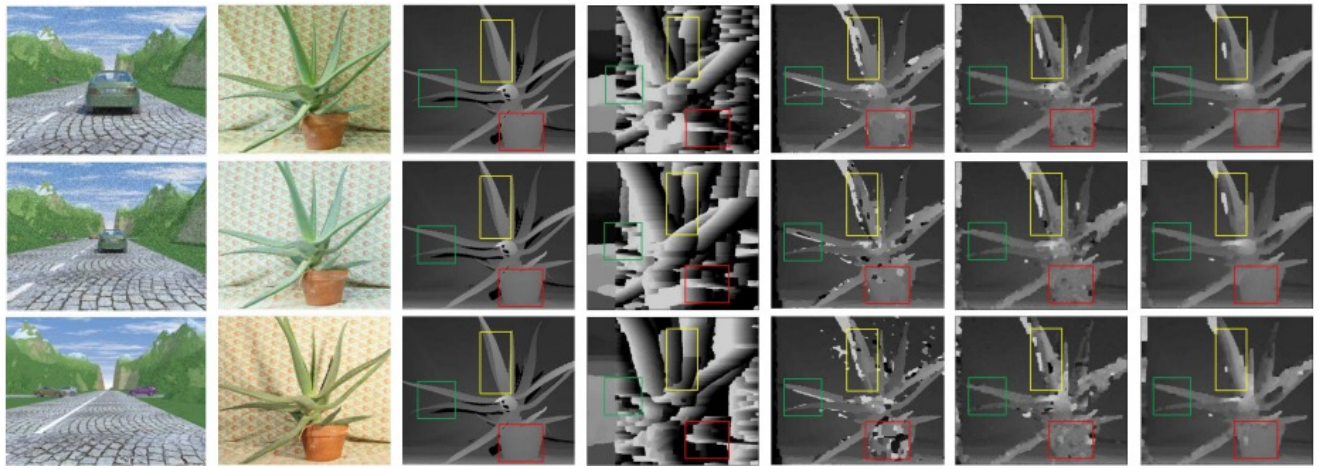

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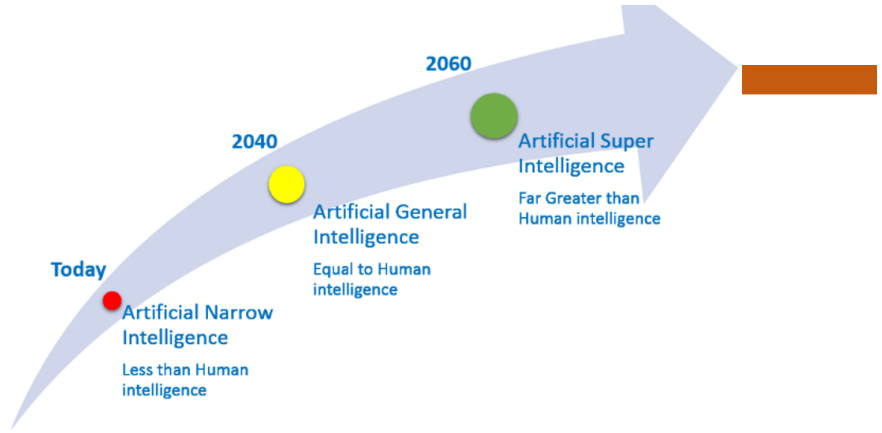

Figure 4: Future evolution of Artificial Intelligence

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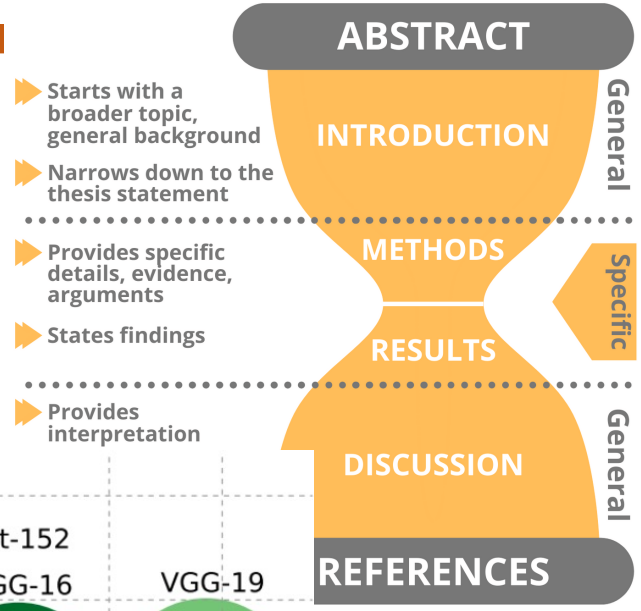
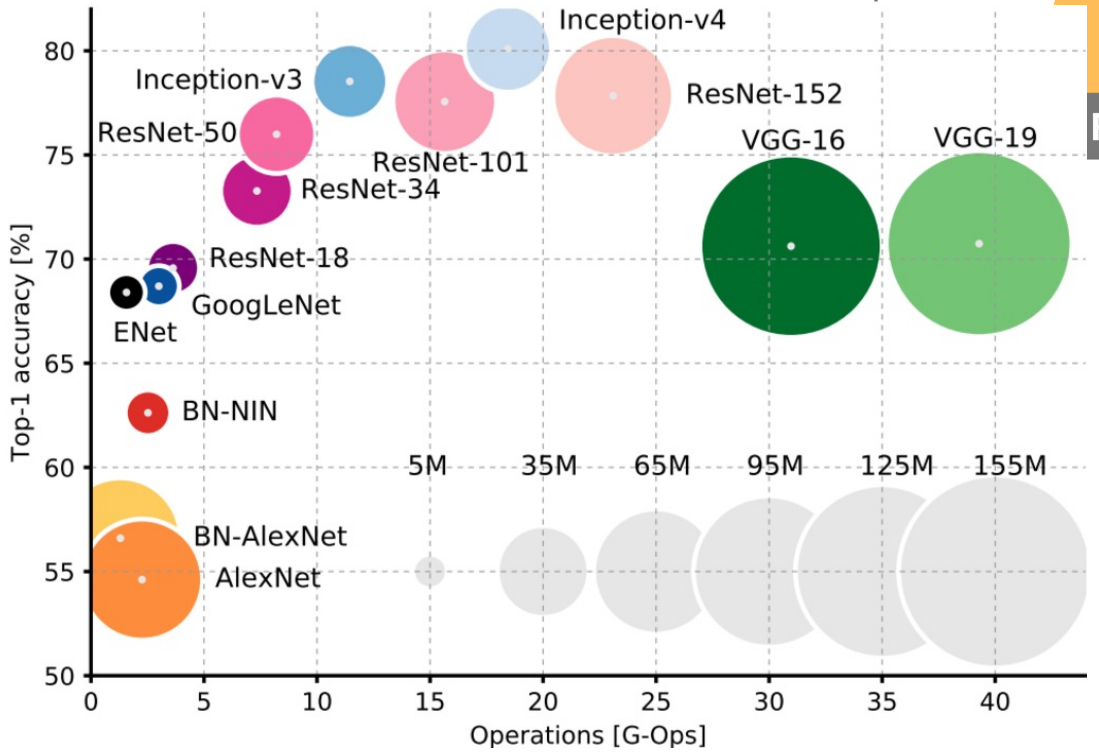


TABLE I
COMPARISON OF STEREO-VISION-BASED VDDE SYSTEMS

System	Stereo configuration	MDD	Stereo matching	Feature/Technique	Other
Nedevschi (2004) [3]	N/A	$90m$	SAD	3–D points grouping	Four additional sensors are used. Processing time: 100ms/frame
Pauplin (2005) [6]	N/A	N/A	N/A	Fly algorithm, Parisian approach	3-D point is randomly generated in ROI. Two CCD cameras are used. Processing time: 300ms/frame
Ruicheck (2004) [7]	N/A	N/A	Genetic-based	Genetic algorithm	Multi-level searching and edge information.Processing time: 400ms/frame
Knoeppel (2000) [15]	Focal length: $12mm$	$150m$	Cross correlation	3–D point extracting and clustering; Kalman filter	CMOS cameras
Bensrhair (2002) [16]	Baseline: $95cm$	N/A	DP applied on edge points	3–D edge shapes of roads, symmetry	CCD cameras used to obtain disparity; Processing time: 960ms/frame
Toulminet (2006) [17]	Focal length: $6mm$	$100m$	DP on edge points	3–D vertical features; symmetry; image correlation	Two stereo cameras used with monocular pattern analysis. Processing time: 95ms/frame
Jung (2007) [18]	Baseline: $30cm$	$60m$	Edge feature	Lane recognition; edge feature correlation	CMOS cameras
Huh (2008) [19]	Baseline: $15cm$	$65m$	Corner feature	Corner features; epipolar constraint; Kalman filter	Developed for highway circumstance
Southall (2009) [21]	Baseline: 7 inches ($17.78cm$)	$100m$	SAD	Edge features; Kalman filter	NTSC cameras
Kormann (2010) [22]	N/A	$30m$	SAD	Mean–shift clustering of plane fitted segments; U/V disparity	3–D data from disparity map is used to detect vehicles as cuboid. Processing time: 390ms/frame.
Hwang (2009) [23]	Baseline: $150m$	N/A	Edge feature based matching	Corner features; cross correlation; Kalman filter	Developed for highway circumstance. Processing time: 10ms/frame
Xu (2009) [24]	Baseline: $96cm$	N/A	SAD	Image symmetrical move	Symmetrical matching. Processing time: 155.5ms/frame. Detection rate: 85%
Chiu (2010) [25]	Baseline: $20cm$	$50m$	Horizontal and vertical line segments	Edge features; line segments	CMOS cameras; Asynchronous binocular system. Processing time: 30ms/frame. Detection rate: 90%
Franke (2011) [28]	Focal length: 830 pixels, Baseline: 35cm	N/A	SGM	Segmentation of the Dynamic Stixel World.	A Stixel is build by fusion of stereo and motion information. Processing time: 25ms/frame



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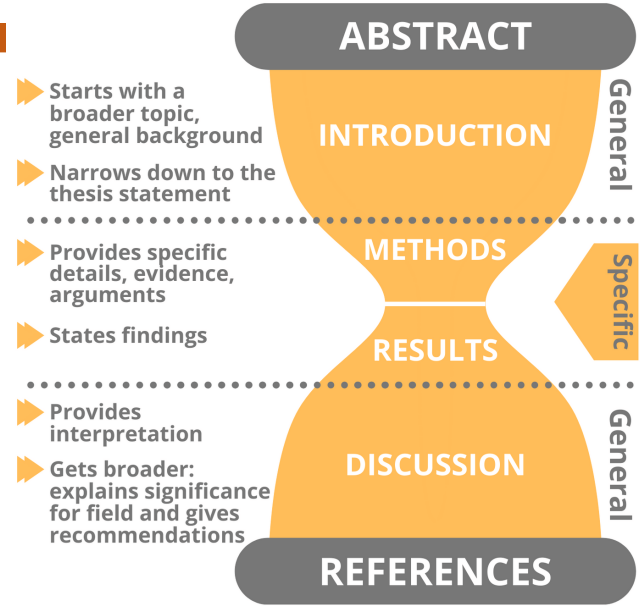

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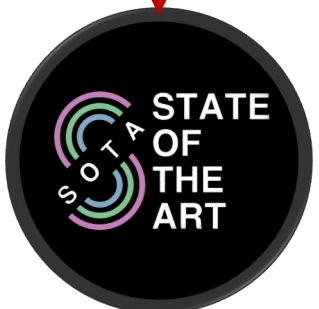

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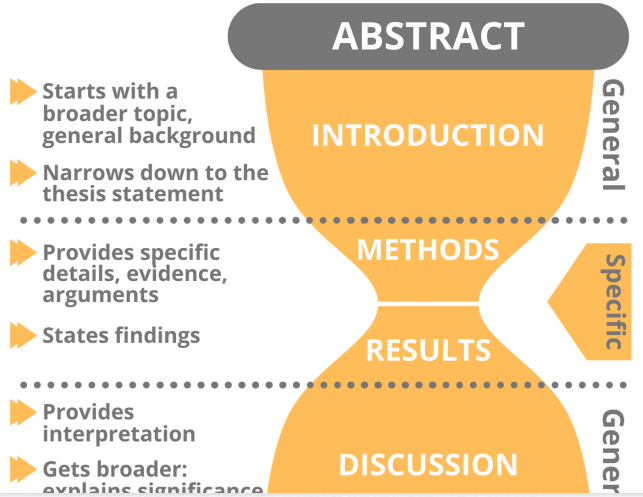

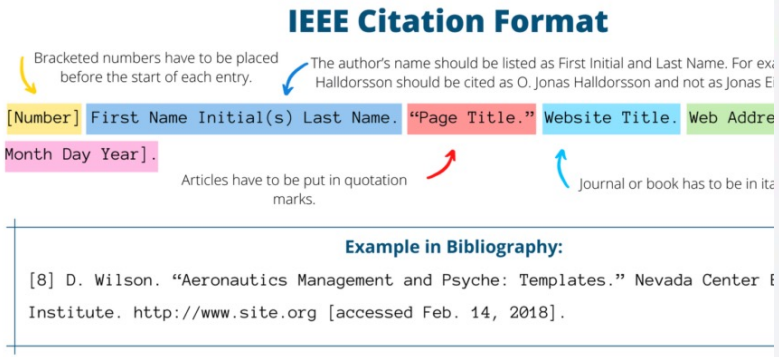

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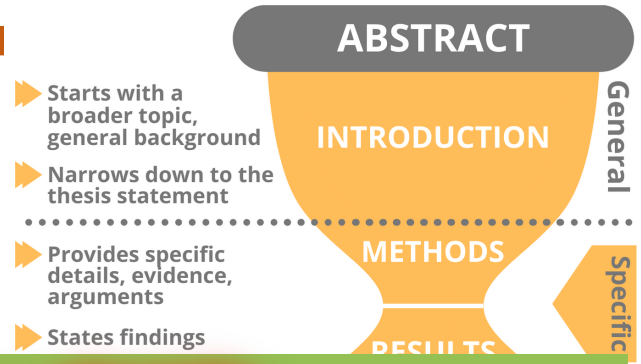

Support Local Pattern and Its Application to Disparity Improvement and Texture Classification

Vinh Dinh Nguyen, Dung Duc Nguyen, Thuy Tuong Nguyen, Vinh Quang Dinh and Jae Wook Jeon,
Member, IEEE

***Abstract*—The Local Binary Pattern (LBP) and its variants have been widely investigated in many image processing and computer vision applications due to their robust ability to capture local image structures and because of their computational simplicity. The existing LBPs extract local structure information by establishing a relationship between the central pixel and its adjacent pixels. However, most local binary patterns miss the relationship among all of the pixels in the local region. Therefore, this paper proposes a novel model to establish this relationship by introducing a support local binary pattern (SLBP). The proposed model improves the performance of the existing LBP methods and results in lower sensitivity to illumination changes and radiometric variations. Moreover, the proposed model has been successfully investigated in two applications: disparity map generation and texture classification. For disparity map generation, the proposed model reduces the root mean square error (RMS) by 23.6% (in Baby1 dataset, Middlebury), and 16.58% (in Aloe dataset, Middlebury) as compared with the standard LBP under radiometric variation conditions. Moreover, the proposed model reduces the RMS by 28.11% as compared with the standard LBP under the Gaussian noise condition in the ESATS dataset. For texture classification applications, the proposed model improves the classification results from 96.26% to 98.13% on the Outext database, from 88.03% to 91.41% on the Xu database, and from 94.00% to 96.67% on the KTH-TIPS database as compared with the completed local binary pattern (CLBP).**

***Index Terms*—Local Binary Pattern, Local Derivative Pattern, Completed Local Binary Pattern, Support Local Pattern.**

I. Introduction

variants into five main categories: multi-scale analysis, handling rotation, handling color, complementary descriptors, and feature selection and learning, as in [3]. Texture classification has been one of the most popular and successful applications that has used LBP during the past few years.

Texture classification is an application that is used to assign an unknown texture to the set of pre-defined textures. The assignment process can be based on the training of VZMR8, VZ_Joint [4] [5], or free training [6]. VZMR8 uses a pre-defined texton library that is constructed from a training set and a set of filter banks in order to classify the unknown texture. A texture data set is divided into two sets, one of which is for a sample model and one that is used for testing during the free training. In conventional LBP [1], a uniform pattern is used to extract the texture information. It achieves very good accuracy in texture classification by combining multiple-scale LBPs, which work well in the case of straight edges or low curvature edges. However, this method is not successful in cases with complicated shapes such as crossing boundaries or corners, as shown in [7]. The Dominant Local Binary Pattern [7] is proposed in order to solve this issue by considering the most frequently occurring patterns in texture images. An analysis in [8] showed that the LBP does not retain global spatial information, so a new LBP with global matching is proposed using the LBP variance. To find another component to supplement LBP, [9] introduced a monogenic-LBP by combining LBP and monogenic signal theory. Re-

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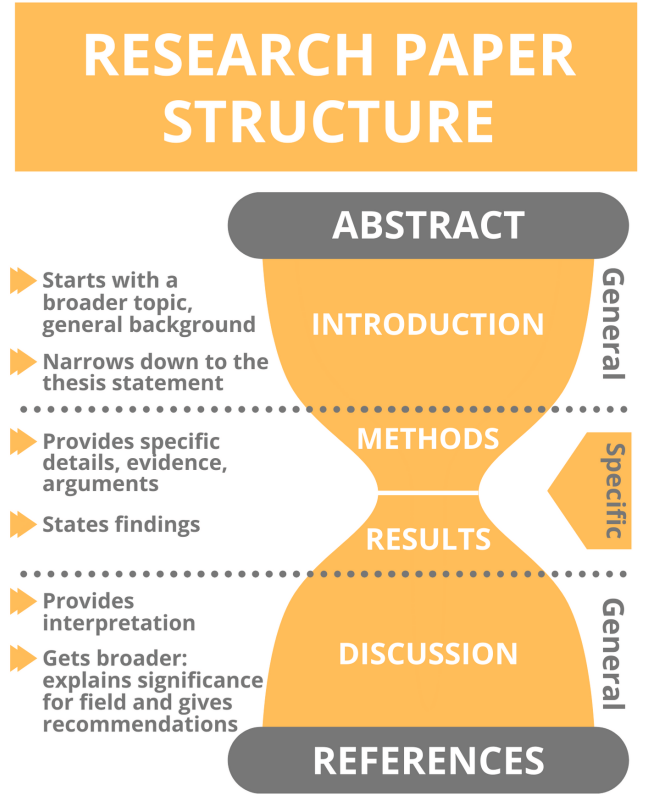
We know of no conflicts of interest associated with this publication, and there has been no significant financial support for this work that could have influenced its outcome. As Corresponding Author, I confirm that the manuscript has been read and approved for submission by all the named authors.

[[Add any other statements/information required by the journal here]]

How to handel Reviewers' comment



Your method is not new

Your contribution is not enough

Performance comparison with SOTA methods

...

final round

Outline

- Performance Evaluation in Detail
- Enough Contributions for Submission
- How to Find Suitable Journal/Conference
- Assignment

Assignment 5

- Requirement:
  - Performance Evaluation and Journal/Conference Selection
  - Submit to: aivnresearch@gmail.com
- Deadline: 12:00 23/12/2023
- Receiving Feedback: 1 week from TA Research Team of AIVN

Assignment 5

Câu hỏi 1 Title of your proposed method

What is the title of your proposed idea or solution?

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Answer:
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```

Câu hỏi 2 Evaluation metrics

Could you please specify which evaluation metrics you will use to assess the performance of your proposed idea or solution?

```
Answer:
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'
```

Câu hỏi 3 Quantitative results

Please describe result of your proposed ideas or solution by using the above evaluation metric (Question 2) and provide explanation (if any)

```
Answer:
'


'
```

Assignment 5

Câu hỏi 4 Qualitative results

Please provide visualizations of the results of your proposed ideas or solutions

```
Answer:
'


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```

Câu hỏi 5 Comparison to Existing methods

Please present a comparison between your proposed idea or solution and at least one existing method, utilizing the evaluation metrics mentioned above

```
Answer:
'


'
```

Câu hỏi 6 Significant and main contributions

Please describe the news of your proposed idea or solution, which you believe emphasize your contributions, differ from existing ones.

```
Answer:
'


'
```


Thank you