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TASK-AWARE SPATIAL CRITICALITY ASSESSMENT OF CAMERA LENS DEFECTS WITH INCOMPLETE MASK EVIDENCE

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Abstract. Camera lens defects may cover the same number of pixels yet obstruct very different parts of a useful viewing region. This paper separates geometric defect coverage from task-aware spatial criticality. It also handles incomplete masks by reporting deterministic lower and upper bounds. A maximum regional score prevents serious obstruction in a small critical region from being hidden by aggregation. Computations on fixed masks show the effects of location, regional dilution, and unresolved pixels. An exhaustive test of 196,608 scalar bounds found no violations under the stated assumptions. The method is an assessment layer for segmentation output, not a claim of calibrated safety risk.

Keywords: camera lens defects, spatial criticality, incomplete masks, region of interest, interval assessment, visual reliability.

Annotatsiya. Kamera obyektividagi nuqsonlar bir xil miqdordagi piksellarni qoplashi mumkin, biroq foydali ko'rish sohasining mutlaqo turli qismlarini to'sib qo'yishi mumkin. Ushbu maqolada nuqsonlarning geometrik qamrovi vazifaga yo'naltirilgan fazoviy kritik darajadan ajratib baholanadi. Shuningdek, to'liq bo'lmagan niqoblar holatida deterministik quyi va yuqori chegaralarni taqdim etish orqali noaniqlik hisobga olinadi. Maksimal hududiy baho kichik, ammo kritik hududdagi jiddiy to'silishning umumlashtirish jarayonida yashirinib qolishining oldini oladi. Belgilangan niqoblar asosida bajarilgan hisob-kitoblarni joylashuv, hududiy suyultirish va aniqlanmagan piksellarning ta'sirini ko'rsatadi. 196 608 ta skalyar chegara bo'yicha o'tkazilgan to'liq tekshiruv belgilangan farazlar doirasida hech qanday buzilish aniqlamadi. Ushbu usul segmentatsiya natijalarini baholash qatlami hisoblanadi va kalibrlangan xavfsizlik xatari to'g'risidagi da'voni anglatmaydi.

Kalit so'zlar: kamera obyektivni nuqsonlari, fazoviy kritik daraja, to'liq bo'lmagan niqoblar, qiziqish sohasi, intervalli baholash, vizual ishonchlilik.

Аннотация. Дефекты объектива камеры могут охватывать одинаковое количество пикселей, однако перекрывать совершенно разные части полезной области обзора. В данной статье геометрическое покрытие дефектов рассматривается отдельно от пространственной критичности, ориентированной на конкретную задачу. Неполные маски также учитываются посредством представления детерминированных нижних и верхних границ. Максимальная региональная оценка предотвращает ситуацию, при которой серьёзное перекрытие небольшой критической области может быть скрыто в процессе агрегирования. Расчёты, выполненные на фиксированных масках, демонстрируют влияние местоположения, регионального разбавления и неопределённых пикселей. Полная проверка 196 608 скалярных границ не выявила нарушений при принятых предположениях. Предложенный метод представляет собой уровень оценки результатов сегментации и не является утверждением о калиброванном риске безопасности.

Ключевые слова: дефекты объектива камеры, пространственная критичность, неполные маски, область интереса, интервальная оценка, визуальная надёжность.

INTRODUCTION

A camera-health monitor should report where the view is compromised, not only how many pixels are defective. A small patch over a doorway may block the whole monitored passage. The same patch elsewhere may not affect that task. In a vehicle camera, contamination near the projected travel path may also matter more than contamination at the image edge. This difference motivates separate measures of defect area and task-relevant obstruction.

Localized soiling coverage is already well established. TiledSoilingNet estimates coverage within image tiles [1], and WoodScape includes fisheye images for automotive perception and soiling detection [2]. Dense models such as U-Net can provide the required masks [3]. However, tile coverage and full-image area do not directly show how much of a chosen task region is blocked. They also become difficult to interpret when some mask pixels remain unresolved.

We therefore calculate three outputs: full-image coverage, task-weighted coverage, and coverage of each critical region. We also mark unresolved pixels as unknown instead of forcing them into the clean class. The resulting interval shows the smallest and largest scores allowed by the available mask evidence. A maximum regional score prevents a small, heavily blocked region from being diluted by a larger intact region.

This is a formulation and computational verification study. It does not introduce a new segmentation network or treat a spatial weight as a new idea. The study asks a narrower question: can the assessment preserve uncertainty, distinguish equal-area defects by location, and expose local obstruction that an aggregate score hides?

LITERATURE REVIEW

Tile-level coverage is useful because multiple contamination classes can occur within the same tile [1]. However, a tile-level percentage does not preserve the exact spatial positions of pixels within that tile. Consequently, a task-relevant region that occupies only part of a tile may remain clear or become fully occluded even when the reported tile-level coverage percentage remains unchanged. Dense masks preserve the spatial information required for a task-aware assessment.

Spatially informed severity estimation has also been considered in recent research. Yang et al. [6] proposed an interpretable static-to-temporal framework for camera lens-soiling severity estimation that incorporates spatial importance into the assessment process. The present study has a more specific objective: it separates geometric and task-relative quantities and establishes bounds for both when part of the mask remains unknown.

Prediction confidence and missing evidence represent distinct issues. Neural-network confidence scores may be miscalibrated [7]; therefore, a high confidence score does not by itself establish that a predicted pixel label is correct. Selective prediction methods allow uncertain predictions to be rejected [8], but rejected pixels still require an explicit treatment within the assessment procedure. In the present approach, such pixels are assigned to an unknown set, which widens the reported interval. The resulting interval is conditional on the correctness of all labels outside the unknown set.

Subsequent empirical evaluation should also account for dataset leakage and annotation quality. Beránek et al. [9] identified both data leakage and annotation inconsistencies in the WoodScape dataset, particularly where sequential frames from the same scene were distributed across training and test subsets. Accordingly, closely related sequential frames should be kept within the same data split during model development and evaluation. ISO 21448 further emphasizes the consideration of functional insufficiencies and performance limitations in safety-related perception systems [10]. However, the calculations presented in this study are intended for diagnostic assessment and do not, by themselves, establish compliance with ISO 21448.

RESEARCH METHODOLOGY

Separate Geometry from Task Relevance

Let the image contain NN pixels. DD is the accepted defect set, and UU is the unresolved set; the two sets do not overlap. All other pixels are treated as clean for this calculation. Thus, unknown means that the current evidence cannot support either label. It does not mean a 0.5 defect probability.

For a complete binary defect mask MM, geometric coverage is the fraction of image pixels marked as defective. A nonnegative task-weight map ww defines the relative importance of different locations. Its total weight must be strictly positive. The two basic quantities are

$$S(M) = \frac{\sum_x M(x)}{N}, \quad C(M) = \frac{\sum_x w(x)M(x)}{\sum_x w(x)}. \quad (1)$$

Both scores range from zero to one. SS is the image-plane coverage, while CC is the fraction of the configured task weight covered by the defect. Neither value represents a collision probability, physical lens area, or object-detection accuracy. This distinction is particularly important for fisheye images, where equal pixel areas do not represent equal scene areas.

The importance map must match the camera and task. A front camera may emphasize a projected travel corridor, while a surveillance camera may emphasize an entrance. A center-weighted map is not a universal choice. The map must use the same crop, resolution, and geometry as the mask and remain fixed during an assessment. Invalid dimensions, negative weights, an empty domain, or zero total weight should cause an error.

Weights are applied after full-image localization. They do not crop the segmenter input or change its loss. The system can therefore detect defects across the full image while separately explaining their relevance to the chosen task.

Prevent Dilution of Individual Region Obstruction

For each nonempty task region RR , its coverage is the number of defect pixels within RR divided by the total number of pixels in RR . The method reports each region separately and also reports their maximum:

$$c_j(M) = \frac{\sum_{x \in R_j} M(x)}{|R_j|}, \quad C_{\max}(M) = \max_j c_j(M). \quad (2)$$

An aggregate CC score may be low even when one small region is severely obstructed. The maximum prevents a large intact region from masking that result. It should be used only when each listed region is independently important. Optional or redundant regions require separate decision rules.

The global SS score remains independent. A defect outside all configured regions may still affect an unmodelled task or indicate general camera degradation. Thus, $C=0C=0$ means that there is no overlap with the current map; it does not prove that the camera is safe.

Bound Incomplete Evidence

The lower mask contains DD . The upper mask contains $DUUD \cup U$. Any admissible true mask must lie between them because each unknown pixel may be either clean or defective. For SS, CC, and each regional score, the lower and upper values are computed as follows:

$$Q_{lo} = Q(1_D), \quad Q_{hi} = Q(1_{DUUD}). \quad (3)$$

Equation (3) also applies to the maximum in Equation (2). The interval is deterministic and conditional on the labels outside UU . It is not a statistical confidence interval. A confident error outside UU can place the true score beyond the reported bounds.

Unknown pixels may result from a temporal filter, an ambiguous boundary, or a failed evidence check. We do not prescribe a confidence threshold because it has not been calibrated here. If no current evidence is usable, the lower mask is empty and the upper mask covers the entire image, giving $[0,1][0, 1]$. This is intentionally uninformative.

The bound follows from monotonicity. Every admissible mask contains DD and is contained in $DUUD \cup U$. Nonnegative sums and division by a fixed positive denominator preserve this order. The same holds for each region and for their maximum. The lower and upper endpoints are attainable by assigning all unknown pixels as clean or defective, so the bounds are tight.

Removing accepted evidence cannot narrow the interval. Turning a known clean pixel into an unknown pixel can only raise the upper endpoint. Turning a known defect into an unknown pixel can only lower the lower endpoint. New evidence can then narrow the interval from either side.

Interpret a Threshold Without Suppressing Uncertainty

For a given threshold, a score is definitely below it only when its upper endpoint is smaller than the threshold. It is definitely at or above the threshold when its lower endpoint reaches the threshold. All other cases remain unresolved. Equality belongs to the above-threshold class.

If a mandatory region is definitely above its threshold, the interface should report that reason. If such a region is unresolved, the system cannot claim that all required regions are below the threshold. The supervisory controller may then request new evidence or limit the use of that camera. The assessment itself does not command braking, cleaning, or sensor substitution.

Explain Results and Bound Sensitivity

For explanation, a $3 \times 33 \times 3$ grid splits each image dimension at 0, one third, two thirds, and the full size, using integer floors. Half-open cells assign every pixel exactly once, even when the dimensions are not divisible by three. These cell percentages are descriptive only and do not replace pixel-level intersections with the task map.

If two complete masks differ at ee pixels, image coverage can differ by at most $e/Ne/N$. The weighted-coverage difference is bounded by the task weight on those pixels divided by the total task weight. For a binary map, if all ee disagreements lie within it, the bound becomes $\min_{|R|}(1, e/|R|) \setminus \min(1, e/|R|)$. The same local bound applies to an individual region.

Computing SS and CC requires one image scan. JJ overlapping regions require $O(JN)O(JN)$ work in a direct implementation. Disjoint regions can share a label map and be accumulated in $O(N+J)O(N+J)$. These costs describe score calculation rather than segmentation inference. The methodological formulation and manuscript preparation were carried out primarily by the authors, with artificial intelligence tools used only as a limited supporting aid, accounting for no more than 10% of the preparation of the article text.

ANALYSIS AND RESULTS

Deterministic Construction

We conducted a small mask-arithmetic study rather than a camera experiment. Each image contained $120 \times 120 \times 120$ pixels. Coordinates were zero-based, and rectangles were half-open. R1R_1 covered $x \in [40, 80) \times y \in [60, 120)$, comprising 2,400 pixels. R2R_2 covered $x \in [0, 20) \times y \in [40, 80)$, comprising 800 pixels. The binary task map was set to one over their union and zero elsewhere, giving a total weight of 3,200.

The rectangles are schematic rather than measured road or doorway projections. They were chosen to keep every calculation transparent. No image generator, trained model, checkpoint, or camera recording was used. The six fixed cases test the arithmetic and decision logic.

Table 1. Exact construction of the six mask cases

Case	Accepted defect rectangle	Unknown rectangle
A	$x [96, 120), y [0, 24)$	Empty
B	$x [48, 72), y [72, 96)$	Empty
C	$x [0, 20), y [40, 60)$	Empty
D	Same as A	$x [40, 80), y [60, 90)$
E	Same as A	$x [90, 120), y [80, 120)$
F	Empty	Entire image

Source: developed by the author.

For Cases A to E, all pixels outside the listed sets were accepted as clean. Case F contained no accepted current evidence. Table 2 presents the results as percentages; each interval represents unresolved evidence rather than run-to-run variation.

Table 2. Computed coverage percentages for the constructed masks

Case	Image S	Weighted C	Region maximum
A	4.00	0.00	0.00
B	4.00	18.00	24.00
C	2.78	12.50	50.00
D	[4.00, 12.33]	[0.00, 37.50]	[0.00, 50.00]
E	[4.00, 12.33]	[0.00, 0.00]	[0.00, 0.00]
F	[0.00, 100.00]	[0.00, 100.00]	[0.00, 100.00]

Source: developed by the author.

Location and Aggregation Effects

Cases A and B each cover 576 pixels, so both have 4% image coverage. Their task-weighted scores differ by 18 percentage points because B lies within R1R_1. Area alone therefore cannot recover task-relative location. The result does not imply that A is harmless outside the configured regions.

Case C covers only 400 pixels but blocks half of R2R_2. Coverage over the full task union is 12.5%, while the maximum regional score is 50%. Separate regional reporting exposes this dilution. It does not alter the detected mask.

Cases D and E have the same accepted defect and 1,200 unknown pixels, so their SS intervals are identical. In D, all unknown pixels lie within R1R_1 and may produce 50% regional obstruction. In E, none of the unknown pixels overlaps either task region, so the task-relative intervals remain fixed. The bounds therefore retain the location of missing evidence.

Loss of Location Within a Display Tile

A second construction used a single $40 \times 40 \times 40$ tile with a task region in its leftmost ten columns. One defect covered those columns, while another covered the rightmost ten columns. Both defects occupied 25% of the tile, but their task-region coverages were 100% and 0%, respectively. Exact tile coverage can therefore lose the location information needed for a specific task.

Exhaustive Verification of Incomplete Masks

We also enumerated all 6,561 clean, defective, and unknown assignments in an eight-pixel domain. The first two pixels formed one task region, the next two formed another, and the remaining four lay outside both. For every

assignment, we enumerated every binary completion of its unknown pixels.

This produced 65,536 assignment-completion pairs and 196,608 scalar checks: image coverage, union coverage, and maximum regional coverage. Every completed value lay within its calculated bounds. At an illustrative threshold of 0.5, 5,346 assignments were definitely at or above the threshold, and 1,215 were unresolved. No definitely-below assignment was later completed above the threshold.

Table 3. Executed logical verification results

Quantity	Count
Ternary evidence assignments	6,561
Assignment and completion pairs	65,536
Scalar interval checks	196,608
Bound violations	0
Definite assignments at threshold 0.5	5,346
Unresolved assignments at threshold 0.5	1,215

Source: developed by the author.

The zero violations agree with the monotonicity proof and verify this finite implementation. They do not demonstrate perfect camera accuracy, calibrated uncertainty, or safety validation.

Sensitivity to Mask Errors

In the $120 \times 120 \times 120$ construction, 100 incorrect pixel labels can change SS by at most 0.69 percentage points. If all errors lie within the task union, CC can change by 3.13 percentage points. If they all lie within the 800-pixel R2R_2, regional coverage can change by 12.5 percentage points. This result shows why small critical regions are more sensitive to mask errors.

The calculations support three limited conclusions. Image area alone does not identify task-relative obstruction. Aggregation may hide severe obstruction in a small mandatory region. An explicit unknown set provides tight conditional intervals. These are mathematical and implementation results, not field evidence of improved vehicle safety.

A later empirical study should split complete contamination episodes across development, validation, and held-out test sets. It should retain camera identity, lens state, task geometry, and preprocessing settings. Holding out entire cameras or installations would provide a stronger test. Task maps must be defined independently of the evaluated defect masks.

Every assessment variant should use the same stored model outputs. Useful comparisons include global area, aggregate weighted coverage, separate regional scores with their maximum, and the interval method. Treating unknown pixels as clean provides an optimistic control, while treating all unknown pixels as defective provides a pessimistic control.

Empirical measures should include score error against annotated masks, regional error, interval coverage, interval width, unresolved-decision frequency, and false-below-threshold decisions. Tests should vary contamination type, day and night conditions, weather, and task geometry, with confidence intervals reported for key differences.

Important failure modes remain. A confident segmentation error outside UU can invalidate the bound. A task map inferred from an obscured image may be incorrect even when the mask is accurate. Cropping, stabilization, or camera movement can misalign maps and masks. Highly dynamic scenes may also require more than a fixed spatial map.

An operational record should retain camera and map versions, timestamp, DD and UU identifiers, interval endpoints, regional values, and the reason for any unresolved status. If the task map changes, the scores must be recomputed because the denominator has changed.

CONCLUSION AND SUGGESTIONS

This paper presented a task-aware assessment of camera lens defect masks. It separates image coverage from task-relative obstruction, reports each critical region, and keeps unknown pixels explicit through deterministic bounds.

Fixed-mask calculations showed equal-area location effects, regional dilution, and the loss of position within a tile. Exhaustive enumeration checked 196,608 bounds without a violation. These results establish properties of the calculation only. Deployment still requires validation of mask accuracy, map geometry, interval usefulness, and decisions made from the scores.

Reproducibility: The study is deterministic and uses no random seed. Tables 1 and 2 can be reproduced using

120×120 Boolean arrays and the listed rectangular slices. The lower mask contains DD, and the upper mask contains DUUD $\cup$ U. Their counts are divided by 14,400 for SS, by 3,200 for CC, and by each region size for regional coverage.

For Table 3, enumerate all length-eight strings over the clean, defective, and unknown states. Use defective pixels for the lower mask and defective plus unknown pixels for the upper mask. Enumerate every binary completion of the unknown positions and verify the three scores against their endpoints.

REFERENCES

1. · Das, A., Krížek, P., Sistu, G., Bürger, F., Madasamy, S., Uricár, M., Kumar, V. R., & Yogamani, S. (2020). TiledSoilingNet: Tile-level soiling detection on automotive surround-view cameras using coverage metric. In *2020 IEEE 23rd International Conference on Intelligent Transportation Systems (ITSC)* (pp. 1–6). IEEE. DOI: 10.1109/ITSC45102.2020.9294677. [IEEE/DOI record](#)
2. · Yogamani, S., Hughes, C., Horgan, J., Sistu, G., Varley, P., O'Dea, D., Uricár, M., Milz, S., Simon, M., Amende, K., Witt, C., Rashed, H., Chennupati, S., Nayak, S., Mansoor, S., Perrotton, X., & Pérez, P. (2019). WoodScape: A multi-task, multi-camera fisheye dataset for autonomous driving. In *Proceedings of the IEEE/CVF International Conference on Computer Vision (ICCV)* (pp. 9308–9318). DOI: 10.1109/ICCV.2019.00940. [Official CVF publication](#)
3. · Ronneberger, O., Fischer, P., & Brox, T. (2015). U-Net: Convolutional networks for biomedical image segmentation. In *Medical Image Computing and Computer-Assisted Intervention – MICCAI 2015, Lecture Notes in Computer Science*, Vol. 9351 (pp. 234–241). Springer. DOI: 10.1007/978-3-319-24574-4_28. [Springer publication](#)
4. · Axmedov, A. G. (2026). *Uncertainty guided classifier gated segmentation for efficient camera lens defect localization*. Manuscript submitted for publication.
5. · Axmedov, A. G. (2026). *Valid-mask temporal consistency filtering for persistent camera lens defect localization and shadow suppression*. Manuscript submitted for publication.
6. · Yang, F., Duan, X., Li, F., & Zhang, L. (2026). A static-to-temporal framework for interpretable camera lens soiling severity estimation in autonomous driving. *Sensors*, 26(11), 3533. DOI: 10.3390/s26113533. [Sensors article](#)
7. · Guo, C., Pleiss, G., Sun, Y., & Weinberger, K. Q. (2017). On calibration of modern neural networks. In *Proceedings of the 34th International Conference on Machine Learning, Proceedings of Machine Learning Research*, 70, 1321–1330. [Official PMLR publication](#)
8. · Geifman, Y., & El-Yaniv, R. (2019). SelectiveNet: A deep neural network with an integrated reject option. In *Proceedings of the 36th International Conference on Machine Learning, Proceedings of Machine Learning Research*, 97, 2151–2159. [Official PMLR publication](#)
9. · Beránek, F., Diviš, V., & Gruber, I. (2025). Soiling detection for advanced driver assistance systems. In *Seventeenth International Conference on Machine Vision (ICMV 2024)*. SPIE. DOI: 10.1117/12.3055223. [Institutional publication record](#)
10. · International Organization for Standardization. (2022). *ISO 21448:2022 Road vehicles — Safety of the intended functionality*. ISO. [Official ISO 21448:2022 page](#)

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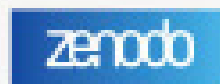
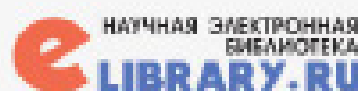
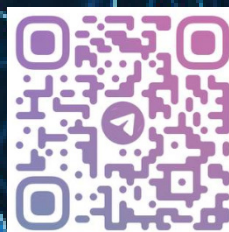
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