Supplemental Material

This is the supplemental material for the CVPR 2017 paper *Analyzing Computer Vision Data - The Good, the Bad and the Ugly* by Oliver Zendel, Katrin Honauer, Markus Murschitz, Martin Humenberger, and Gustavo Fernández Domínguez

Overview:

1. Visualization of algorithm results for each of the identified hazard frames for all datasets (all thumbnail images are taken from the respective datasets): Section 1
2. Cumulative calculation of average performances for all datasets: Section 2
3. Full hazard list specialized for stereo vision: Section 3
4. Identified hazards per dataset (and corresponding frame): Section 4
5. URLs of datasets (Datasets are the same as in Table 1 of the submitted paper): Table 12

1. Performance results of algorithms for all hazard frames

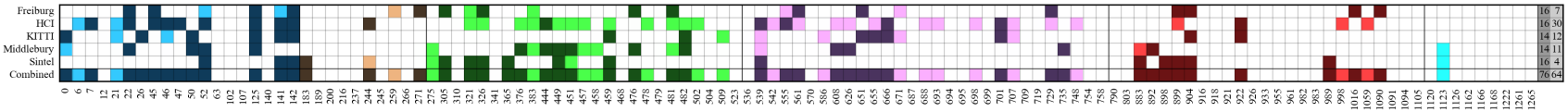

Figure 1. Overview of found/disputed entries including gaps with missing entries

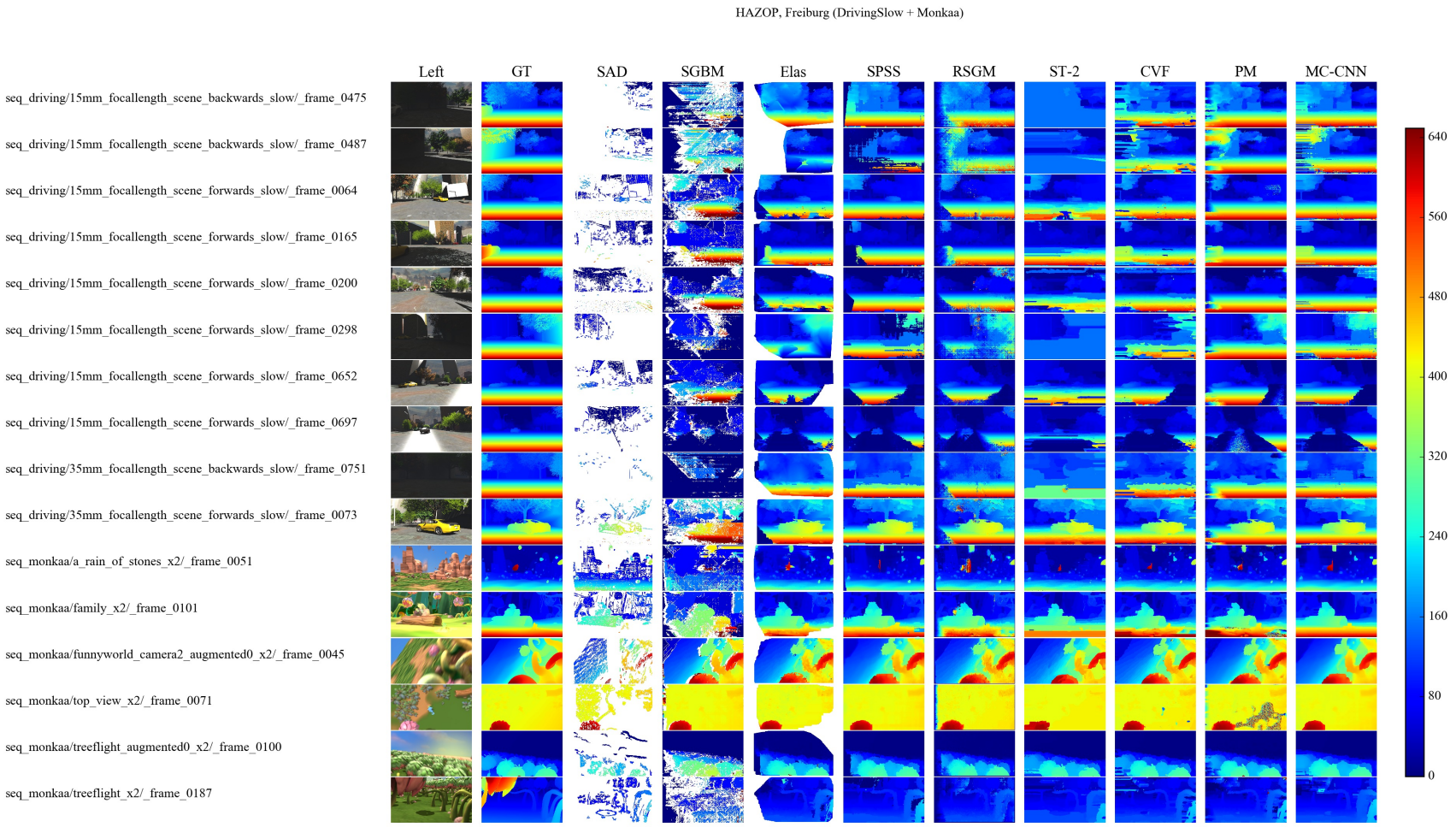

Figure 2. Disparity of each hazard frame from the Freiburg dataset

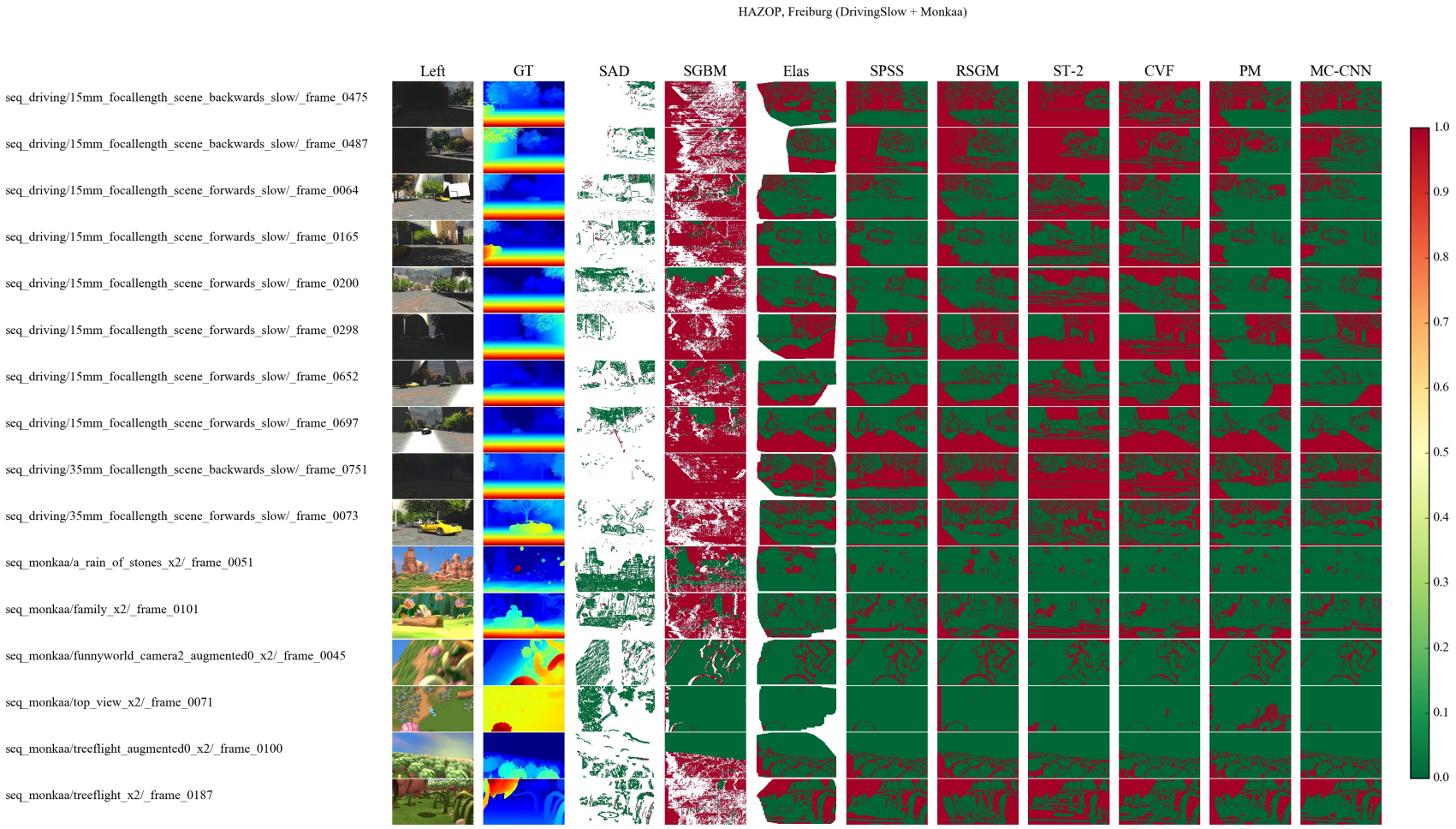

Figure 3. Pixels with an error $> 4pxl$ compared to GT; each hazard frame from the Freiburg dataset

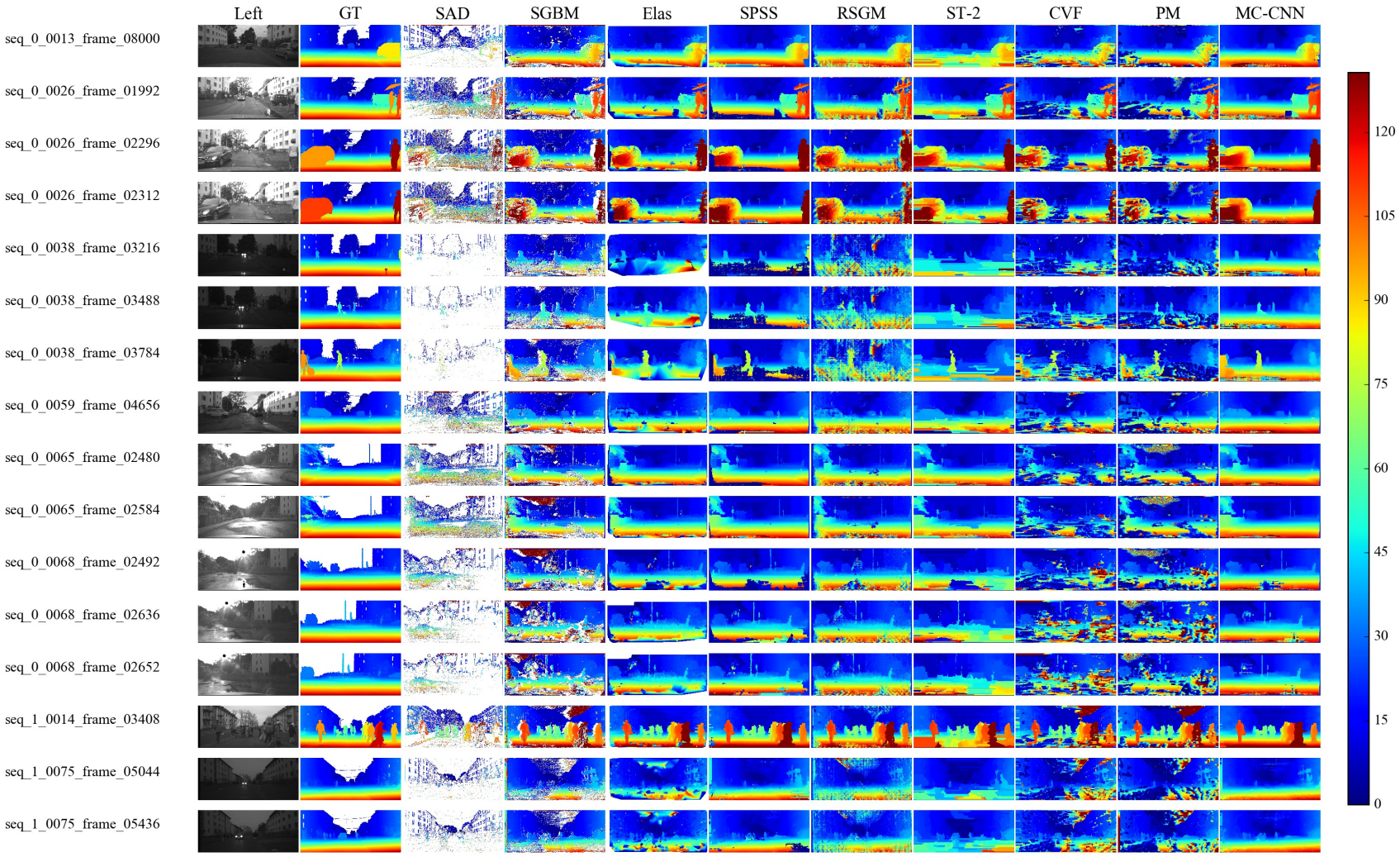

Figure 4. Disparity of each hazard frame from the HCI dataset

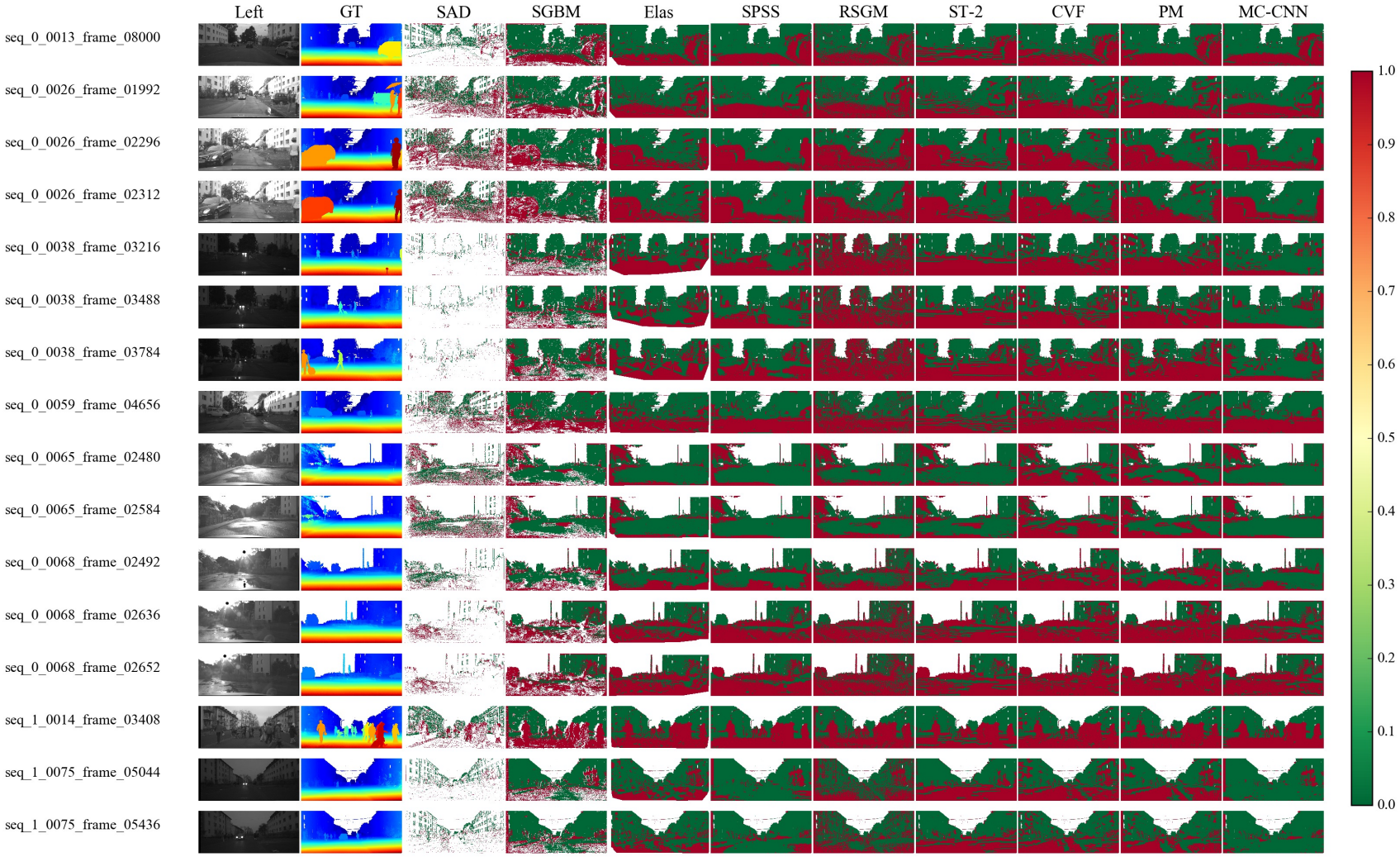

Figure 5. Pixels with an error $> 4pxl$ compared to GT; each hazard frame from the HCI dataset

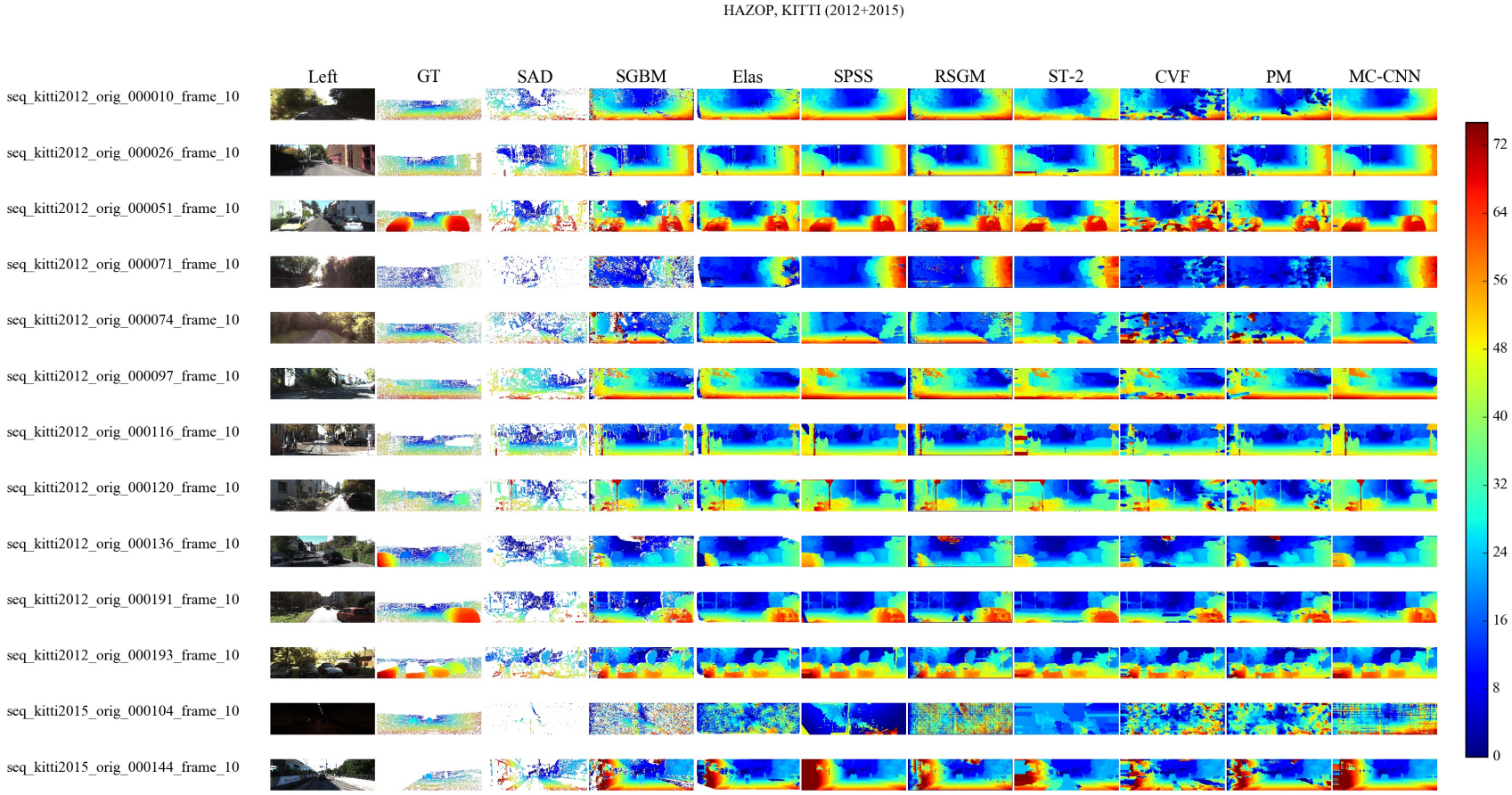

Figure 6. Disparity of each hazard frame from the KITTI datasets (2012 & 2015)

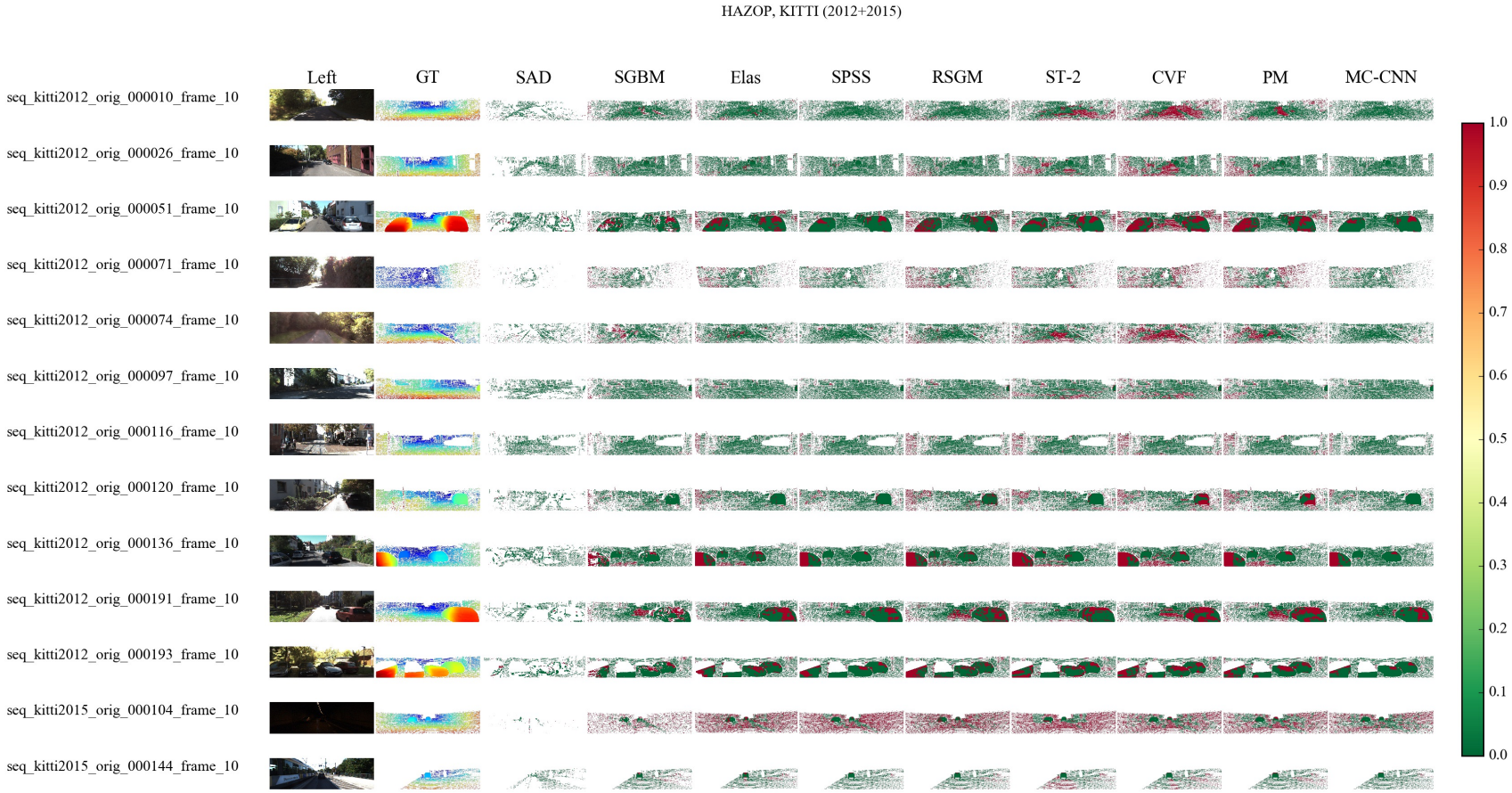

Figure 7. Pixels with an error $> 4pxl$ compared to GT; each hazard frame from the KITTI datasets (2012 & 2015)

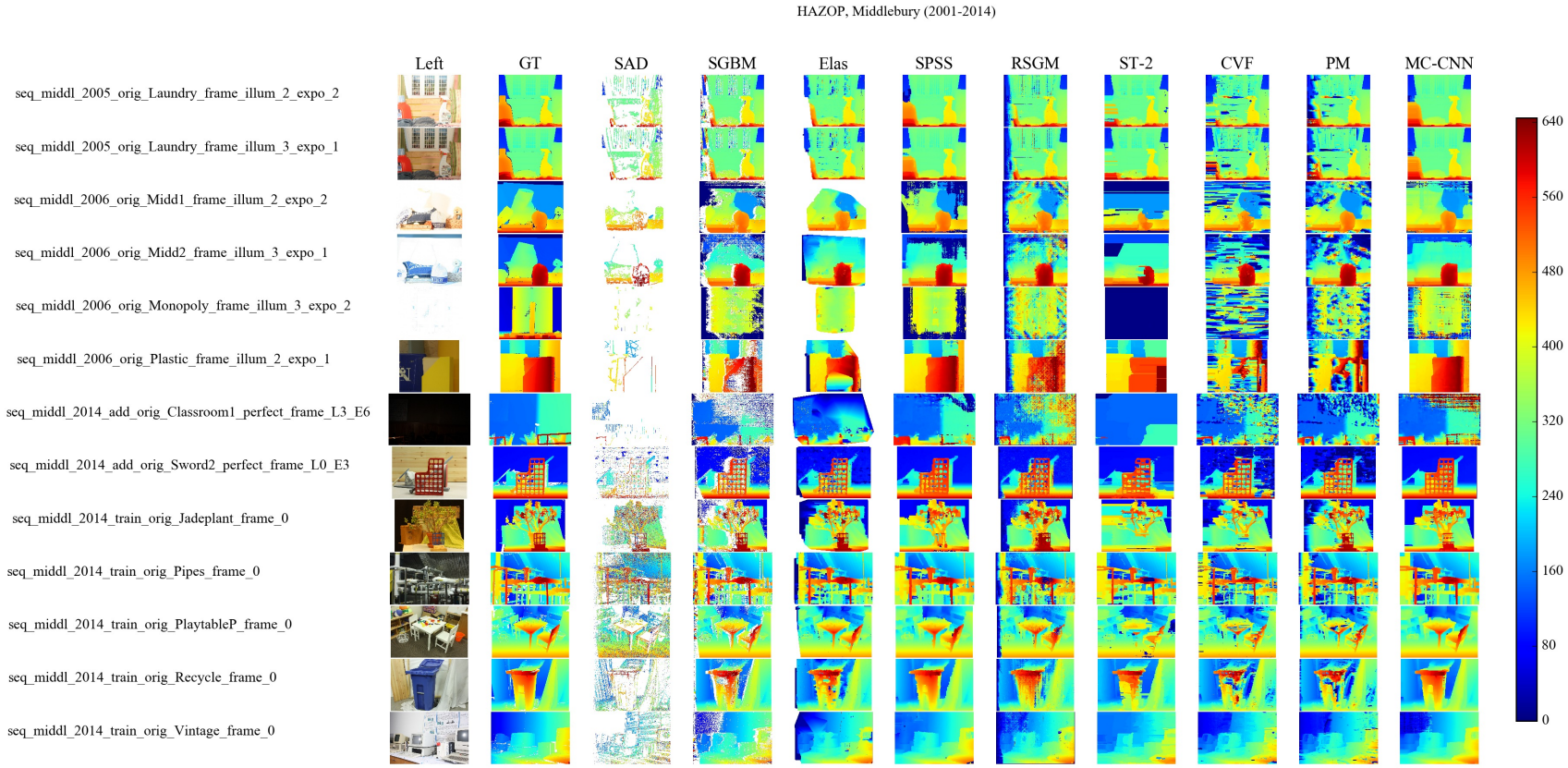

Figure 8. Disparity of each hazard frame from the Middlebury datasets

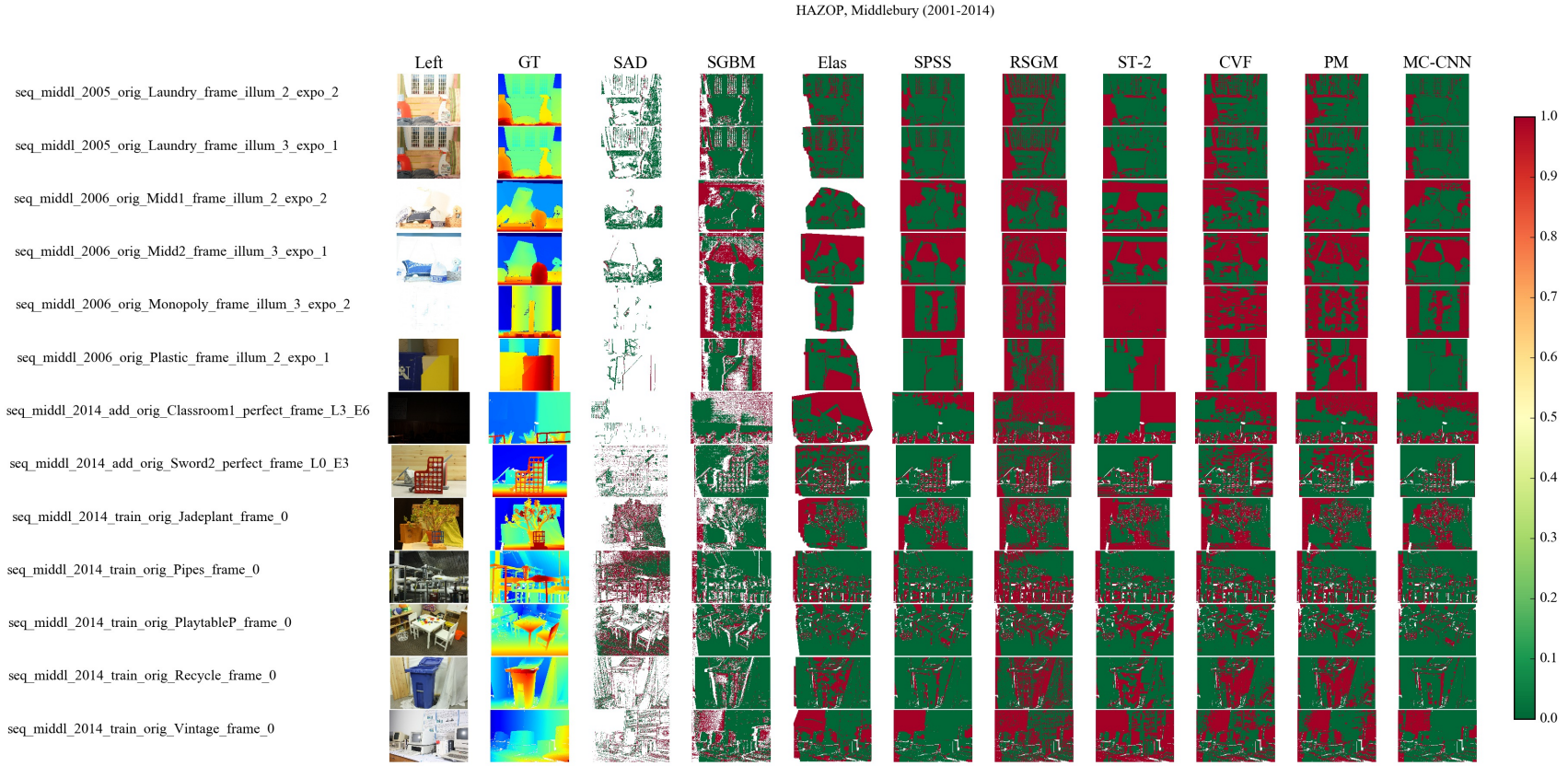

Figure 9. Pixels with an error $> 4pxl$ compared to GT; each hazard frame from the Middlebury datasets

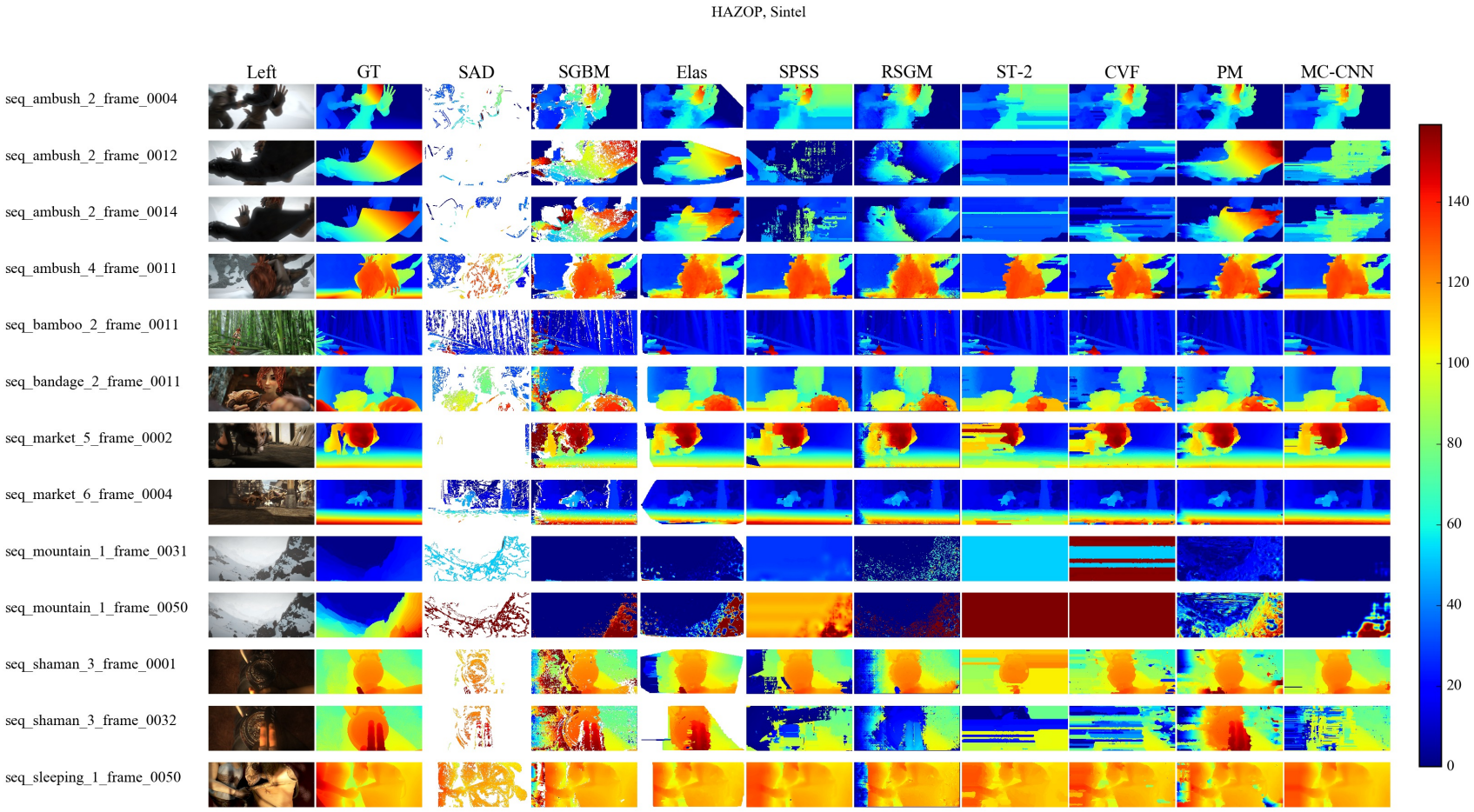

Figure 10. Disparity of each hazard frame from the Sintel dataset

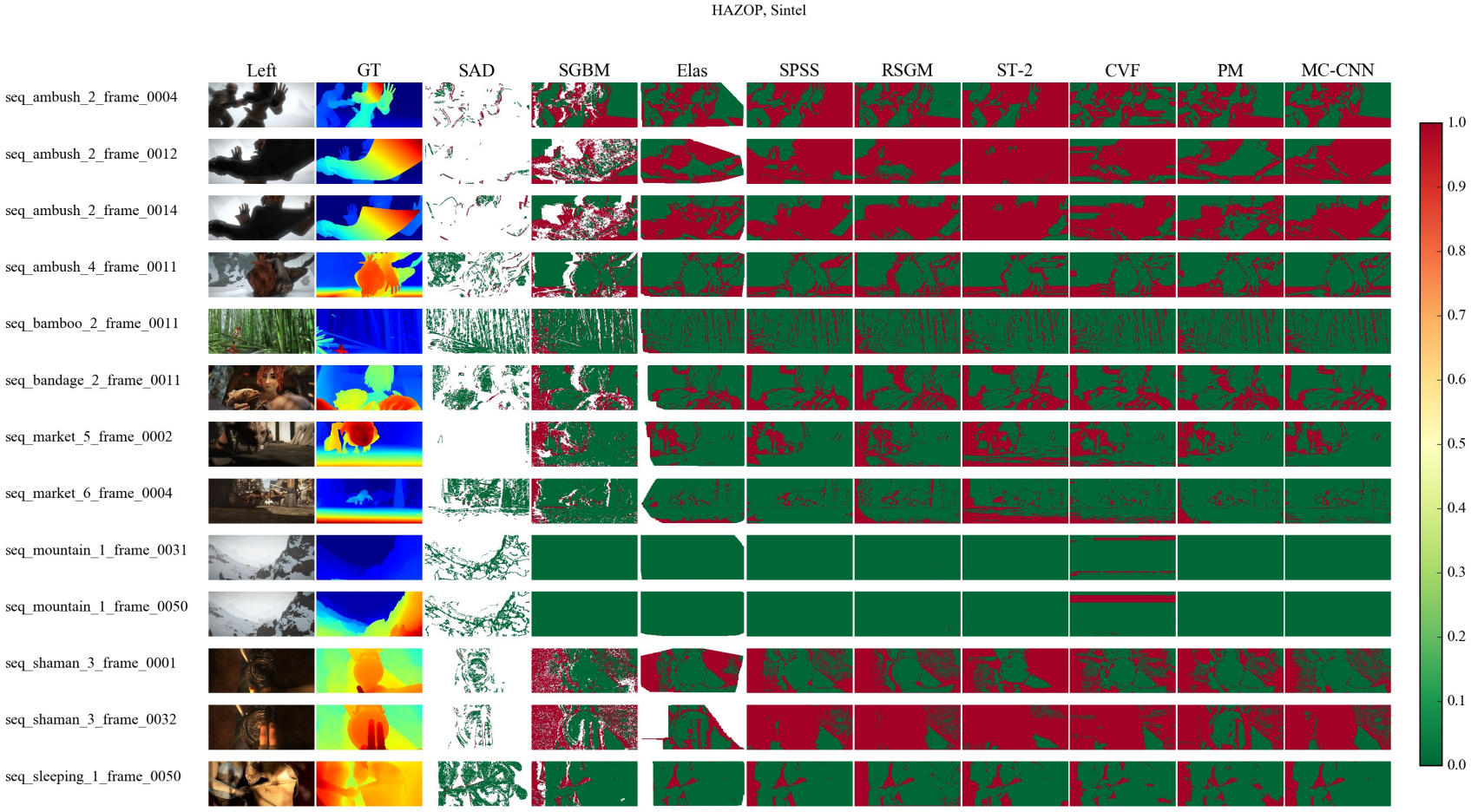

Figure 11. Pixels with an error $> 4pxl$ compared to GT; each hazard frame from the Sintel dataset

2. Cumulative calculation of average performances for all datasets

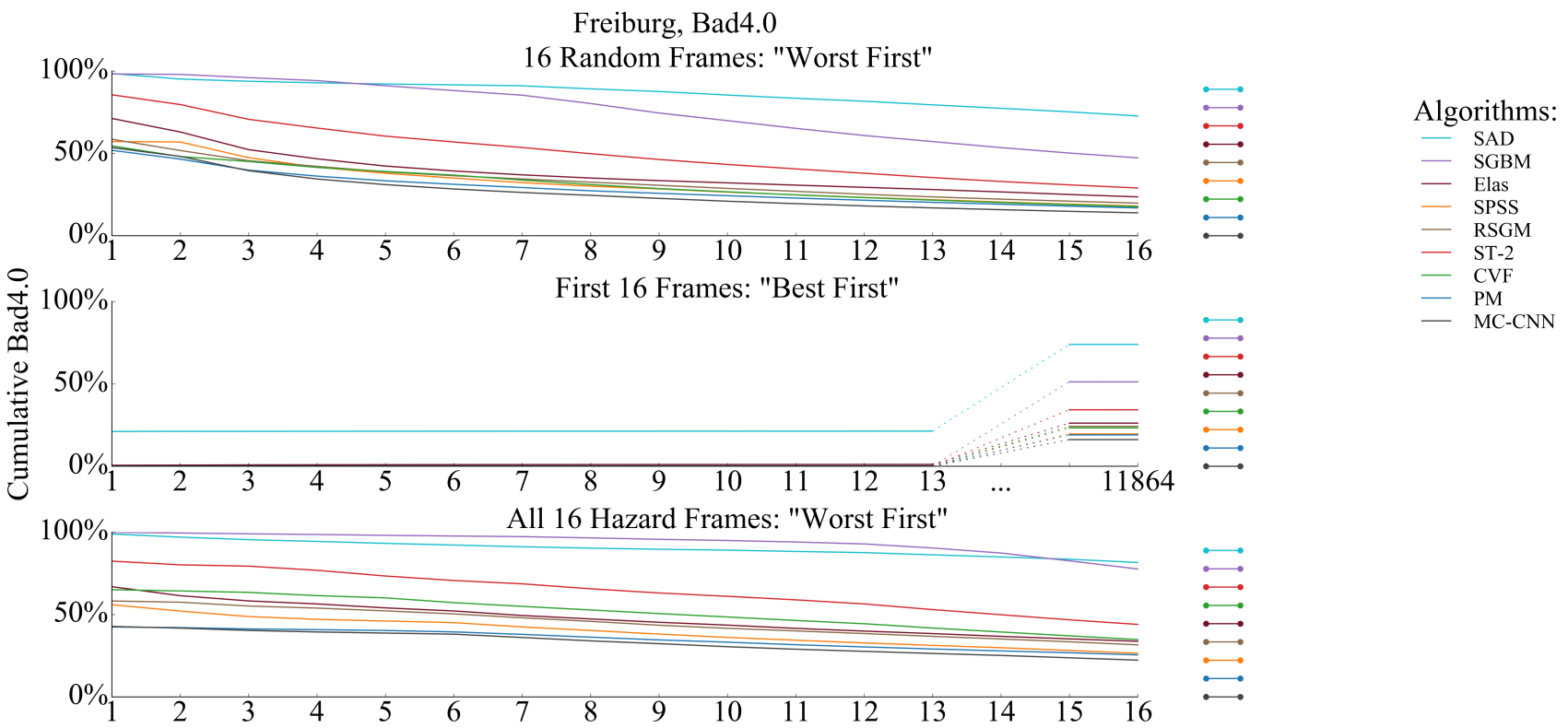

Figure 12. Comparison of cumulative average performance of 16 frames from Freiburg: Random picking, easiest frames, hazard frames (all sorted by difficulty)

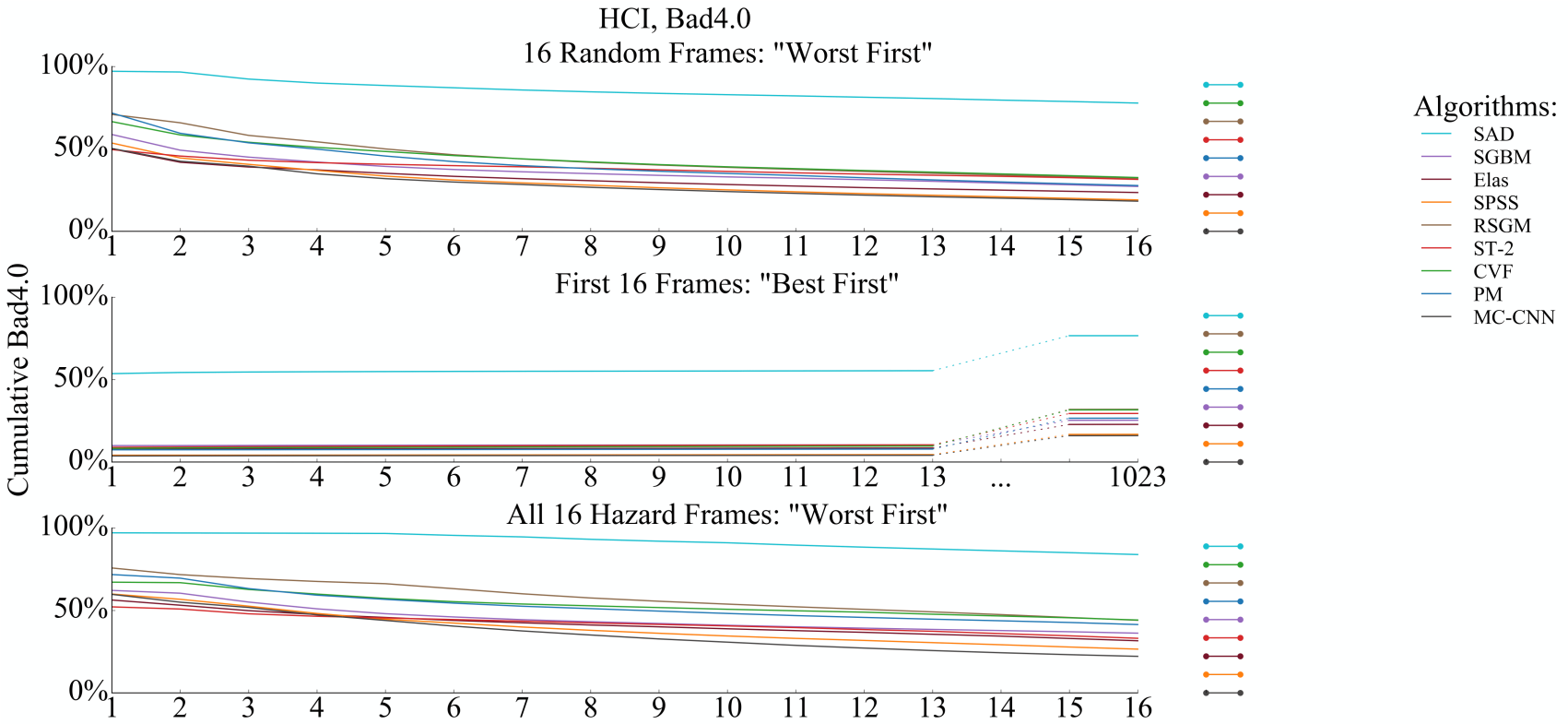

Figure 13. Comparison of cumulative average performance of 16 frames from HCI: Random picking, easiest frames, hazard frames (all sorted by difficulty)

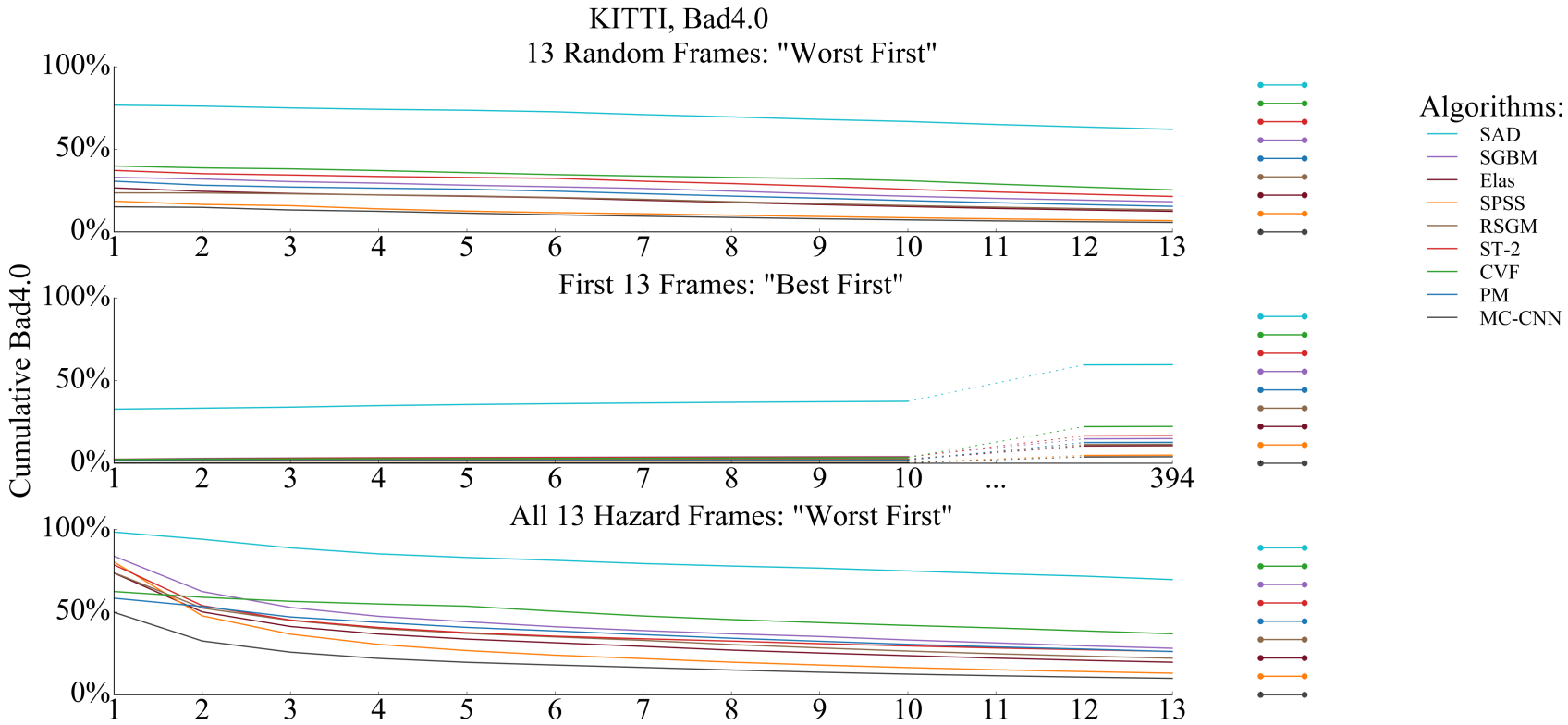

Figure 14. Comparison of cumulative average performance of 13 frames from KITTI: Random picking, easiest frames, hazard frames (all sorted by difficulty)

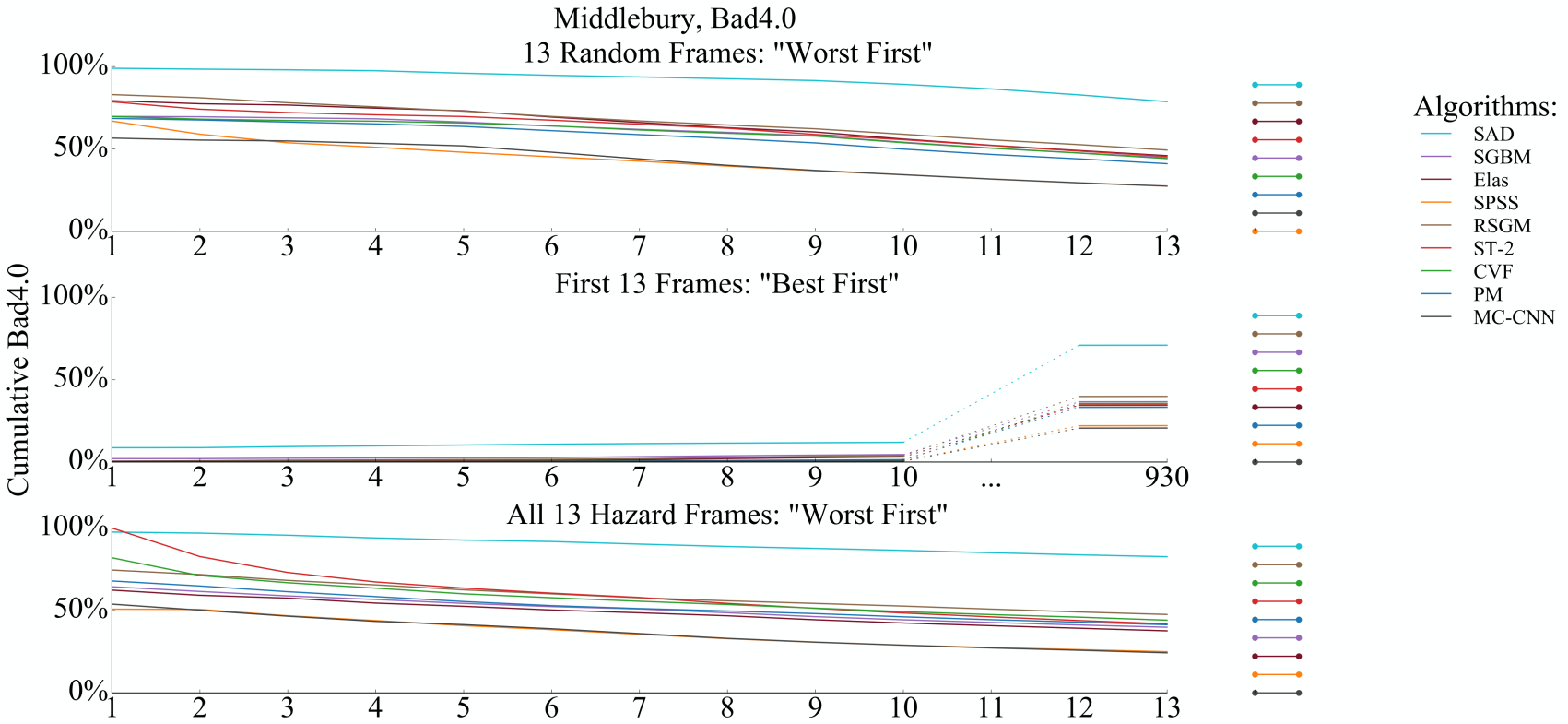

Figure 15. Comparison of cumulative average performance of 13 frames from Middlebury: Random picking, easiest frames, hazard frames (all sorted by difficulty)

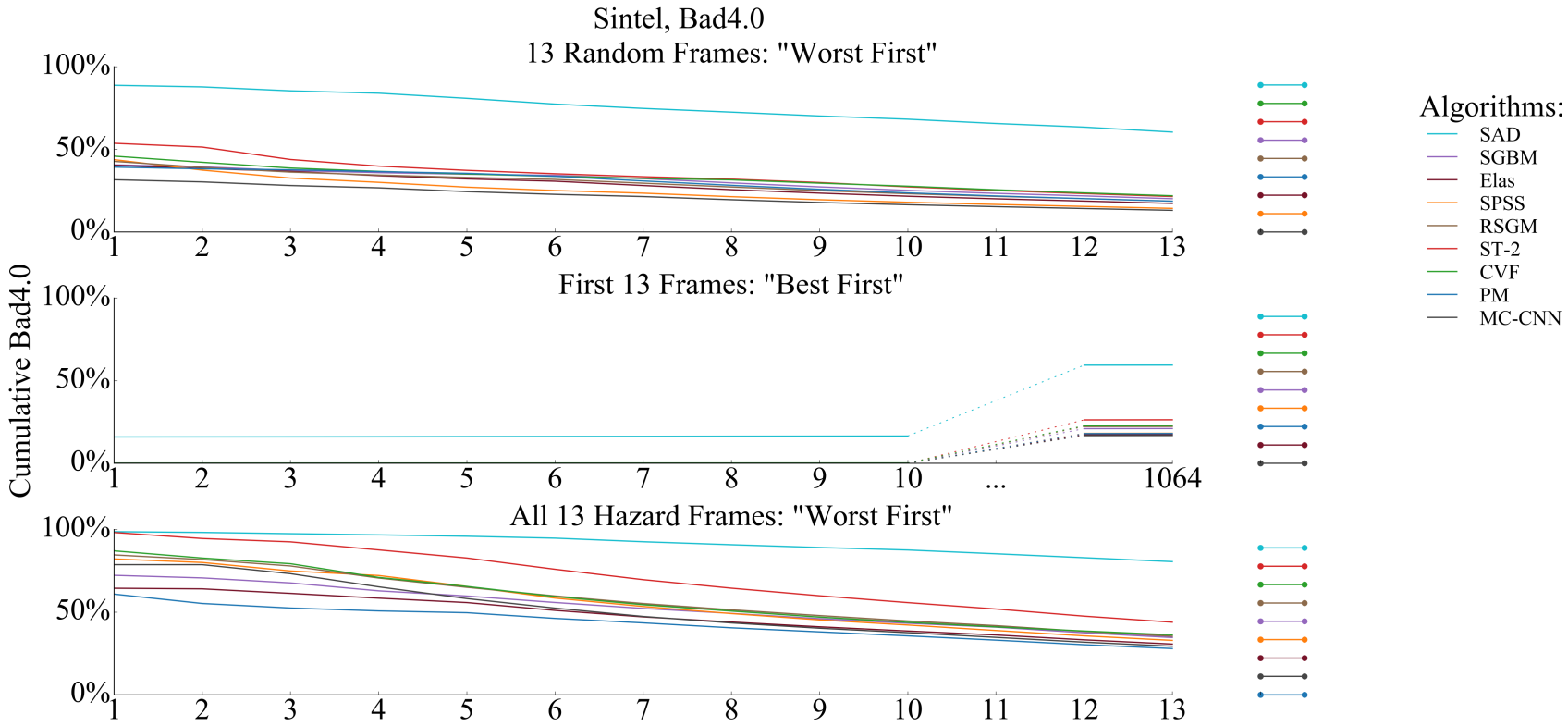

Figure 16. Comparison of cumulative average performance of 13 frames from Sintel: Random picking, easiest frames, hazard frames (all sorted by difficulty)

3. Full hazard list

Table 1: Full table of specialized hazard list for the stereo vision task

hid	Loc	GW	Par	meaning	consequence	hazard	entry
0	L.s.	No	Number	No l.s.	No light available	Sensor will receive no light, but thermal noise or black current can cause wrong input	Highly underexposed image where black-level noise makes up most of the data; Integration test: system is self-aware that its output (or output at these areas) are not trustworthy
6	L. s.	As well as	Number	Mirrors fake additional l. s.s	L.s. can appear at locations other than where they are	Algorithm confuses position of l. s.s	L.s. as well as mirror image of the same l. s. are visible in the image. Critical example for stereo vision: L.s. and reflection are on the same epipolar line (e.g. table with candle with a large mirror directly behind it).
7	L. s.	As well as	Number	Mirrors fake additional l. s.s	Increases shadow complexity	Algorithm detects more l. s.s than exist	A l.s. and its clear reflection are near-perfect aligned on the same epipolar line
12	L. s.	Spatial periodic	Number	Several l. s.s are configured in periodic manner	Consequences depend on combined param.	Hazards depend on combined param.	There is a periodically ordered array/line of l.s. aligned on the same epipolar line for both cameras (this can occur at large distances or when aligned with the horizon-line)
21	L. s.	Less	Position	L.s. near to observer	Lighting of scene can be too strong	Over- and underexposure in same scene possible	L.s. visible in image is near to the camera and overexposed while areas surrounding the l. s. quickly get dark and under exposed (E.g. room only lit by a candle)
22	L. s.	Less	Position	L.s. near to observer	Light intensity may decrease (with increasing distance from l.s.) significantly within scene	Only parts close to l.s. sufficiently illuminated	Scene with extreme light fall-off: minority of image is well lit with a rapidly decreasing illumination around it
26	L. s.	Part of	Position	Part of l.s. is visible	L.s. at the image's edge looks different than in the middle	Overexposure (of image parts)	L.s. in image is cut apart by image border

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hid	Loc	GW	Par	meaning	consequence	hazard	entry
45	L. s.	In front of	Position	L.s. is part of scene (in front of observer)	L.s. can be directly visible from observer	Overexposure (of image parts) - local outshining	L.s. is prominently visible in image and is surrounded by considerable overexposed areas
46	L. s.	In front of	Position	L.s. is part of scene (in front of observer)	L.s. at the imageĂŹs edge looks different than in the middle	Reflections of optics in image	Clearly visible Bokeh together with the l. s. causing it (e.g. the sun)
47	L. s.	In front of	Position	L.s. is part of scene (in front of observer)	L.s. can be directly visible from observer	Virtual rays in image	L.s. together with clearly visible streaks of light radiating in a radial fashion from L.s.
50	L. s.	Behind	Position	L.s. behind Observer	Objects illuminated with small angle between direction of light and direction of view	Small irregularities on object surfaces with same colours as surroundings may remain undetected	Scene where sun (or other strong l.s. is directly behind the observer. Relevant untextured object's structure is not reconstructed due to missing object self-shading.
52	L. s.	Behind	Position	L.s. behind Observer	Little contrasts on smooth surfaces	Reflecting areas oriented parallel to image plain may appear over exposed	Sun behind camera is casting light on a white wall causing overexposure
63	L. s.	Faster	Position	L.s. moves faster than expected	L.s. stays shorter at a place than expected	Too weak light	L.s. visible in image with a long elongated thin shape (e.g. neon tube) creating an unusually prolonged overexposed area
102	L. s.	More	Texture	L. s. has too much texture	The l. s. produces a texture of its own by projecting a textured light beam (virtual texture)	Texture of emitted light is confused with texture on object. This creates false positive detections.	L.s. projects a texture onto a surface while a very similar texture is already present next to it as part of another object's surface texture, both textures are aligned on the same epipolar lines

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Table 1: Full table of specialized hazard list for the stereo vision task

hid	Loc	GW	Par	meaning	consequence	hazard	entry
107	L. s.	As well as	Texture	L. s. projects combination of two textures, one expected, the other unexpected	Blending of lightings, complex illumination and shadowing	Small changes in l.s. configuration may cause large differences in responses of CV algorithm (e.g. Moire)	L.s. projects a thin structured pattern onto a surface that produces two distinctly different Moire patterns in the left/right camera
125	L. s.	More	Intensity	L.s. is too strong	Too much light in scene	Overexposure of lit objects	Directly lit object is overexposed in an otherwise correctly exposed scene/image
140	L. s.	More	Beam	Large beam angle, even omni-dir. emission of light	All objects will be lit	Reflections in all shiny surfaces possible	Very bright scene without overexposure but very little contrast due to approximating an ambient lighting situation with nearly no shadows (self-shading neither)
141	L. s.	Less	Beam	Focused beam	Only fractions of objects will be lit	Large parts of scene may be dark	Headlight situation with only a small part of the scene sufficiently being lit. Large parts are underexposed.
142	L. s.	Less	Beam properties	Focused beam	Only fractions of objects will be lit	Unsmooth illumination of surfaces	Scene where a prominent object is only half lit by the scene's l.s. while a large portion remains severely underexposed
183	Medium	Less	Transparency	Medium is optically thicker than expected	Less light can pass through	Less contrast than expected could result in mismatches	Fog / haze in image reduces visibility depending on distance from observer
189	Medium	As well as	Transparency	Two different media have a different optical thickness	Refraction occurs: changes the path of light from the object to the observer	The object appears to be displaced	There is a large part of the scenery clearly visible within a different medium than in directly in front of the observer (e.g. view clean/clear water with lots of details visible beneath the water surface)
200	Medium	As well as	Spectrum	Medium has similar colour as nearby l.s./object	Low contrast	Objects and medium become indistinguishable	Scenery contains a medium (air, water) with comparable colour and particles/textures as the objects in the scene
216	Medium	Spatial periodic	Texture	Texture of medium is periodic (periodic density fluctuations)	Medium projects periodic texture onto surfaces	Confusion with object texture by CV alg. possible	A periodic appearing density fluctuation creates a periodic pattern on a visible surface aligned with the stereo system's epipolar geometry

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hid	Loc	GW	Par	meaning	consequence	hazard	entry
237	Medium	No	Particles	No particles in the medium	No particles in the medium which scatter transmitting light	If particles are needed to e.g. visualize flow dynamics, this will be hampered	The border between two media is very clean and the medium is clean as well thus preventing the detection of the medium border itself
244	Medium	More	Particles	Particles are large(r than expected)	Particles appear as distinct objects	Particles are misinterpreted as objects	Large hailstones, snowflakes or raindrops look like parts of the actual scene/objects in the scene thus creating faulty matches
245	Medium	More	Particles	Particle size is bigger than the light's wavelength	Geometric Scattering	See Less Trans or More Texture	Cloud of visible particles (e.g. pollen, small leaves) in the air are obscuring the scene
259	Medium	Where else	Particles	Particles fill up different parts of the scene with different density	Different areas of scene exhibit different visual effects	Different recognition quality throughout an image	Scene is split into two roughly equally big parts: one without particles and another with considerable amount of particles (e.g. a view with a roof covering a area where no snow/rain is falling and an outside part full of rain/snow)
266	Medium	Close	Particles	Particles very close to Observer	Single particles may cover larger scene fractions	Single particles are confused with real scene objects	A single particle that is close to the observer looks very similar to an object in the scene while both are aligned on the same epipolar lines
271	Medium	Faster	Particles	Particles move faster than expected	Motion blur of particles	Blurred particles obfuscate (parts of) scene	Scene contains particles moving fast enough to have a noticeable motion blur
275	Object	No	Position	Pos. cannot be defined/ detected	An object's "central" point cannot be defined	One object is reported as several	Large, diffuse or highly structured or flexible objects like clouds, fungus mycelium, or table-cloth is broken into many objects small enough so that noise/speckle filtering might remove them
305	Object	Faster	Position	Obj. moves faster than expected	Obj. stays shorter at a place than expected	Transversal motion blur	Object is moving from left to right fast enough to have a noticeable motion blur

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Table 1: Full table of specialized hazard list for the stereo vision task

hid	Loc	GW	Par	meaning	consequence	hazard	entry
310	Object	More	Size	Obj. is larger than expected	Obj. has a size more similar to other objects than its own characteristic size	Object is confused with some other object	Two very similar objects but of different scaling are present in the scene. The two objects are positioned on the same epipolar lines and their projected size is the same (due to perspective effects)
321	Object	Part of	Size	Only Part of Obj. area is visible	Obj. is either partially occluded	Object is not correctly recognized	Larger parts of an object are occluded (left view vs. right view) so that the remaining parts might get rejected as noise/speckles
326	Object	Part of	Size	One of the Object extents is missing	Degenerated configuration of object surface	CV alg. fails because of a degenerated case	A large but very thin object is positioned in such a way that exactly one of the two cameras sees only the thin edge of it without much surface.
341	Object	Faster	Size	Obj. size changes faster than expected	Obj. shrinks/increases/pulses remarkably during exposure	Radial motion blur	Scene contains an expanding/shrinking object that has a noticeable radial motion blur (not caused by ego-motion!)
365	Object	Faster	Orientation	Orient. changes faster than expected	Obj. rotates remarkably during exposure	Rotational motion blur	Scene contains a rotating object that possesses noticeable rotational motion blur (not caused by ego-motion!)
376	Object	Less	Complexity	Object is less complex than expected	Object lacks natural features	Insufficient amount of natural features leads to faulty/no results in 3D reconstruction or self-localisation	Simple non-planar object without texture or self-shading (e.g. grey opaque sphere)
383	Object	Other than	Complexity	Object has a complete different complexity (shape) than expected	Parts of object are identical	Mismatch of object parts in stereo lead to wrong depth or shape recognition	Locally simple repeating parts of an object that is otherwise complex (e.g. house facade with a regular grid of windows)

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Table 1: Full table of specialized hazard list for the stereo vision task

hid	Loc	GW	Par	meaning	consequence	hazard	entry
444	Object	No	Texture	Object has no texture	Object is either monochrome, or is highly reflective or transparent	Texture-based CV alg. will not work	Large parts of the image are completely textureless
449	Object	Less	Texture	Object has less texture than expected	Texture is no significant identification property	Texture-based CV alg. is hampered	Two objects at the same image height (on epipolar lines) have very little texture thus allowing a mismatch
451	Object	As well as	Texture	Object has a mixture of periodic and aperiodic texture	Semi-periodic texture: periodic at coarse LOD, but differences in detail	Object not correctly recognized	Texture of a large object is periodically repeating on a coarse level while small local variations exist
457	Object	Spatial periodic	Texture	Obj.texture is periodic	Same appearance of texture on different parts of objects	Object parts are confused	Texture on epipolar line is highly repetitive (coarse and detail level) and mostly normal to the screen (nearly no perspective distortion)
458	Object	Spatial periodic	Texture	Obj.texture is periodic	If the period undercuts half the resolution of the observer spatial aliasing occurs	Stereo alg.s compute wrong depth maps due to mismatch of texture cells	Fine-structured texture undercuts spatial resolution of the sensor. Aliasing artifacts create a different moire patterns for the two images
459	Object	Spatial aperiodic	Texture	Obj. texture is aperiodic	Texture does not precisely repeat, but variations are irrelevant	Irregular (stochastic) mismatches in stereo images	A large area is loosely periodically tiled (w.r.t. epipolar lines) but the tiling is not perfect (e.g. floor tiling with some variations)
468	Object	Remote	Texture	Two very different textures are touching on the same object	Borders between the textures create strong contrast there	Object recognition hampered, if border between textures creates new visual artifacts	Two prominent textures on the same object are creating a very distinct border region where they collide. This border region is only visible by one camera but occluded for the other

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hid	Loc	GW	Par	meaning	consequence	hazard	entry
476	Object	No	Reflectance	Obj. has no reflectance	No light reflected	Object confused with shadow	Well-lit scene contains a very dark/black object that appears to have has neither texture nor shading due to its low albedo
478	Object	More	Reflectance	Obj. has much Refl. (more than expected)	Shiny surface - mirror	Object not recognized	Object has strongly reflecting material that creates an arbitrary mirror-image as the object's texture
479	Object	More	Reflectance	Obj. has much Refl. (more than expected)	Overexposure of the observer	Reflected objects taken for real	Object has strongly reflecting material that mirrors larger parts found on the same epipolar line
481	Object	As well as	Reflectance	Obj. has both shiny and dull surface	Diffuse reflection with highlight/glare	Object recognition distorted by glares	Object has a large glare spot on its surface that obscures different areas in the left/right image; this happens when the glare inducing l.s. is positioned near to object and observer
482	Object	As well as	Reflectance	Obj. has both shiny and dull surface	Diffuse reflection with highlight/glare	Local overexposure due to glares	Object has a large glare spot on its surface that obscures same areas in the left/right image
502	Object	More	Transparency	Obj. is highly transparent	Transparent object	Object not recognized	Highly transparent empty object covers large parts of the scene, the scenery behind the object is clearly visible
504	Object	More	Transparency	Obj. is more transparent than expected	Transparent object	Objects within it not correctly recognized due to distortions, e.g. through glass	Highly transparent object encompassing a second opaque object that gets distorted due to the transparent object's shape
509	Object	As well as	Transparency	Obj. is both more and less transp. than expected	Obj. consists of parts with high and low transparency	Object itself and objects behind it are merged	Scene contains a large object with a mixture of high transparency and low transparency. The object and the scenery behind it are close to both cameras so that occlusions occur
523	Object	In front of	Transparency	Objects in front of a transparent object are visible together with the other object	Objects in front of a transparent object are visible together with the other object	Objects are confused	Two transparent objects are entangled in such a way that both allow the view on the other object. They are arranged on epipolar lines so that different parts might get faulty correlations

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Table 1: Full table of specialized hazard list for the stereo vision task

hid	Loc	GW	Par	meaning	consequence	hazard	entry
536	Objects	No	Number	No objects	Scene with no objects (only l. s.s and media)	Non-existing objects might erroneously be reported by CV alg.	Scene without visible objects of any kind; only homogeneous medium and pixel noise is visible
539	Objects	More	Number	More objs. than expected	Scene is more complex than expected	False negatives: objects are missed	Scenery made up of many individually different objects at different distances that clutter the scene and create a highly variating disparity range
542	Objects	More	Number	More objs. than expected	Scene is more complex than expected	An object is covered such that uncovered parts are interpreted as belonging to different objects	Two objects occlude different parts of two other objects. The occluded parts are the exact/near copies of the vice-versa occluded part -> the first object occludes something that the second occluder reveals (and vice-versa)
555	Objects	Spatial periodic	Number	Object arrangement is periodical	Observer resolution and windowing have to be appropriate to capture a characteristic arrangement	If resolution of field of view are not appropriate detection based on characteristic arrangements is corrupted	Highly periodic placement of identical objects along the epipolar line creates repeating structures which lead to potential mismatches
561	Objects	In front of	Number	A number of obj. is in front of each other (in respect to the observer)	They cover each other	They are indistinguishable	Identical objects are arranged in such a way that one of the objects completely covers the other object in one of the images. Thus the covering object can create faulty matches with the covered object
570	Objects	More	Positions	More discrete relative Pos.s of Obj.s than expected	Object positions are quantized at a greater resolution than expected	CV alg. expects discrete positions but gets positions in between them confused	Subpixel-Accuracy can be tested by special test data sets (e.g. images with exactly 0.5 or 0.3333 pxl of disparity etc.)

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Table 1: Full table of specialized hazard list for the stereo vision task

hid	Loc	GW	Par	meaning	consequence	hazard	entry
586	Objects	Spatial periodic	Positions	Objects are located regularly (different kind)	Different kind of objects appear in a geometrically regular pattern	Only regularity detected, but not the individual objects	Similar objects (but not identical) are arranged in a highly periodic fashion on the epipolar line
608	Objects	More	Occlusion	More objects occlude each other than expected	Less details of objects are visible	Detection quality is decreased by less information of needed Objects	Some objects are positioned at two distinct distances. The frontal objects create considerable occlusions that might prevent the correlation of the backside objects
626	Objects	Spatial aperiodic	Occlusion	Occl. creates a chaotic /unordered pattern	Occlusions are chaotic	CV alg. is not handling occlusions correctly	Scene is dominated by an aperiodically perforated object near to the observer thus occluding many parts of the scene behind the object
651	Objects	More	Shadowing	More shadowing than expected	Large parts of scene in shadow	Underexposure: objects in shadow not detected	Large parts of a well lit scene are underexposed due to large shadows cast by objects not seen in the scene.
655	Objects	Less	Shadowing	Less shadowing than expected	More parts of scene in light than usual	Overexposure: similar to No	Largely open space with little shadows creating an overexposed lighting condition
666	Objects	Where else	Shadowing	Reflecting obj. is within shadow	Reflecting object is less recognizable than if illuminated	Reflecting objects in shadow remain undetected	Scene contains a highly reflective object in a shadowed area which reflects a well-lit object into both cameras. Both objects are relatively near to the two cameras so that the reflection of the object appears at different parts of the mirroring object
671	Objects	Spatial periodic	Shadowing	Spatial periodic shadows, there is some order/rule as to what parts of an object are shaded	Regular shadows creates a pattern	CV alg. confuses shadow pattern with object	Highly periodic shadows along epipolar line creates repeating structures which lead to potential mismatches

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Table 1: Full table of specialized hazard list for the stereo vision task

hid	Loc	GW	Par	meaning	consequence	hazard	entry
687	Objects	More	Reflectance	There are more reflections between objects than expected	Creates multiple views within the scene	CV alg. might confuse reflectance with reality and infer wrong position/relation data	Both object and its clear reflection are visible on the same epipolar line (and same distance) in both left+right image. The mirrored object is symmetric (mirror image looks like the original object) which can lead to a faulty correlation.
688	Objects	More	Reflectance	There are more reflections between objects than expected	Can create multiple visible instances of the same object	CV alg. detects more objects than there are in the scene	Both object and its clear reflection are visible on the same epipolar line (and same distance) only in one of the two images (the other image shows only the object itself). The mirrored object is symmetric (mirror image looks like the original object) which can lead to a faulty correlation.
693	Objects	Part of	Reflectance	A reflection on an object is partially visible	A highlight in an object is partially covered by another	Overblending - partial hampering of correct situation recognition	A prominent glare spot is only visible in one of the two images
694	Objects	Reverse	Reflectance	Observer sees itself in a reflection instead of expected object	Own body/ observer itself visible as an object	CV alg. confuses observer/its own body with other objects	Scene contains a clear reflection of observer (e.g. camera head, measurement vehicle) that is epipolar aligned with objects/parts that look like parts of the observer thus leading to a potential mismatch
695	Objects	Reverse	Reflectance	Refl. are reversed	Object reflections appear reversed to expected, e.g. upside down, or laterally inverted	CV alg. confused	Scene contains a large concave mirror that shows an clean upside-down copy of parts of the scenery
698	Objects	Where else	Reflectance	Refl. Obj. is Transp.	On Obj.s. surface, reflected and seen through objects merge	Misinterpretation of reflecting object and its associated images	Objects surface shows a blend/mixture of clear reflectance as well as transparently parts behind the image

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Table 1: Full table of specialized hazard list for the stereo vision task

hid	Loc	GW	Par	meaning	consequence	hazard	entry
699	Objects	Spatial periodic	Reflectance	Refl. creates an ordered pattern	Ordered reflectance creates a pattern	CV alg. confuses reflectance pattern with object or textures	Highly periodic clear reflection of the same object along epipolar line creates repeating structures which lead to potential mismatches
701	Objects	Spatial aperiodic	Reflectance	Refl. creates a chaotic /unordered pattern	Refl. is chaotic/irregular	CV alg. confused by irregular reflectance -> misdetections	Large parts of the image show an irregular specular reflection (mirror-like but with lots of distortions; not a diffuse reflectance)
707	Objects	Close	Reflectance	Refl. Obj. is closer to Observer than expected	Reflections are larger and/or brighter than expected	Overexposure: reflection too bright	A large prominent glare spot is created by a l. s. right next to the observer (but not directly visible on the images)
709	Objects	Remote	Reflectance	Refl. Obj. is more remote from reflected object than expected	Association between real obj. and mirror image lost	False positive. mirror image reported as real object	Both object and its clear reflection are visible on the same epipolar line in both images but are positioned at different distances. The mirrored object is symmetric (mirror image looks like the original object) which can lead to a faulty correlation.
719	Objects	Behind	Reflectance	Refl. obj. behind observer	If also a reflecting object in front of observer, infinite reflections can occur	CV alg. confused	Observer is placed between two large parallel mirror facing each other so that "infinite" number of reflections occur
729	Objects	Part of	Transparency	Parts of an object are transparent and allow a part of another object to be seen	Complex mixture of multiple objects visible through projection although the objects are not intertwined	Misdetection of objects as appearances are changed	Object has transparent parts that show a different object while other parts remain opaque
735	Objects	Spatial periodic	Transparency	Transp. creates an ordered pattern	Regular transparencies in scene	CV alg. confuses transparency pattern with object	Highly periodic placement of windows/holes/clearings along epipolar line creates repeating view of a uniform background which lead to potential mismatches

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Table 1: Full table of specialized hazard list for the stereo vision task

hid	Loc	GW	Par	meaning	consequence	hazard	entry
748	Objects	In front of	Transparency	Transp. obj. in front of another Transp. obj.	Transparency effects accumulate	Objects not correctly separated	Two transparent objects are positioned behind each other so that the scenery behind the last object is still clearly visible (e.g. looking through two windows in series)
754	Objects	More	Wave	More interferences between objects than expected	Accumulation of optical effects such as halos, rainbows, auras etc.	CV alg. confused - misinterpretation of visual effects	Scene contains a prominent rainbow effect (mist/haze with a view dependent colour band). This normally only occures with a strong l.s. in behind the observer
758	Objects	Spatial periodic	Wave	Spatial periodic variation of Wave effects (of some objects)	Interferences occur regularly in scene	Confusion of objects causing interference effects	Scene contains pronounced refraction rings (e.g. oil slick)
790	Obs. Opto.	Close	Number	All observers are close to each other (short baseline)	Short baseline makes triangulation results less accurate since the displacement of corresponding images pts. is smaller	Camera pose estimation fails or is inaccurate	Easy to produce by supplying the same images for left/right
803	Obs. Opto.	More	Field of View	Observer uses a bigger FOV than expected	Focal length smaller than expected	More distant entities not detected	Scene has a wide FOV (>135deg)
883	Obs. Opto.	Part of	Viewing position	VPos is Part of scene (within scene)	Sensor too close to scene - scene partially defocused	Defocused objects not correctly recognized	In a scene with considerable depth of field: slightly near objects visible by both cameras are out of focus (near plane)
892	Obs. Opto.	Spatial aperiodic	Viewing position	Observer position is not constrained (perhaps within a given range)	Additional uncertainties due to arbitrary position of observer	Additional uncertainties introduce additional uncertainties for the position estimation of objects	Relative position between cameras slightly changed compared to their initial positions/orientations; Extrinsic calibration is thus slightly off

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Table 1: Full table of specialized hazard list for the stereo vision task

hid	Loc	GW	Par	meaning	consequence	hazard	entry
898	Obs. Opto.	Remote	Viewing position	VPos is more remote from scene than expected	Object distance is bigger than expected (out of focus)	Relevant scene details not recognized	In a scene with considerable depth of field: slightly distant objects visible by both cameras are out of focus (far plane)
899	Obs. Opto.	Remote	Viewing position	VPos is more remote from scene than expected	Object have less details than expected	Objects distances estimated less accurate	Scenery is in focus but all parts are far away (only small disparities)
904	Obs. Opto.	Faster	Viewing position	Observer moves faster than expected	Motion blur more likely with longer exposures	Blurred objects misdetected	Image has parts with clearly visible motion blur
916	Obs. Opto.	Part of	Transparency	Part of optics are less transparent than expected (e.g. dirt on lens)	Defocused areas	Misinterpretation due to thick dust irregularly distributed on lens surfaces	One camera lenses contain dust/dried mud that creates a partially defocused area in the image
918	Obs. Opto.	Part of	Transparency	Observer block part of the image	Parts of the image are black	(Partially) Blocked Objects are not detected	Lens body/lens hood is prolonged and its corners are thus blocking the view
921	Obs. Opto.	Other than	Transparency	The transparency of sensor optics is completely different from expected, e.g. due to broken lenses	The scene looks completely differently than expected, e.g. parts of it are multiplied	Strong confusion of CV alg. if fault not detected	Lens is broken cleanly through parts of the center region, apart form the crack the remaining image is clear and sharp
922	Obs. Opto.	Where else	Transparency	Lens body is not completely light proof, light can reach sensor from the side of the body	Flare effects	Overexposure of parts of the scene	Image has pronounces flare effect visible without the emanating l. s. associated with it

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Table 1: Full table of specialized hazard list for the stereo vision task

hid	Loc	GW	Par	meaning	consequence	hazard	entry
926	Obs. Opto.	Spatial aperiodic	Transparency	The transparency of the lenses changes in a spatially irregularly manner,	The intensity of the image is irregularly reduced	In particular, dense stereo vision is significantly hampered, since pollution is very likely different for both cameras.	Two cameras both have considerable comparable amount of dirt/pollution but with different distributions
933	Obs. Opto.	Before	Transparency	Shutter opens or closes before this is expected	Photoelectric events are exposed to light out of schedule	Rolling Shutter is causing artifacts which are misinterpreted as object properties	Images contain rolling shutter artifacts (both cameras are triggered at the same time but moving objects get distorted due to the rolling shutter)
955	Obs. Opto.	Where else	Spectrum	Different parts of spectrum are transmitted to different locations (chromatic aberration)	Washed-out/Defocused edges	Stereo imaging: matching preciseness decreased	Scene with considerable chromatic aberration and many visible edges
961	Obs. Opto.	More	Lenses number	More lenses are in lens assembly than expected	More reflections between lenses	Lens reflections are misinterpreted as textures or objects	Lens creates double images of parts from the scenery
982	Obs. Opto.	More	Lenses geometry	More optical effects due to strongly curved lens surfaces	Distortion: barrel or pincushion	Distortion: scene geometry misinterpreted	Image with radial distortion not perfectly removed (e.g. somewhat bad intrinsic calibration)
983	Obs. Opto.	More	Lenses geometry	More optical effects due to strongly curved lens surfaces	Vignetting: image darkening toward the edges	Vignetting: increased	Images have considerably amounts of vignetting and scene contains many objects close to the observer
989	Obs. Opto.	Less	Lenses geometry	Less optical corrections due to weakly curved lens surfaces	Focus range is limited in distance (long-sighted)	Close objects defocused - poorly recognized	Scene contains some sharp parts in the background and increasingly out-of-focus parts in the foreground

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Table 1: Full table of specialized hazard list for the stereo vision task

hid	Loc	GW	Par	meaning	consequence	hazard	entry
998	Obs. Opto.	Spatial aperiodic	Lenses geom.	Spatial aper. disturbance or imperfections of lens geometry	Bright rays virtually emanate from bright objects within scene	Objects in defect zones of image are not detected correctly	Scratches or rain drops in front of the lens create long bright streaks emanating from all l. s.s in the scene (lens flare?)
1016	Obs. Opto.	Less	Focusing	DoF is smaller than expected	Essential scene parts are out of focus	Blurred image areas misinterpreted as being empty or "medium only"	Images background and main objects in the scene are out of focus
1059	Obs. Opto.	Where else	Aperture	Aperture form is projected into different places within the image	Chromatic aberration in shape of aperture (See More Colour)	Aperture projection is mistaken for an object	Bokeh is visible on the image and has a shape and position to make it prone to confusions with other parts of the image. Critical case for stereo vision: Bokeh and confusion object lie on the same epipolar line
1090	Obs. Opto.	No	Optical Point Spread Function	No optical blurring before discretisation	Staircasing of edges and lines, Aliasing artifacts	Apparent texture differs from true texture	Image contains strong aliasing artifacts
1091	Obs. Opto.	No	Opt. PSF	No optical blurring before discretisation	Moire patterns in intensity and colour of repetitive textures	Unpredictable differences between appearance of corresponding points/regions	Very different textures in left and right image due to large scale Moire effects
1094	Obs. Opto.	More	Opt. PSF	PSF's extent is larger than expected	Loss of contrast, PSF effects a bigger neighbourhood of pixels	Loss of small objects	One of the two sensors is somewhat out of focus
1105	Obs. Opto.	Spatial periodic	Opt. PSF	Periodic pattern visible in the PSF, *i.e.* The PSF is spatially periodic	Additional small scale blurriness creating a spatial pattern	Contours of objects are duplicated and create possibility for confusions	Inter-lens reflections create visible copy of objects in the image

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Table 1: Full table of specialized hazard list for the stereo vision task

hid	Loc	GW	Par	meaning	consequence	hazard	entry
1120	Obs. Electr.	More	Exp./Shutter	Longer exposure time than expected	More light captured per image than expected	Overexposure	One of the two images is largely overexposed while the other still shows a lot of detail
1123	Obs. Electr.	Less	Exp./Shutter	Shorter exposure time than expected	Less light captured per image than expected	Underexposure	Large image area is underexposed and shows a lot of blacklevel noise there
1126	Obs. Electr.	As well as	Exposure and shutter	Multiple exposures	Multiple frames superimposed into one image	Movement is miscalculated	Two previous frames are blended/combined into one image
1162	Obs. Electr.	Part of	Resolution (spatial)	Only along one dimension Resol. is different from expected	Only along one dimension Resol. is different from expected	Image/pixel ratio other than expected leading to image distortions	Image before rectification originates from considerably rectangular pixels (instead of square, near to e.g. 2:1 ratio)
1166	Obs. Electr.	Part of	Resolution (spatial)	Part of pixel area is insensitive	Part of pixel area is insensitive	Noise increased	Images contain strong static image noise for well-lit scenes
1168	Obs. Electr.	Reverse	Resolution (spatial)	Resolution is n*m instead of m*n	Resolution is n*m instead of m*n	Size of pixel lines and columns reversed, but number of pixels per image as expected	Image has a considerably larger height than width (untypical image dimensions)
1222	Obs. Electr.	Less	Quality	More overflow effects than expected	E.g. blooming	Blooming effects misinterpreted as objects or object parts	Large difference in light intensity between indoor and outdoor creates large blooming effects around the edges of a window
1261	Obs. Electr.	Reverse	Quantization/Sampling	Pixel intensity is encoded inverse to expected	Image is encoded as its "negative"	Scene recognition breaks down	One camera delivers image negative instead

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Table 1: Full table of specialized hazard list for the stereo vision task

hid	Loc	GW	Par	meaning	consequence	hazard	entry
1265	Obs. Electr.	Other than	Quantization/Sampling	Quantisation is other than expected	Intensity output is other than expected	Colours and shadows misinterpreted, derived scene geometry has systematic deviations	Images use logarithmic quantization instead of linear (wrong gamma mapping; mid-tones are washed out)

4. Found Hazard Frames (Accepted as well as Disputed)

Table 2. Accepted Hazard Frames from the Freiburg Dataset

HID	Frame
22	driving/15mm_focallength_scene_forwards_slow/_frame_0298
45	driving/15mm_focallength_scene_forwards_slow/_frame_0200
125	driving/15mm_focallength_scene_forwards_slow/_frame_0064
142	driving/15mm_focallength_scene_forwards_slow/_frame_0652
271	monkaa/a_rain_of_stones_x2/_frame_0051
305	monkaa/family_x2/_frame_0101
326	driving/15mm_focallength_scene_forwards_slow/_frame_0165
476	driving/15mm_focallength_scene_backwards_slow/_frame_0475
481	driving/15mm_focallength_scene_forwards_slow/_frame_0697
561	monkaa/treeflight_x2/_frame_0187
651	driving/35mm_focallength_scene_backwards_slow/_frame_0751
729	driving/35mm_focallength_scene_forwards_slow/_frame_0073
899	monkaa/top_view_x2/_frame_0071
904	driving/15mm_focallength_scene_backwards_slow/_frame_0487
1016	monkaa/funnyworld_camera2_augmented0_x2/_frame_0045
1090	monkaa/treeflight_augmented0_x2/_frame_0100

Table 3. Accepted Hazard Frames from the HCI Dataset

HID	Frame
7	0_0065_frame_02584
22	0_0038_frame_03216
45	0_0065_frame_02480
46	0_0068_frame_02652
47	0_0068_frame_02636
52	0_0026_frame_02296
125	0_0059_frame_04656
141	0_0038_frame_03784
142	0_0038_frame_03488
244	0_0013_frame_08000
444	0_0026_frame_02312
539	1_0014_frame_03408
555	1_0075_frame_05436
666	0_0026_frame_01992
701	0_0068_frame_02492
922	1_0075_frame_05044

Table 4. Accepted Hazard Frames from the KITTI Datasets

HID	Frame
0	kitti2015_000104_frame_10
26	kitti2012_000071_frame_10
50	kitti2015_000144_frame_10
125	kitti2012_000116_frame_10
141	kitti2015_000104_frame_10
142	kitti2012_000120_frame_10
459	kitti2012_000026_frame_10
482	kitti2012_000051_frame_10
651	kitti2012_000010_frame_10
655	kitti2012_000191_frame_10
666	kitti2012_000136_frame_10
701	kitti2012_000193_frame_10
904	kitti2012_000097_frame_10
922	kitti2012_000074_frame_10

Table 5. Accepted Hazard Frames from the Middlebury Datasets

HID	Frame
22	middl_2014_add_Classroom1_perfect_frame_L3_E6
50	middl_2006_orig_Midd1_frame_illum_2_expo_2
52	middl_2006_orig_Monopoly_frame_illum_3_expo_2
125	middl_2006_orig_Midd2_frame_illum_3_expo_1
376	middl_2014_train_orig_Recycle_frame_0
444	middl_2006_orig_Plastic_frame_illum_2_expo_1
449	middl_2005_orig_Laundry_frame_illum_2_expo_2
451	middl_2014_train_orig_Pipes_frame_0
476	middl_2014_train_orig_Jadeplant_frame_0
482	middl_2014_train_orig_Vintage_frame_0
608	middl_2014_train_orig_Jadeplant_frame_0
626	middl_2014_add_Sword2_perfect_frame_L0_E3
735	middl_2005_orig_Laundry_frame_illum_3_expo_1
892	middl_2014_train_orig_PlaytableP_frame_0

Table 6. Accepted Hazard Frames from the Sintel Dataset

HID	Frame
52	sleeping_1_frame_0050
141	shaman_3_frame_0001
142	market_5_frame_0002
183	mountain_1_frame_0031
305	ambush_2_frame_0004
321	ambush_2_frame_0014
326	ambush_2_frame_0012
365	ambush_4_frame_0011
449	shaman_3_frame_0032
459	market_6_frame_0004
539	bamboo_2_frame_0011
883	bandage_2_frame_0011
898	bandage_2_frame_0011
899	mountain_1_frame_0050
904	ambush_2_frame_0004
989	ambush_2_frame_0014

Table 7. Disputed Hazard Frames from the Freiburg Dataset

HID	Frame
52	driving/15mm_focallength_scene_backwards_slow/_frame_0133
141	driving/15mm_focallength_scene_backwards_slow/_frame_0796
259	monkaa/lonetree_augmented1_x2/_frame_0446
321	driving/35mm_focallength_scene_forwards_slow/_frame_0081
383	driving/15mm_focallength_scene_backwards_slow/_frame_0140
555	monkaa/treeflight_x2/_frame_0017
671	driving/15mm_focallength_scene_backwards_slow/_frame_0615

Table 8. Disputed Hazard Frames from the HCI Dataset

HID	Frame
6	0_0038_frame_03216
21	0_0038_frame_03720
47	0_0068_frame_02796
321	1_0026_frame_02760
326	0_0026_frame_02328
376	0_0013_frame_08392
383	0_0050_frame_08696
449	0_00_23_frame_02500
451	0_0000_frame_04816
457	0_0013_frame_08392
459	0_0050_frame_08600
478	0_0026_frame_02272
481	0_0000_frame_04904
482	0_0038_frame_03224
502	0_0013_frame_07968
542	1_0026_frame_02616
561	1_0014_frame_03352
608	0_0000_frame_04400
626	0_0059_frame_09972
655	0_0068_frame_02476
688	0_0038_frame_03728
693	0_0038_frame_03424
698	0_0000_frame_04936
701	0_0026_frame_02304
707	0_0068_frame_02580
729	0_0026_frame_02152
748	1_0032_frame_02364
899	0_0067_frame_03900
998	0_0038_frame_03536
1059	0_0065_frame_02504

Table 9. Disputed Hazard Frames from the KITTI Datasets

HID	Frame
21	kitti2012_000071_frame_10
26	kitti2015_000061_frame_10
46	kitti2012_000074_frame_10
50	kitti2012_000020_frame_10
459	kitti2015_000088_frame_10
509	kitti2015_000058_frame_10
539	kitti2012_000116_frame_10
586	kitti2012_000193_frame_10
655	kitti2015_000169_frame_10
671	kitti2012_000143_frame_10
707	kitti2012_000193_frame_10
922	kitti2015_000062_frame_10

Table 10. Disputed Hazard Frames from the Middlebury Datasets

HID	Frame
0	middl_2014_add_Cable_perfect_frame_L1_E7
275	middl_2006_orig_Bowling1_frame_illum_3_expo_1
383	middl_2001_orig_tsukuba_frame_3
449	middl_2014_train_orig_Playtable_frame_0
457	middl_2014_train_orig_Playtable_frame_0
458	middl_2006_orig_Wood2_frame_illum_2_expo_1
481	middl_2006_orig_Bowling1_frame_illum_2_expo_0
482	middl_2005_orig_Laundry_frame_illum_2_expo_1
539	middl_2014_train_orig_Playtable_frame_0
883	middl_2001_orig_map_frame_0
1123	middl_2006_orig_Baby3_frame_illum_1_expo_0

Table 11. Disputed Hazard Frames from the Sintel Dataset

HID	Frame
244	bamboo_2_frame_0007
275	bandage_1_frame_0028
451	market_6_frame_0005
481	ambush_6_0003
1123	shaman_3_frame_0050

Table 12. Summary of datasets and the associated url.

NAME	**YEAR**	**URL**
Middlebury	2002	http://vision.middlebury.edu/stereo/data/scenes2001/
Middlebury	2003	http://vision.middlebury.edu/stereo/data/scenes2003/
Middlebury	2007	http://vision.middlebury.edu/stereo/data/scenes2006/
EISATS S1	2008	http://ccv.wordpress.fos.auckland.ac.nz/eisats/set-1/
EISATS S2	2008	http://ccv.wordpress.fos.auckland.ac.nz/eisats/set-2/
EISATS S6	2009	http://ccv.wordpress.fos.auckland.ac.nz/eisats/set-6/
New College	2009	http://www.robots.ox.ac.uk/NewCollegeData/
Pittsburgh	2009	http://pfid.rit.albany.edu/
EVD	2011	http://cmp.felk.cvut.cz/wbs/#datasets
Ford Campus	2011	http://robots.engin.umich.edu/SoftwareData/Ford
HCI-Robust	2012	https://hci.iwr.uni-heidelberg.de/Robust_Vision_Challenge_2012
KITTI 2012	2012	http://www.cvlibs.net/datasets/kitti/eval_stereo_flow.php?benchmark=stereo
Leuven	2012	https://www.inf.ethz.ch/personal/ladickyl/Leuven.zip
Tsukuba	2012	http://www.cvlab.cs.tsukuba.ac.jp/dataset/tsukubastereo.php
HCI-Synth	2013	http://heidata.customers.aldago.com/dataset
Stixel	2013	http://www.6d-vision.com/ground-truth-stixel-dataset
Daimler Urban	2014	http://www.6d-vision.com/scene-labeling
Malaga Urban	2014	http://www.mrpt.org/MalagaUrbanDataset
Middlebury	2014	http://vision.middlebury.edu/stereo/data/scenes2014/
Cityscapes	2015	https://www.cityscapes-dataset.com/
KITTI 2015	2015	http://www.cvlibs.net/datasets/kitti/eval_scene_flow.php?benchmark=stereo
MPI Sintel	2015	http://sintel.is.tue.mpg.de/stereo
Freiburg CNN	2016	http://lmb.informatik.uni-freiburg.de/resources/datasets/SceneFlowDatasets.en.html
HCI Training	2016	http://www.hci-benchmark.org/dataset
SYNTHIA	2016	http://synthia-dataset.net/
Virtual KITTI	2016	http://www.xrce.xerox.com/Research-Development/Computer-Vision/Proxy-Virtual-Worlds
Oxford RobotCar	To appear	http://robotcar-dataset.robots.ox.ac.uk/