

***Align Technology, Inc.,
Petitioner,***

V.

***Dental Monitoring SAS,
Patent Owner***

IPR2024-00052 & IPR2024-00110

U.S. Patent Nos. 11,049,248 & 11,109,945

Patent Owner's Demonstratives

▶ State of the Art for Aligner Fit Assessment	3
▶ '248 Patent	8
▶ No Motivation to Assess Aligner Fit from Aligner Images	11
▶ No Motivation to Combine Kim, Invisalign, and Salah with Maninis	25
▶ Maninis is Not Prior Art	47
▶ Level of Skill in the Art	51
▶ Semantic Contours Are Not “Tooth Attributes” (Claims 7 and 14)	63
▶ Petitioner Identifies No Deep Learning Device That Can Train On or Output “Image Attributes” (Claim 8)	72
▶ '945 Patent	74

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State of Art – In Person Assessment of Aligner Fit

Undisputed dental evidence explains that aligners were assessed visually and manually

Fitting Invisalign (EX2055), 2^[1]

Good Fit



Poor Fit



Kusnoto Decl. (EX2030), ¶¶44, 49

¶44: “As of July 2017, effective conventional aligner treatment required frequent and regular in-person orthodontic examinations.”

¶49: “[E]ach aligner was visually and manually examined for large gaps between the aligner and the teeth.”

¶49: “Using their hands, the orthodontist would manually examine the aligner for potential rocking (that is, movement of one part of the aligner off of a patient’s teeth when pressure is applied to another part of the aligner).”

State of Art – In Person Assessment of Aligner Fit

Undisputed dental evidence explains that cellphone images were not used

Fitting Invisalign (EX2055), 2



Kusnoto Decl. (EX2030), ¶¶45, 51, 60

¶45: “These in-person examinations did not involve quantitative measurements concerning aligner fit.”

¶51: “In July 2017, it was not standard of care to rely on images of aligners in the service position, let alone images captured using a cellphone camera, to evaluate aligner fit.”

¶60: “Although Invisalign includes certain photos, a POSA would have understood that these photos were simply examples of what an orthodontist might observe during an in-person appointment. There is no suggestion in Invisalign that those images were taken remotely, for example, using a cellphone, or that such images could be used for the remote or virtual assessment of aligner treatment.”

State of Art – In Person Assessment of Aligner Fit

Undisputed dental evidence explains that high quality dental images required training

Kusnoto Decl. (EX2030), ¶¶28, 32, 33

¶28: “[A]s of 2017, these standard orthodontic photographs were captured by dental professionals during in-office patient appointments.”

¶32: “Once the patient, retractor, and mirror (if one was needed for the specific view) were in position, the dental professional in 2017 would acquire the standard set of images, typically with a DSLR camera setup. This setup usually comprised a DSLR camera, a specific type of lens, and a ring light.”

¶33 “Acquiring the standard orthodontic images required specialized training that dental professionals would begin in dental school and continue to receive throughout their careers.”

- In 2017, **cellphones could not** capture high quality dental images

Provisional Patent Appl. to Carrier (EX2064), [004]

uncomfortable to the patient. Some doctors and dental technicians may instead attempt to capture dental photos using a mobile phone. However, mobile phones typically have a wide angle camera lens. If a camera of a mobile phone is held sufficiently close to the teeth of the patient to provide an image of the teeth having a high level of detail, dental photos may be blurry and have optical distortion. If the camera of the mobile phone is too far to the teeth, dental photos cannot meet the orthodontic standards. In general, commonly available cameras, and particularly mobile phone cameras, may be faster and easier to use.

State of Art – In Person Assessment of Aligner Fit

Undisputed dental evidence that deep learning was not accepted in the dental field

Kusnoto Decl. (EX2030), ¶86

¶86: “The use of deep learning or machine learning in the acquisition and/or analysis of dental photographs had not been accepted by the dental community as of July 2017.”

¶86: As Align’s dental expert, Dr. Valley, has previously opined, ‘the dental and orthodontic field’ is ‘a very conservative field,’ and ‘[i]t takes a while before new methods become mainstream.’ EX2036 [Valley Dep. Tr. IPR-2019-000132], 50:3-5, 50:19-24. ... This is because our decisions to adopt new technologies impact patient outcomes. As a field, we were thus very cautious to change how we did things.”

- **No** evidence of computer-aided or deep learning analysis of aligner images
- **Only** reference that discusses non-human image analysis in dental field is Salah, which does not even mention clear aligners

Salah (EX1008), 35:12-36:14

The following non-limiting methods, although not preferred, can also be used:

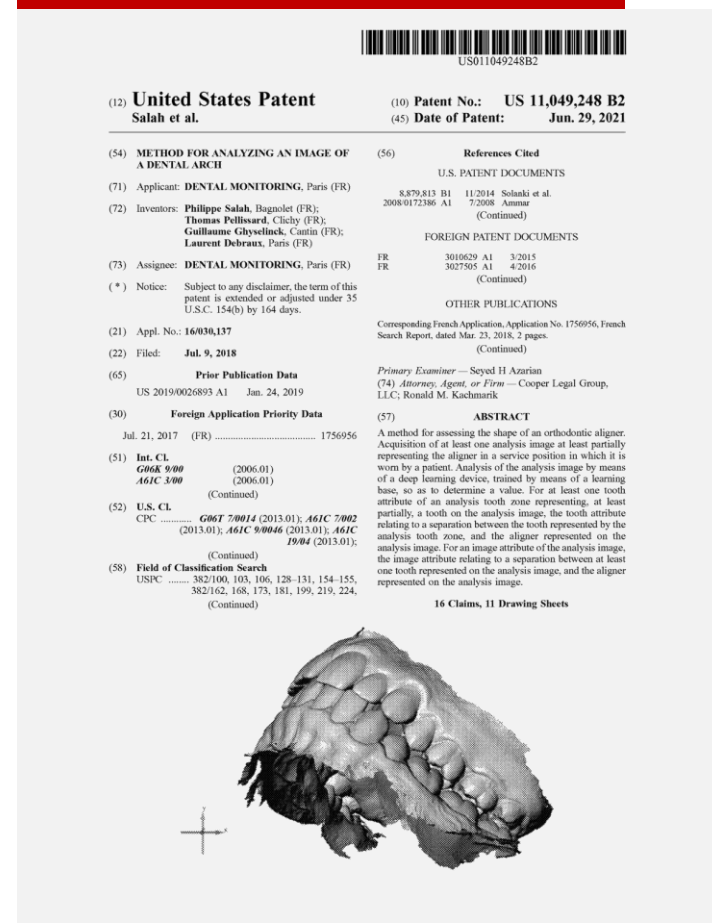
- by “Deepleraning” [sic].

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The Challenged '248 Patent

Groundbreaking method to assess aligner fit using deep learning device on cellphone aligner image

'248 Patent (EX1001)



1. A method for assessing the shape of an orthodontic aligner, said method comprising the following steps:

a") more than 1 week after the start of the treatment with the aligner, acquisition of at least one image at least partially representing the aligner in a service position in which it is worn by a patient, called “analysis image”, the analysis image being a photograph, or an image extracted from a film;

b") analysis of the analysis image by means of a deep learning device, trained by means of a learning base, so as to determine a value

for at least one tooth attribute of an “analysis tooth zone” representing, at least partially, a tooth on said analysis image, the tooth attribute relating to a separation between the tooth represented by the analysis tooth zone, and the aligner represented on the analysis image, in the step a”), a cellphone is used to acquire the analysis image.

The Challenged '248 Patent

Groundbreaking method to assess aligner fit using deep learning device on cellphone aligner image

'248 Patent (EX1001)

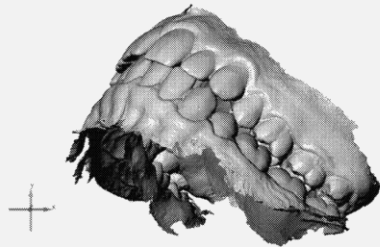
No prior art disclosure of acquiring aligner images and no motivation to assess aligner fit from aligner images

Guillaume Ghyselsack, Coutin (FR);
Laurent Debraux, Paris (FR)
(73) Assignee: DENTAL MONITORING, Paris (FR)
(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35

FOREIGN PATENT DOCUMENTS
FR 3010629 A1 3/2015
FR 3027505 A1 4/2016
(Continued)
OTHER PUBLICATIONS

No motivation and no reasonable expectation of success to train Maninis or use Maninis to perform the claimed analysis as proposed in Petition

(Continued)
(58) Field of Classification Search
USPC: 382/100, 103, 106, 128-131, 154-155,
382/162, 168, 173, 181, 199, 219, 224,
(Continued)
analysis image, for an image attribute of the analysis image,
the image attribute relating to a separation between at least
one tooth represented on the analysis image, and the aligner
represented on the analysis image.
16 Claims, 11 Drawing Sheets



1. A method for assessing the shape of an orthodontic aligner, said method comprising the following steps:
 - a") more than 1 week after the start of the treatment with the aligner, acquisition of at least one image at least partially representing the aligner in a service position in which it is worn by a patient, called "analysis image", the analysis image being a photograph, or an image extracted from a film;
 - b") analysis of the analysis image by means of a deep learning device, trained by means of a learning base, so as to determine a value for at least one tooth attribute of an "analysis tooth zone" representing, at least partially, a tooth on said analysis image, the tooth attribute relating to a separation between the tooth represented by the analysis tooth zone, and the aligner represented on the analysis image, in the step a"), a cellphone is used to acquire the analysis image.

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Kim's Method of Assessing Teeth Alignment Uses Teeth Positions

Kim never purports to disclose a novel way to assess aligner fit

Kim (EX1005)

US 20170281313A1

(19) United States
(12) Patent Application Publication
(43) Pub. No.: US 2017/0281313 A1
(45) Pub. Date: Oct. 5, 2017

(54) METHOD AND SYSTEM FOR PROVIDING REMOTE TEETH ALIGNMENT SERVICES AND COMPUTER-READABLE MEDIUM ON WHICH THE METHOD IS RECORDED
(52) U.S. CL. A61C 7/00 (2013.01); A61C 7/08 (2013.01); G06F 19/3418 (2013.01); G06K 9/00221 (2013.01)
(71) Applicant: eClear International Co., Ltd., Los Angeles, CA (US)
(72) Inventor: TAEWEON KIM, Seoul (KR)
(21) Appl. No.: 15/890,720
(22) Filed: Apr. 5, 2016

Publication Classification
(51) Int. CL. A61C 7/00 (2006.01); G06K 9/00 (2006.01); G06F 19/00 (2006.01)

ABSTRACT
Provided are a method and system for providing remote teeth alignment services, and a computer-readable medium on which the method is recorded. A method of providing remote teeth alignment services using a computer system including at least one orthodontic patient terminal, an orthodontist terminal, a clear aligner manufacturer terminal, and a server computer connected to a network includes receiving a teeth alignment report information inputted from the orthodontic patient terminal and storing the input teeth alignment report information, and transmitting the stored teeth alignment report information to the orthodontist terminal.

ALIGN EXHIBIT - 1005

Kim does:

- disclose assessing teeth alignment based on teeth positions
- disclose taking images of bare teeth and of bare aligners

Kim does not:

- assess aligner fit
- suggest taking images of **aligners in a service position**
- disclose any non-human analysis of any images, let alone using a deep learning device

Kim's "clear aligner information" is not:

- an image of the aligner in a service position
- used for diagnosis or treatment

IPR2024-00052:

Paper 20, 16-22, 51; EX2028, ¶¶68-86, 184-194; EX2030, ¶¶70-79

IPR2024-00110:

Paper 16, 20-27, 37, 43; EX2028, ¶¶66-83, 148-157; EX2030, ¶¶70-79

IPR2024-00052 & IPR2024-00110

DEMONSTRATIVE EXHIBIT – NOT EVIDENCE

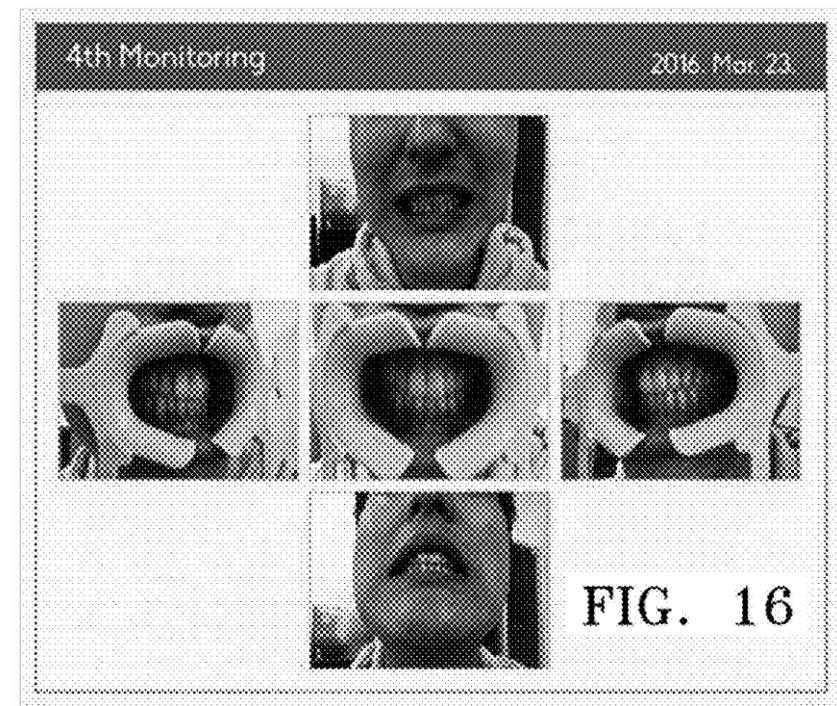
Kim's Method of Assessing Teeth Alignment Uses Teeth Positions

Kim never purports to disclose a novel way to assess aligner fit

- Teeth alignment assessment is **only** based on tooth positions
- Teeth alignment information can include **only** photographs of “teeth alignment state of the orthodontic patient”
- Kim's benefits of “reduced diagnosis time and cost” flow **only** from use of “teeth alignment information”

Kim (EX1005), [0010]

[0010] The present invention provides a method and system for providing remote teeth alignment services, by which an orthodontist may obtain accurate teeth alignment information using a device, e.g., a smartphone, of an orthodontic patient, may remotely and accurately diagnose the condition of the patient based on the teeth alignment information, and may remotely provide information about an accurate step of a clear aligner to be currently worn by the orthodontic patient, thereby greatly reducing a diagnosis time and cost of the orthodontic patient and the orthodontist, the accuracy of



Kim's Teeth Alignment Information Is Distinct From Clear Aligner Information

Assessing teeth alignment is distinct from assessing aligner fit

- Teeth positions **only** are used for diagnosis and treatment
- Images of **bare aligners** are used **only** to check the state of the aligner
- Kim uses “currently worn” to refer to the **current aligner** in the set of aligners, **not** to mean that it is in the patient's mouth

Kim (EX1005), [0063], [0041], [0066]

[0063] The teeth alignment guidance information transmission program 67 may be a program for receiving the teeth alignment report information and then transmitting the teeth alignment guidance information received from the orthodontist terminal 20, to the orthodontic patient terminal 10 in such a manner that the orthodontist accurately determines a current teeth alignment state of the orthodontist and advises, for example, an appropriate step of a clear aligner to be currently worn by the orthodontic patient.

[0041] For example, the orthodontic patient terminal 10 may be a device of an orthodontic patient who desires to remotely receive information about an accurate step of a clear aligner to be currently worn by the orthodontic patient, using the system of the present invention.

[0066] The clear aligner information transmission program 69 may be a program for receiving the clear aligner information about a currently worn clear aligner from the orthodontic patient terminal 10, storing the clear aligner information, and transmitting the clear aligner information to the orthodontist terminal 20 in such a manner that the orthodontist checks a photo or a video of the clear aligner currently worn by the orthodontic patient, and determines whether the clear aligner is normal and corresponds to an appropriate step.

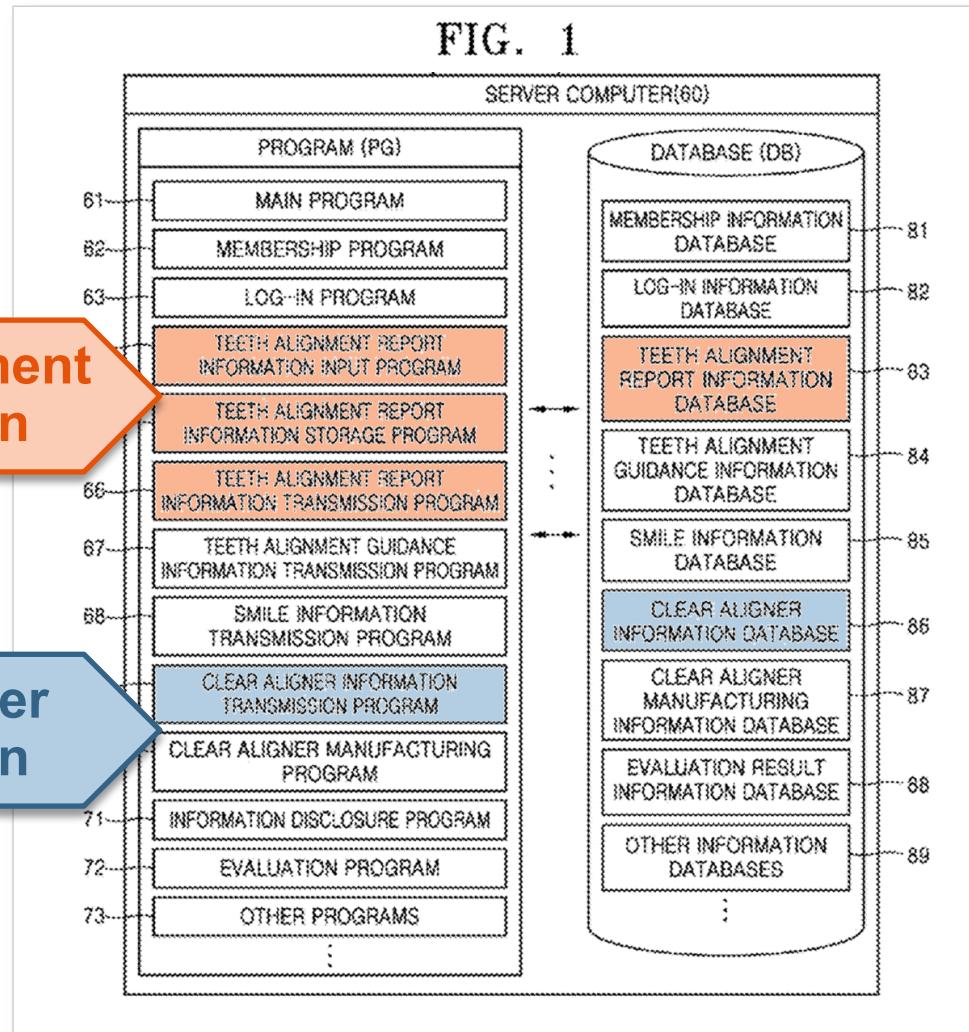
IPR2024-00052:
EX1005 [0063], [0041], [0066]; Paper 20, 16-22, 51; EX2028,
¶¶68-86, 184-194; EX2030, ¶¶70-79

IPR2024-00110:
EX1005 [0063], [0041], [0066]; Paper 16, 20-27, 37, 43; EX2028,
¶¶66-83, 148-157; EX2030, ¶¶70-79

IPR2024-00052 & IPR2024-00110
DEMONSTRATIVE EXHIBIT – NOT EVIDENCE

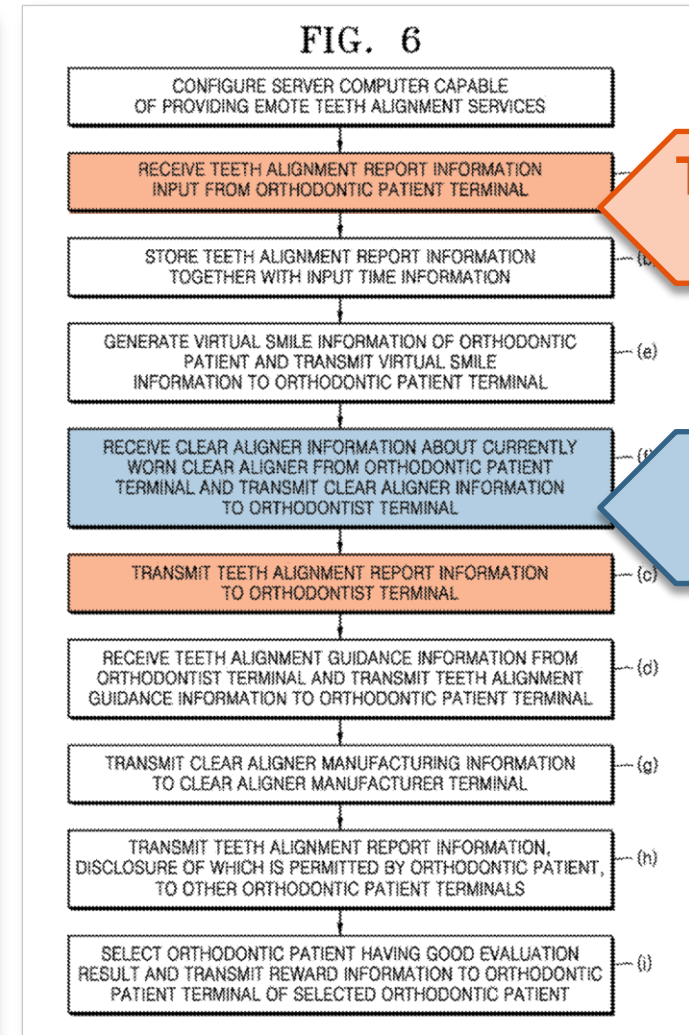
Kim's Teeth Alignment Information Is Distinct From Clear Aligner Information

Kim collects, processes, stores, and uses them differently



Teeth Alignment Information

Clear Aligner Information



Teeth Alignment Information

Clear Aligner Information

Invisalign Concerns In-Person Assessments of Aligner Treatment

Invisalign never purports to disclose a novel way to assess aligner fit

Invisalign (EX1006)



IPR2024-00052:
Paper 20, 22-26, 52-53 ; Paper 30, 18; EX2028, ¶¶87-96
184-194; EX2030, ¶¶58-69; EX2054, 66:8-15
IPR2024-00110:
Paper 16, 27-31, 38, 44; EX2028, ¶¶84-93, 148-157;
EX2030, ¶¶58-69; EX2054, 66:8-15

Invisalign:

- is a clinical guide “to help the Invisalign practitioner”
- is provided to “orthodontists and dentists”
- describes how to conduct in-office check-ups with steps taken “at every patient appointment” that cannot be performed remotely

Invisalign:

- is “not a remote treatment disclosure”
- does not suggest taking images of aligners in service position, let alone with a cellphone
- does not disclose any non-human analysis of any images
- provides no method to quantitatively measure separation

IPR2024-00052 & IPR2024-00110
DEMONSTRATIVE EXHIBIT – NOT EVIDENCE

Petitioner's Motivation to Combine Is Unsupported

Petitioner alleges that Figure A in Invisalign provides a motivation

Figure A is **not representative** of an aligner fit situation that an orthodontist would have seen in 2017

Petition (IPR2024-00052, Paper 2), 30



“Invisalign further illustrates that such a gap is visually distinguishable in a digital photograph of a patient's teeth that at least partially represents an aligner worn in a service position on the teeth.”



Petitioner's Motivation to Combine Is Unsupported

Dr. Foroosh admitted to having “no idea” if Figure A in Invisalign is representative

Unlike Dr. Foroosh, **Dr. Kusnoto does know** what an orthodontist would have encountered



Foroosh Tr. (EX2054), 45:8-19, 60:23-61:4

- A.** Again, you want me to provide an opinion of how things may be seen in a dentist's office. I'm not a dentist. I've never practiced as a dentist. I don't know how common it is, as you refer to it, to see this particular situation. I don't know. I have no idea.
- A.** Again, the people who have drafted this document, I know that some of them are probably dentists or orthodontist. I don't know what an orthodontist would encounter. I mean, I don't know the answer to a question.



Kusnoto Decl. (EX2030), ¶61

¶61: “[B]ased on my experience, this is an aligner that has been partially inserted to demonstrate the gap between teeth and aligners and is not representative of an aligner fit situation that would have been encountered by an orthodontist in 2017. . . . A POSA would also have recognized that most aligner unseats would have a substantially less visible gap.”



Petitioner's Motivation to Combine Is Unsupported

Petitioner incorrectly alleges that its combination uses methods known in the art

In 2017, orthodontists did **not** make quantitative evaluations of aligner fit from images and there was **no way** to do so

Petition (IPR2024-00052, Paper 2), 22-23

“This combination would be applying known methods for orthodontic evaluation of aligner fit based upon the appearance of the aligner worn on the patient's teeth, as taught by Invisalign in order to analyze a photo or video of the aligner worn by the patient, as taught by Kim, thereby providing feedback regarding tooth-aligner separation to aid an orthodontist regarding whether the clear aligner is normal and corresponds to an appropriate step of treatment.”



Invisalign does **not teach evaluation of aligner fit based simply upon the appearance**



Kim does **not teach analysis of a photo or video of the aligner worn by the patient**

IPR2024-00052:

Paper 2, 22-23; Paper 20, 47-54; Paper 30, 13-17; EX2030,
¶¶45, 64, 69

IPR2024-00110:

Paper 2, 20; Paper 16, 36-41, 43-46; Paper 25, 7-10; EX2030,
¶¶45, 64, 69

IPR2024-00052 & IPR2024-00110
DEMONSTRATIVE EXHIBIT – NOT EVIDENCE

Petitioner's Motivation to Combine Is Unsupported

Dr. Foroosh does not know how orthodontists assess separation in-person

Unlike Dr. Foroosh, **Dr. Kusnoto does know** how an orthodontist assessed aligner fit



Foroosh Tr. (EX2054), 74:9-16, 13:11-15

- Q.** Does Invisalign tell an orthodontist how to measure whether a gap is within or over 1 millimeter?
- A.** Again, how an orthodontist makes that measurement is out of the scope of my expertise, out of, I'm going to say, my pay grade. But **how orthodontists make those measurements, I don't know.**
-
- Q.** And **Kim generally relates to diagnosing and treating patients based on those patient-created photographs in what Kim calls a "teeth alignment report" [i.e., tooth positions];** right?
- A.** Yes.



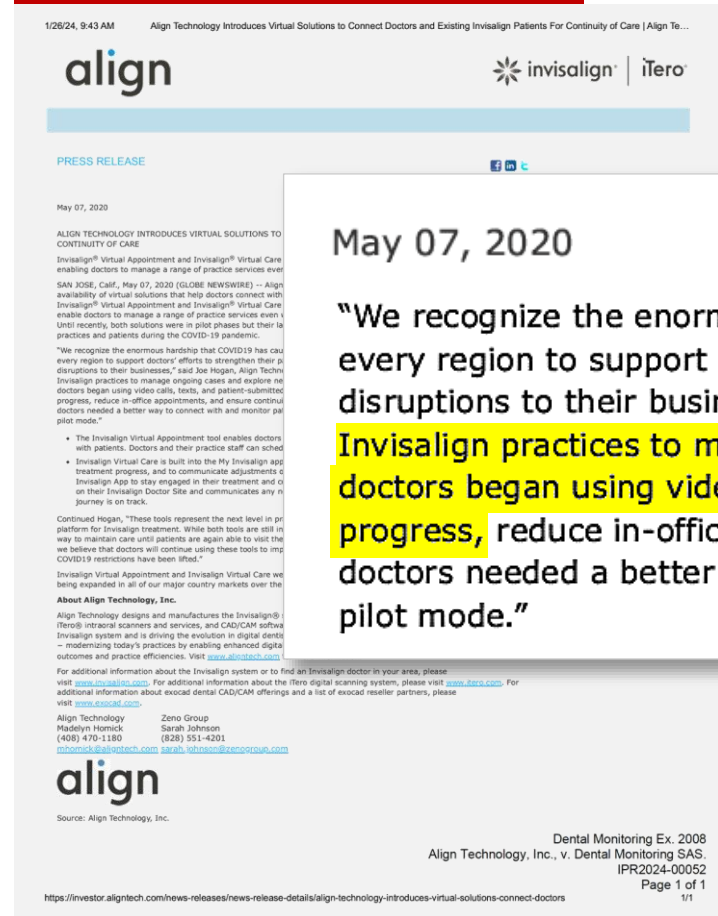
Kusnoto Decl. (EX2030), ¶¶45, 64, 76

- ¶45: As of 2017, "conventional in-person aligner treatment examinations . . . **did not involve quantitative measurements concerning aligner fit.** . . ."
- ¶64: "In reality, **there was no way to make quantitative evaluations of aligner fit** from visual inspection of a digital image in 2017. . . . instead, orthodontists relied on visual approximations."
- ¶76: "A POSA would **not have understood Kim to suggest assessing aligner fit from a photograph.** Assessing aligner fit is different from assessing teeth alignment."

Petitioner's Motivation to Combine Is Unsupported

Petitioner admits that orthodontists did not assess aligner fit from images in 2017

**Align Press Release
(IPR2024-00052, EX2008)**



Align Technology CEO, Joe Hogan:

May 07, 2020

"We recognize the enormous hardship that COVID19 has caused Invisalign patients around the world and we are working in every region to support doctors' efforts to strengthen their patients' experiences with Invisalign treatment and to minimize disruptions to their businesses," said Joe Hogan, Align Technology CEO. "We also identified opportunities to collaborate with Invisalign practices to manage ongoing cases and explore new ways for doctors to conduct consultations. Early on, many doctors began using video calls, texts, and patient-submitted photos through a variety of platforms to help monitor patient progress, reduce in-office appointments, and ensure continuity of patient care during treatment. It quickly became clear that doctors needed a better way to connect with and monitor patients, so we accelerated the launch of new tools that were still in pilot mode."

Salah never purports to disclose a novel way to assess aligner fit

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A61N 43/40 (2006.01) A61C 9/00 (2006.01)
A61P 11/0 (2006.01)

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LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX,
MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT,
QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST,
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European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES,
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MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI
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NE, SN, TD, TG).

Published:
with international search report (Art. 21(3))

(54) Title: METHOD FOR MONITORING DENTITION

(54) Title: PROCÉDÉ DE CONTRÔLE DE LA DENTITION

(57) Abstract. The invention relates to a method for monitoring a property of the appearance of the teeth of a patient, said method including the following consecutive steps: A) acquiring, by means of a first acquisition apparatus, at least one first two-dimensional image of said patient of a first reference gauge, referred to as "initial image"; B) acquiring, by means of a second acquisition apparatus, at least one second two-dimensional image of said teeth and of a second reference gauge having the same appearance as the first reference gauge, referred to as "updated image"; C) standardizing the initial and updated images such that the representations of the first and second reference gauges; on the standardized initial and updated images have the same appearance; D) before or after step C, marking the same region of the teeth on the initial and updated images; and E) comparing the appearance of said region in the standardized initial and updated images.

(57) Abrégé: L'invention concerne un procédé de contrôle d'une propriété d'aspect de dents d'un patient, ledit procédé comportant les étapes successives suivantes: A) acquisition, au moyen d'un premier appareil d'acquisition, d'un moins une première image bidimensionnelle desdites dents et d'une première jauge de référence, dite « image initiale »; B) acquisition, au moyen d'un deuxième appareil d'acquisition, d'un moins une deuxième image bidimensionnelle desdites dents et d'une deuxième jauge de référence présentant un même aspect que la première jauge de référence, dite « image actualisée »; C) normalisation des images initiale et actualisée de manière que les représentations des première et deuxième jauges de référence sur les images initiale et actualisées normalisées présentent un même aspect; D) avant ou après l'étape C, repérage d'une même région des dents sur les images initiale et actualisée; E) comparaison de l'aspect de ladite région sur les images initiale et actualisées normalisées.

WO 2016/066651 A1

- assesses tooth positions by updating 3D models of a patient's teeth
- concerns tracking the movement of teeth, not an apparatus moving them

- suggest remotely assessing aligner fit
- suggest taking images of aligners in a service position
- suggest analyzing images with an aligner in a service position
- encourage use of deep learning

IPR2024-00052 & IPR2024-00110
DEMONSTRATIVE EXHIBIT – NOT EVIDENCE

Salah Teaches Away From Aligner Contour Analysis

Salah recommends use of high contrast outlines identified with high probability and reliability

- **Aligners visually blend with teeth** and represent areas of low contrast
- Salah **teaches away** from contour detection with low contrast aligner images

Salah (EX1008), 60:20-22, 60:25-61:1

the points in this area will therefore be high. On the other hand, a low-contrast area, such as a blurred zone, can be assimilated to an area corresponding to a contour with a low probability, and the quality of the points in this area will be low. In this example, the probability of a point in the

A quality threshold is used to filter the initial discriminant information. If the quality threshold is high, the discriminant information retained after filtering will be few in number, but highly reliable. If the quality threshold is low, the discriminant information retained will be abundant, but unreliable. In the example of contour information, image analysis will then lead to the retention of “false” contour points, i.e. points which, will be mistakenly considered as belonging to the contour of teeth and gums.

IPR2024-00052:

EX1008, 60:20-22, 60:25-61:1; Paper 20, 29-30, 54-55, 60-61;
Paper 30, 17-19; EX2028, ¶¶122-124, 171, 191, 197

IPR2024-00110:

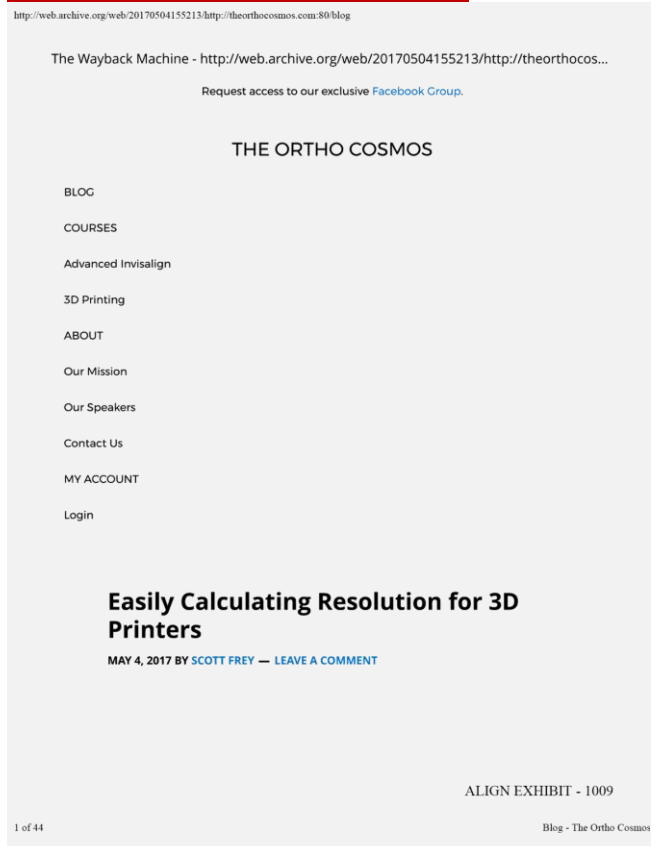
EX1008, 60:20-22, 60:25-61:1; Paper 16, 33-35, 48-49; Paper 25,
11-12; EX2028, ¶¶120-122, 146, 154, 164, 166

IPR2024-00052 & IPR2024-00110
DEMONSTRATIVE EXHIBIT – NOT EVIDENCE

Frey Is Not Prior Art And Cannot “Confirm” Motivation

Frey discusses Patent Owner’s own inventive path

Frey Blog (EX1009)



IPR2024-00052:
EX1009; Paper 20, 56-58; Paper 30, 22-23; EX2028, ¶¶169-170, 192-193; EX2030, ¶¶50-51
IPR2024-00110:
EX1009; Paper 16, 58-60; 25, 12-13; Paper 25, 12-13; EX2028, ¶¶144-145, 155-156; EX2030, ¶¶50-51

Frey:

- is derived from Patent Owner

Frey:

- is **not** prior art
- is **not** a ground reference and cannot supply missing claim element
- does **not** disclose any non-human analysis of any images
- does **not** suggest any quantitative assessments of aligner fit from any images
- does **not** suggest using computer or deep learning to analyze any images

IPR2024-00052 & IPR2024-00110
DEMONSTRATIVE EXHIBIT – NOT EVIDENCE

▶ State of the Art for Aligner Fit Assessment	3
▶ '248 Patent	8
▶ No Motivation to Assess Aligner Fit from Aligner Images	11
▶ No Motivation to Combine Kim, Invisalign, and Salah with Maninis	25
▶ Maninis is Not Prior Art	47
▶ Level of Skill in the Art	51
▶ Semantic Contours Are Not “Tooth Attributes” (Claims 7 and 14)	63
▶ Petitioner Identifies No Deep Learning Device That Can Train On or Output “Image Attributes” (Claim 8)	72
▶ '945 Patent	74

Petitioner's Combination

Petitioner relies on COB to perform a semantic analysis to satisfy Step 1(b'')

Undisputed COB **cannot be trained in this way with the identified learning base to perform the alleged analysis**

'248 Patent (EX1001), cl. 1

1. A method for assessing the shape of an orthodontic aligner, said method comprising the following steps:
a") more than 1 week after the start of the treatment with the aligner, acquisition of at least one image at least partially representing the aligner in a service position in which it is worn by a patient, called "analysis image", the analysis image being a photograph, or an image extracted from a film;
b") analysis of the analysis image by means of a deep learning device, trained by means of a learning base, so as to determine a value for at least one tooth attribute of an "analysis tooth zone" representing, at least partially, a tooth on said analysis image, the tooth attribute relating to a separation between the tooth represented by the analysis tooth zone, and the aligner represented on the analysis image, in the step a"), a cellphone is used to acquire the analysis image.

"[A] POSA would have been motivated to adapt Salah and Kim's image acquisition and analysis apparatus to employ a deep learning architecture [*i.e.*, Figure 2, COB] as taught by Maninis."

"Maninis's deep learning device is trained on a 'training dataset' (*i.e.*, a 'learning base' as recited in the '248 patent). EX1007, 3."

"[P]roviding an appropriately annotated training set" with "labels used to identify the locations of teeth, aligners, and the gaps between them," *i.e.*, semantic labels.

Using trained COB to detect "boundaries corresponding to the edges of the teeth and the aligner . . . and the regions defined by these boundaries would be identified by what was found within each region, such as a particular tooth, aligner surface, or gap between them," *i.e.*, semantic contours.

Petitioner Relies on Maninis COB as Deep Learning Device

3. Step 1(b'')

b'') analysis of the analysis image by means of a deep learning device, trained by means of a learning base, so as to determine a value

Petition (IPR2024-00052, Paper 2), 34, 36

Petitioner relies **exclusively** on Maninis's COB deep learning architecture as satisfying the "deep learning device"

Maninis's "deep learning architecture," illustrated below, shows generation of contours using multiple feature map layers in a CNN to detect image contents at different scales (fine and coarse detections) as well as different orientations.

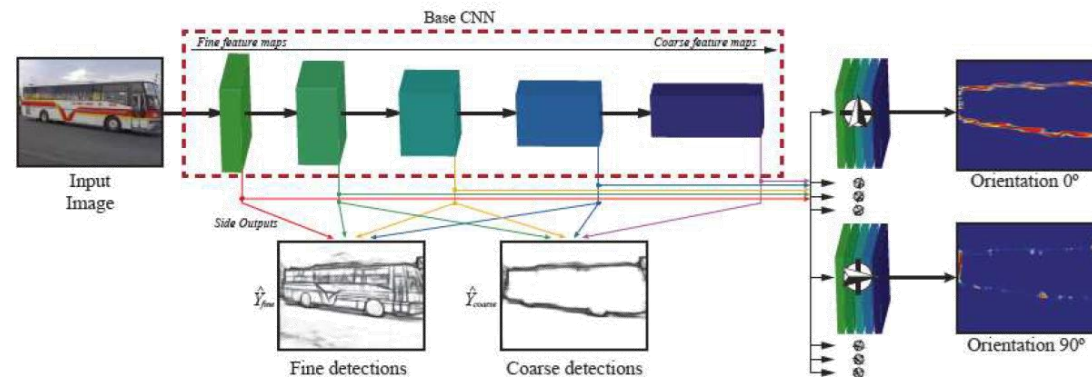


Fig. 2. Our deep learning architecture (best viewed in color). The connections show the different stages that are used to generate the multiscale contours. Orientations further require additional convolutional layers in multiple stages of the network.

Petitioner Relies on Maninis COB as Deep Learning Device

3. Step 1(b'')

b'') analysis of the analysis image by means of a deep learning device, trained by means of a learning base, so as to determine a value

Petition (IPR2024-00052, Paper 2), 26, 34

Petitioner relies **exclusively** on Maninis's COB deep learning architecture as satisfying the "deep learning device"

by Salah and Kim. For example, a POSA would have been motivated to adapt Salah and Kim's image acquisition and analysis apparatus to employ a deep learning architecture as taught by Maninis, trained on images relevant to the dental imaging applications of Salah, Kim, and Invisalign. Maninis's deep learning architecture would provide specific functionalities required by Salah, Kim, and Invisalign, including the ability to identify objects (such as the teeth and aligners depicted in each image) and to detect contours (such as the edges of teeth and aligners useful to assess aligner fit as taught by Invisalign). EX1002, ¶78.

Petitioner Relies on Maninis COB Training

3. Step 1(b'')

b'') analysis of the analysis image by means of a deep learning device, trained by means of a learning base, so as to determine a value

Petition (IPR2024-00052, Paper 2), 34, 37

Petitioner relies **exclusively** on Maninis's description of training the COB neural network as satisfying the "trained" by means of a learning base limitation

Maninis's deep learning device is trained on a "training dataset" (i.e., a "learning base" as recited in the '248 patent). EX1007, 3; EX1002, ¶100. In one example, Maninis uses a training dataset 10,103 images with "localized pixel-wise semantic annotations," meaning pixel-by-pixel indications of each object's location in each image. EX1007, 5-6; EX1002, ¶100. For training and optimization

Petitioner Relies on Maninis COB Training

- The only values in the Maninis COB training set are **binary** “{0,1}” – *i.e.* **“not part of a contour” or “part of a contour”**
- It is undisputed that a deep learning device trained in this way **cannot** determine semantic contours

Petition (IPR2024-00052, Paper 2), 37

Maninis’s deep learning device is trained on a “training dataset” (i.e., a “learning base” as recited in the ’248 patent). EX1007, 3; EX1002, ¶100. In one example, Maninis uses a training dataset 10,103 images with “localized pixel-wise semantic annotations,” meaning pixel-by-pixel indications of each object’s location in each image. EX1007, 5-6; EX1002, ¶100. For training and optimization

Maninis (IPR2024-00052, EX1007), 3

Training deep contour detectors: The recent success of [2] is based on a CNN to accurately regress the contours of an image. Within this framework, the idea of employing a CNN in an image-to-image fashion without any post-processing has proven successful, and lead to a big leap in performance for the task of contour detection. Their network, HED, produces scale-specific contour images (side outputs) for different scales of a network, and combines their activations linearly to produce a contour probability map. Using the notation of the authors, we denote the training dataset by $S = \{(X_n, Y_n), n = 1, \dots, N\}$, with X_n being the input image and $Y_n = \{y_j^{(n)}, j = 1, \dots, |X_n|\}, y_j^{(n)} \in \{0, 1\}$ the predicted pixelwise labels. For simplicity, we drop the subscript n . Each of the M side outputs minimizes the objective function:

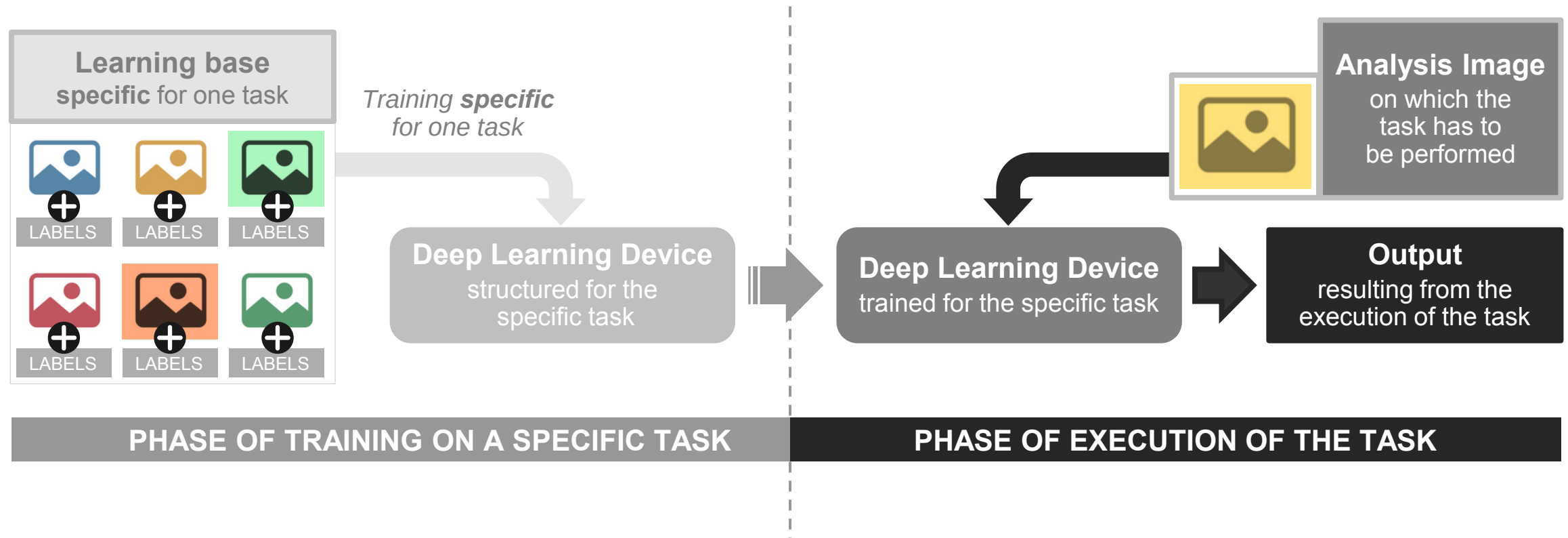
$$\ell_{side}^{(m)}(\mathbf{W}, \mathbf{w}^{(m)}) = -\beta \sum_{j \in Y_+} \log P(y_j = 1 | X; \mathbf{W}, \mathbf{w}^{(m)}) - (1-\beta) \sum_{j \in Y_-} \log P(y_j = 0 | X; \mathbf{W}, \mathbf{w}^{(m)}) \quad (1)$$

where $\ell_{side}^{(m)}$ is the loss function for scale $m \in \{1, \dots, M\}$, $\mathbf{W}$ denotes the standard set of parameters of the CNN, and $\{\mathbf{w}^{(m)}, m = 1, \dots, M\}$ the corresponding weights of the the m -th side output. The multiplier β is used to handle the imbalance of the substantially greater number of background compared to contour pixels. Y_+ and Y_- denote the contour and background sets of the ground-truth Y , respectively. The probability $P(\cdot)$ is obtained by apply-

Petitioner's Combination Is Fatally Flawed

A deep learning device must be trained to perform a specific task

A deep learning device is designed for **a specific task**. It is structured to receive **a specific type of training**, based on **a specific labeled dataset** (the learning base).



Petitioner's Combination Is Fatally Flawed

A deep learning device must be trained to perform a specific task

A deep learning device is designed for **a specific task**. It is structured to receive **a specific type of training**, based on **a specific labeled dataset** (the learning base).



Mongan Decl. (IPR2024-00052, EX2028), ¶61

“In other words, it was known that each neural network trained for an image recognition task is unique and specific to the annotated images on which it has been trained, and its success (then and now) depends on the quality of that training and the challenge(s) of the attributes it is tasked with recognizing.”



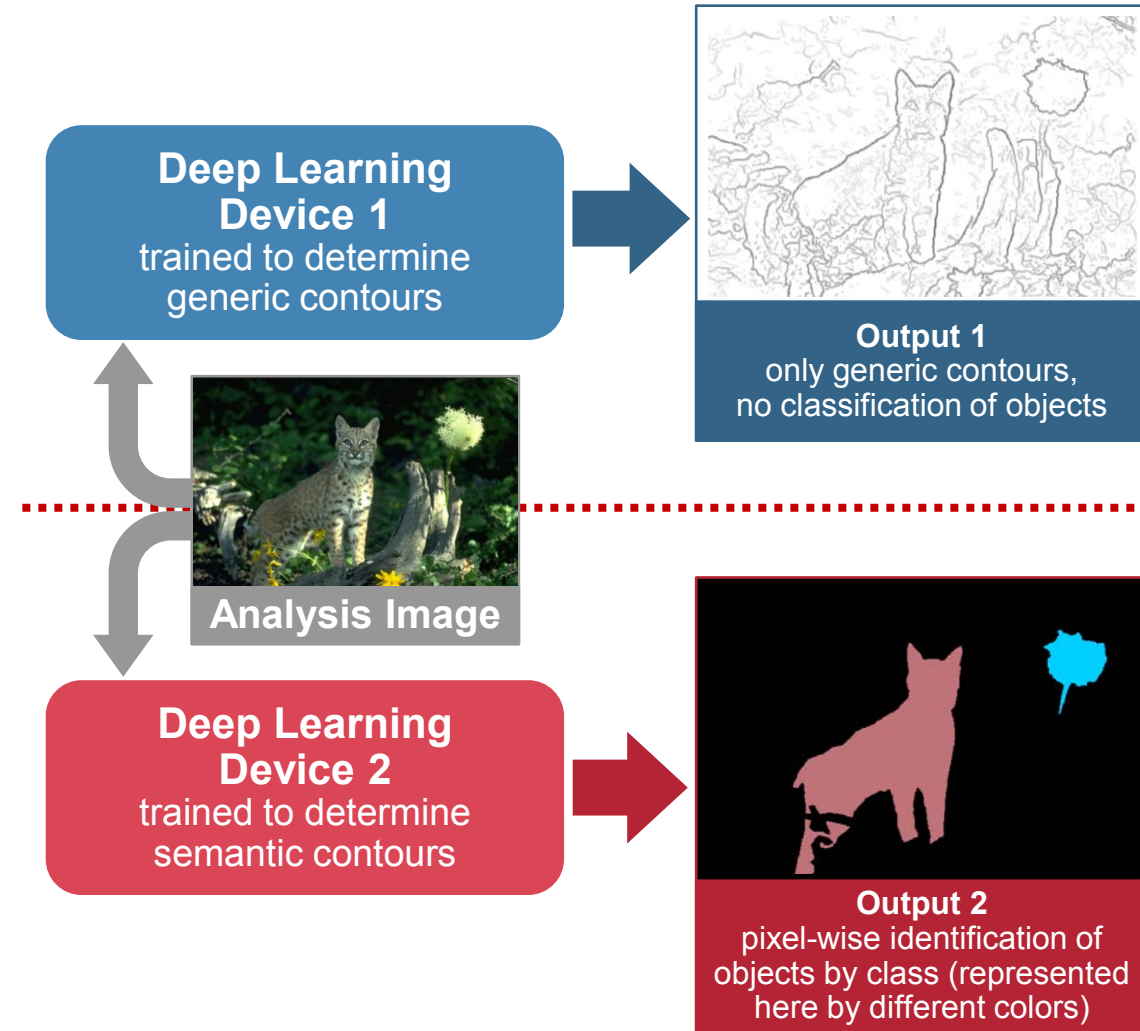
Foroosh Tr. (IPR2024-00052, EX2054), 169:22-171:11

“[G]enerally speaking, deep learning needs to be either trained or be a pretrained model to perform the task that you're looking for. That task might be anything. It could be recognizing a pattern, but it could be many other things.”

Petitioner's Combination Is Fatally Flawed

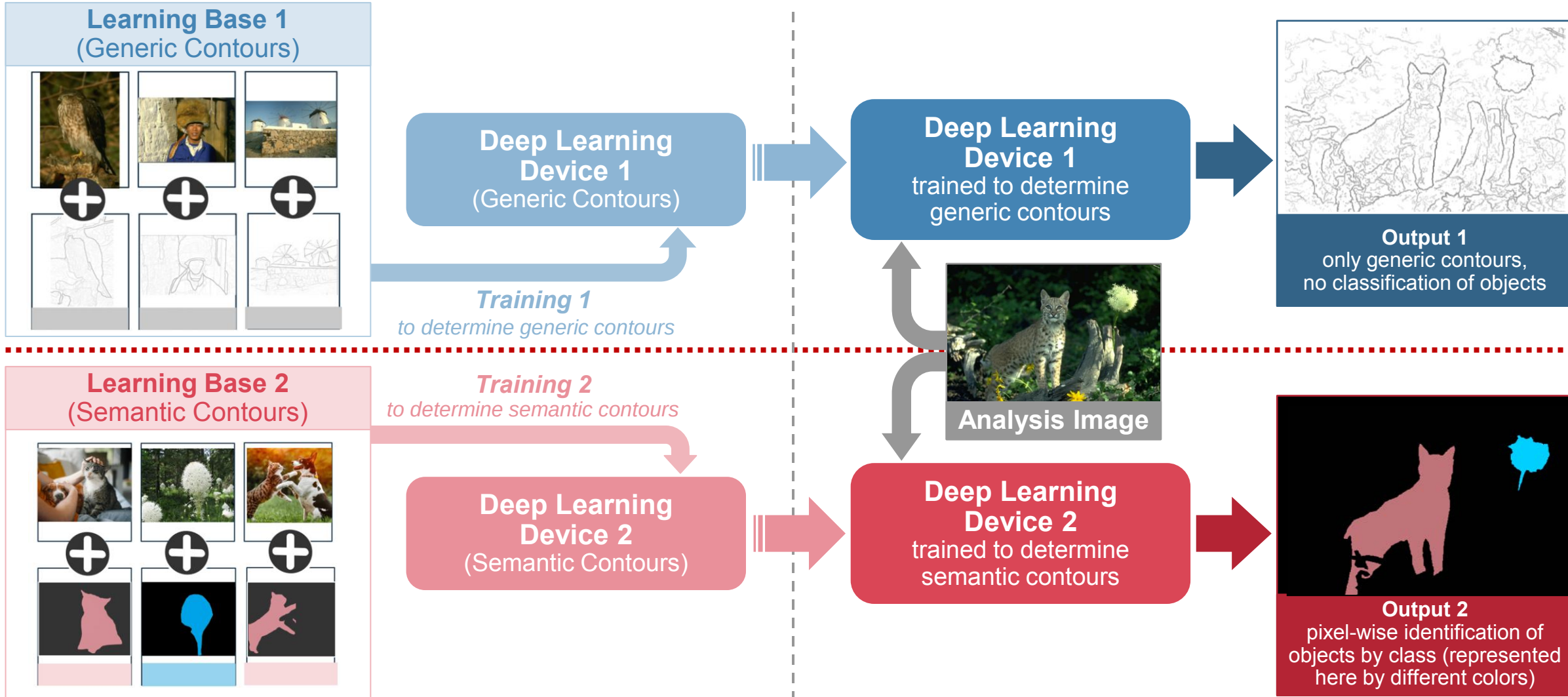
The training and functionality of deep learning devices are determined by their architecture

A deep learning device must be **trained** to perform a **specific task**



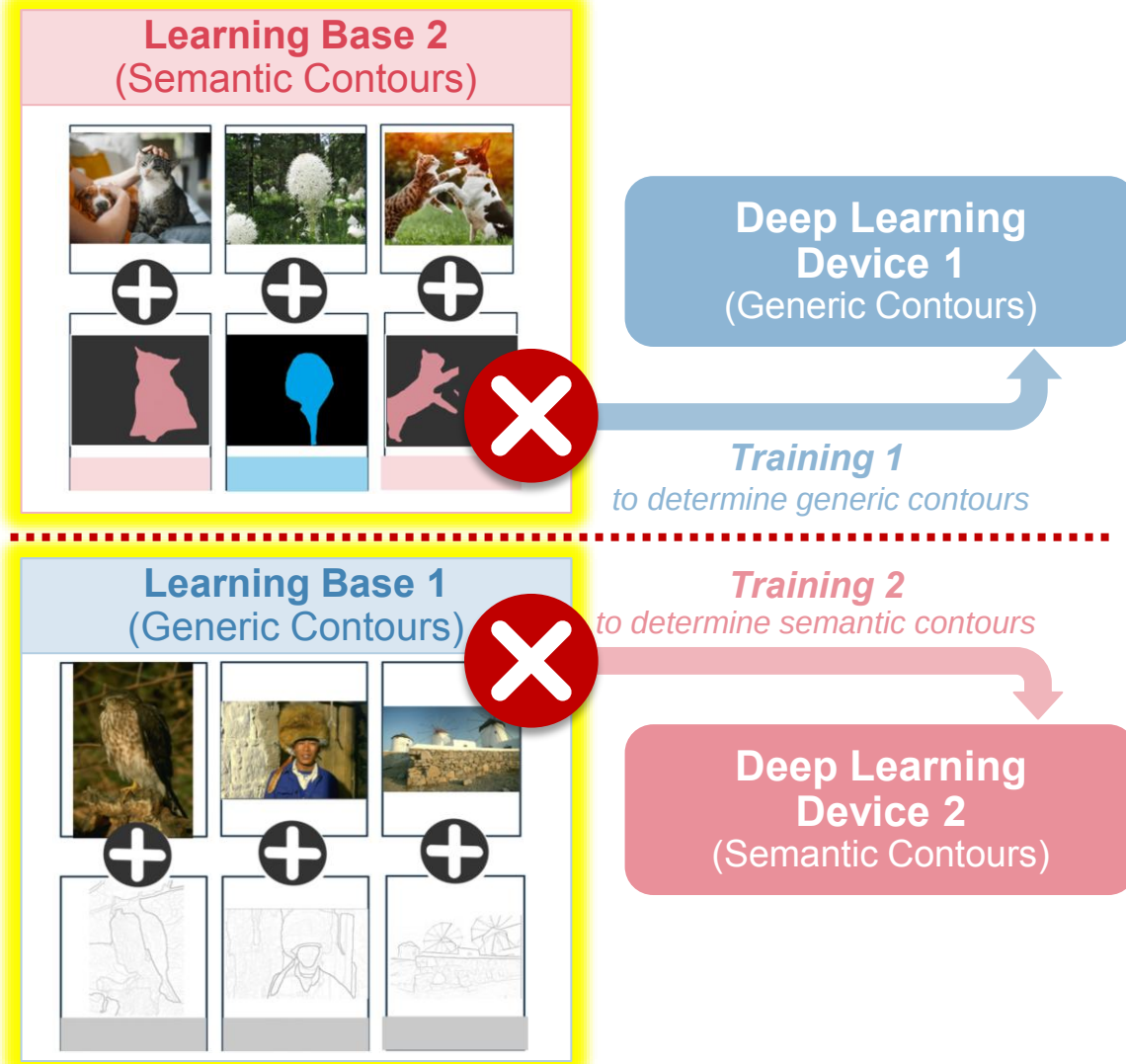
Petitioner's Combination Is Fatally Flawed

The training and functionality of deep learning devices are determined by their architecture



Petitioner's Combination Is Fatally Flawed

Deep learning devices are not generic or interchangeable

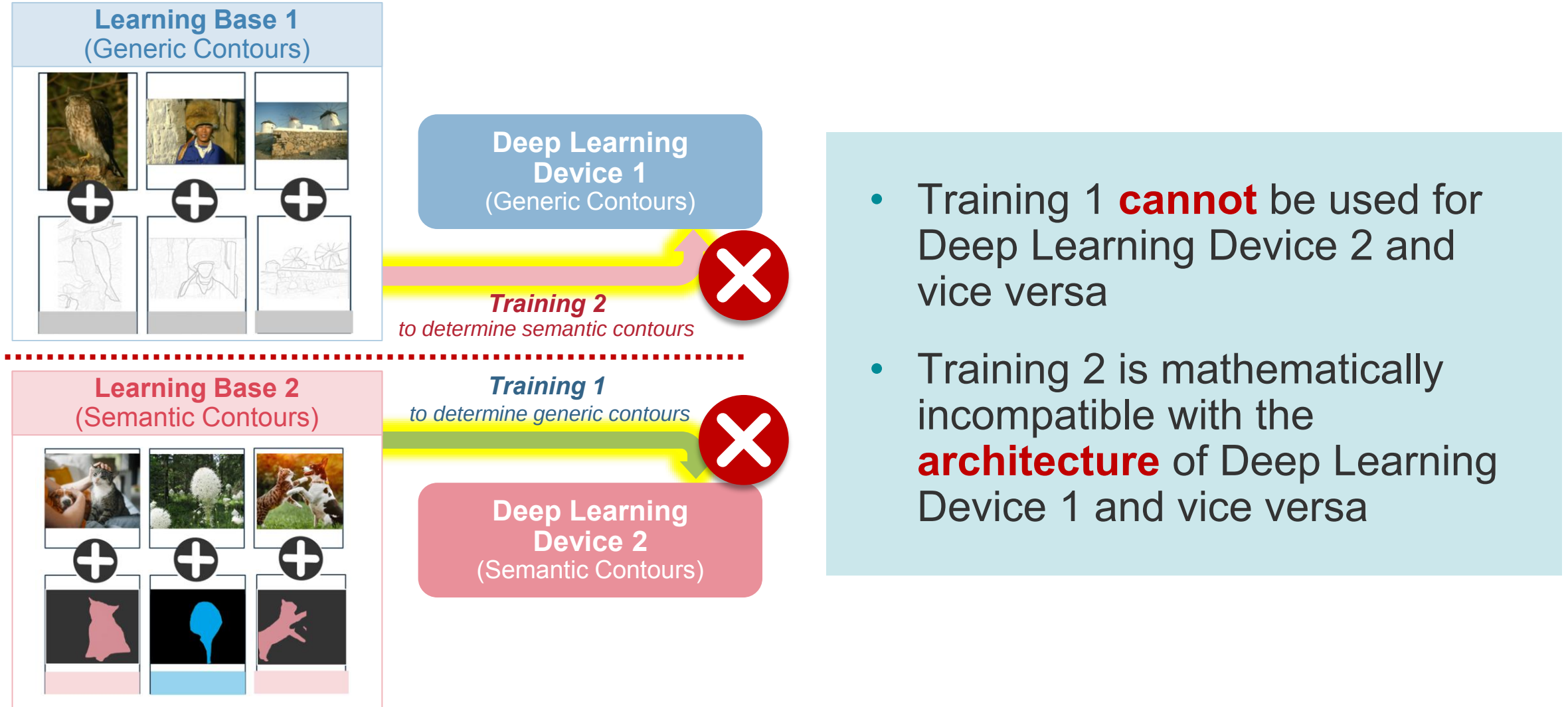


Learning Base 1 **cannot** be used for Training 2 and vice versa

- **Learning Base 1: binary** (1, 0) pixel-wise annotations (i.e., contour, not contour)
- **Learning Base 2:** pixel-wise **class** specific annotations (i.e., cat, flower, background)
- Learning Base 2 **cannot** be used for Training 1 because it includes information that cannot be accepted
- Learning Base 1 **cannot** be used for Training 2 because it lacks necessary information

Petitioner's Combination Is Fatally Flawed

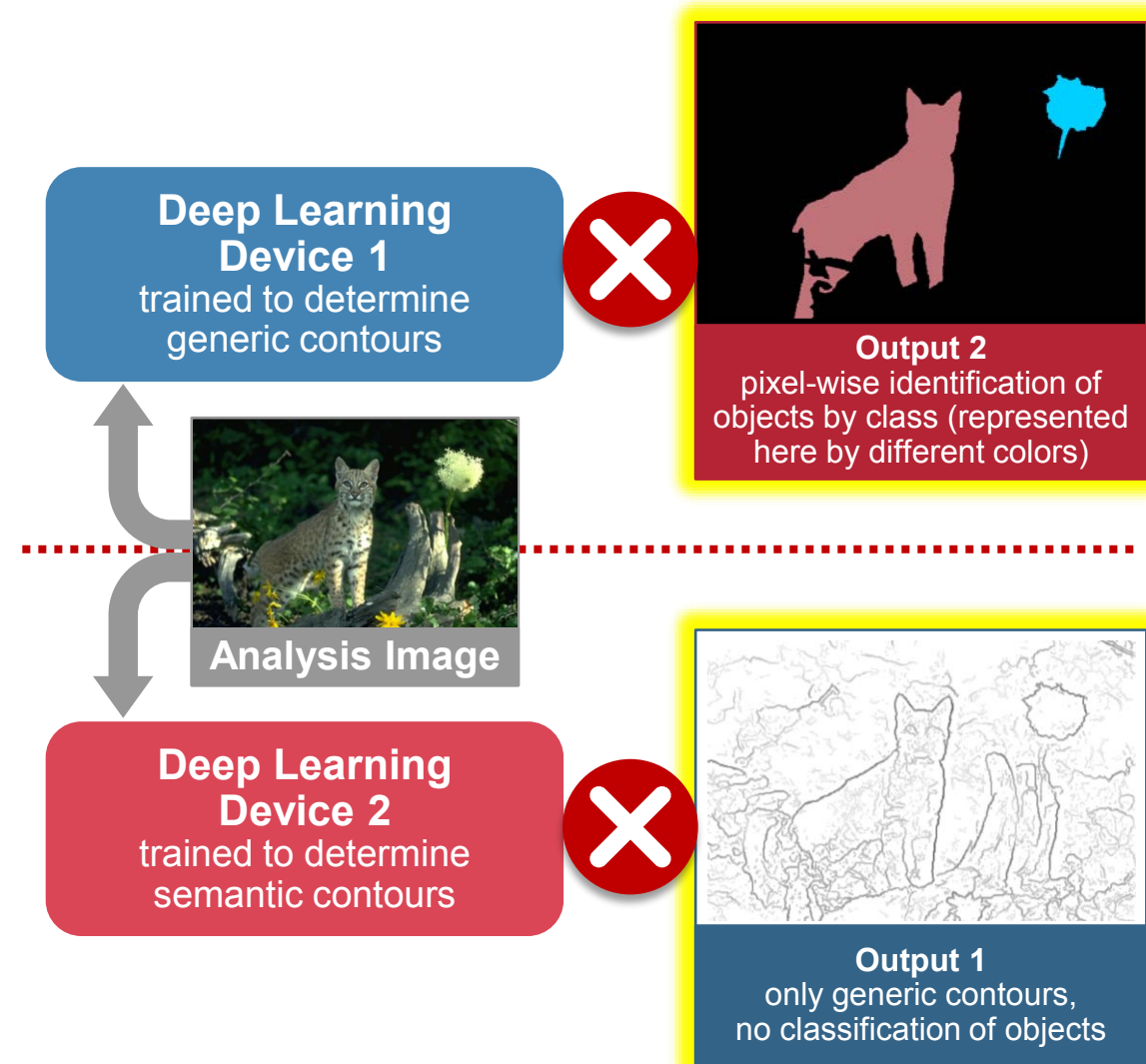
Deep learning devices are not generic or interchangeable



Petitioner's Combination Is Fatally Flawed

Deep learning devices are not generic or interchangeable

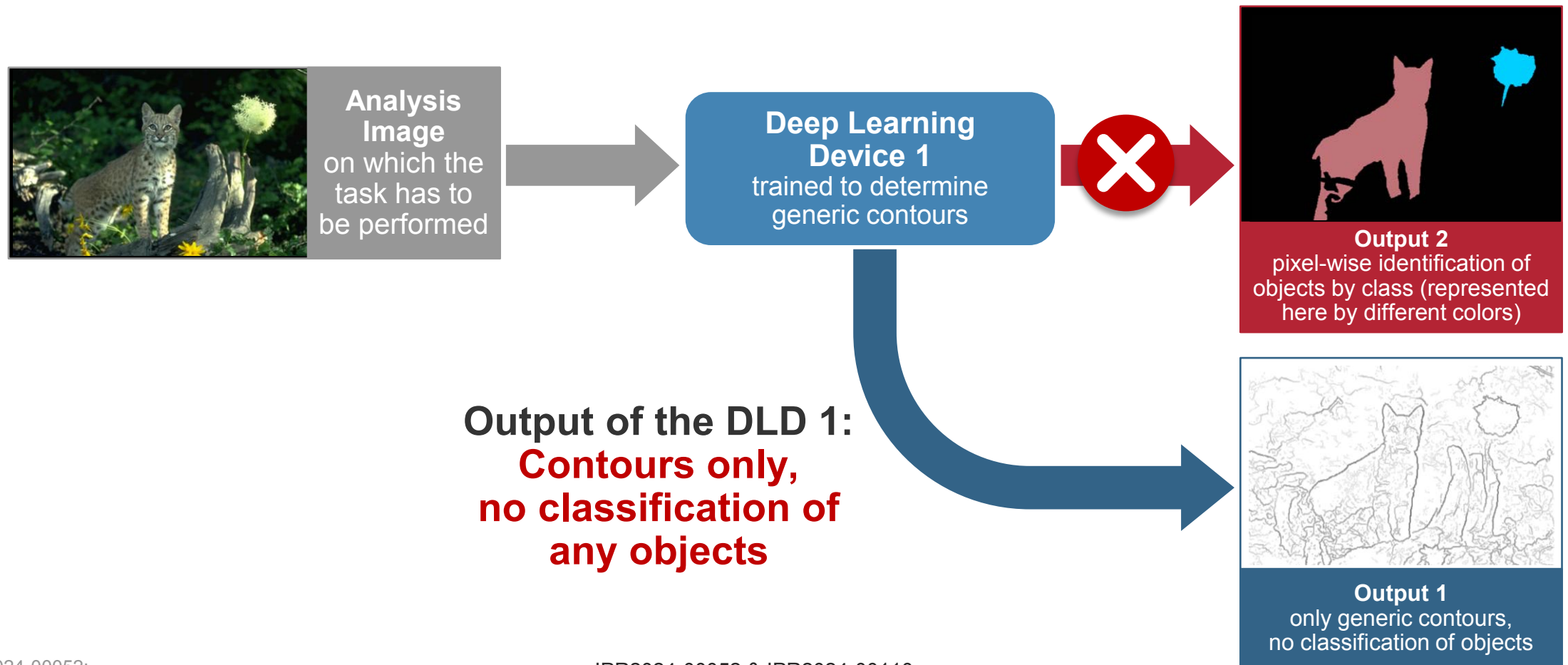
Deep Learning Device 1
cannot determine Output 2
and vice versa



Petitioner's Combination Is Fatally Flawed

Deep learning devices are not generic or interchangeable

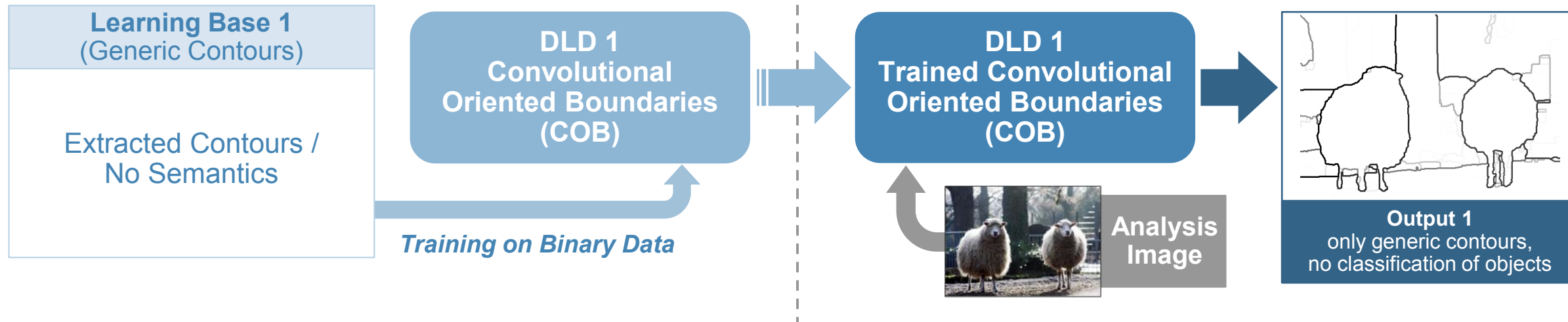
Deep Learning Device 1 is **fundamentally incapable** of generating semantic contours



Petitioner's Combination Is Fatally Flawed

Maninis's COB is trained on generic contours to output generic contours

Output of Maninis's COB: **Contours only, no identification of any objects**

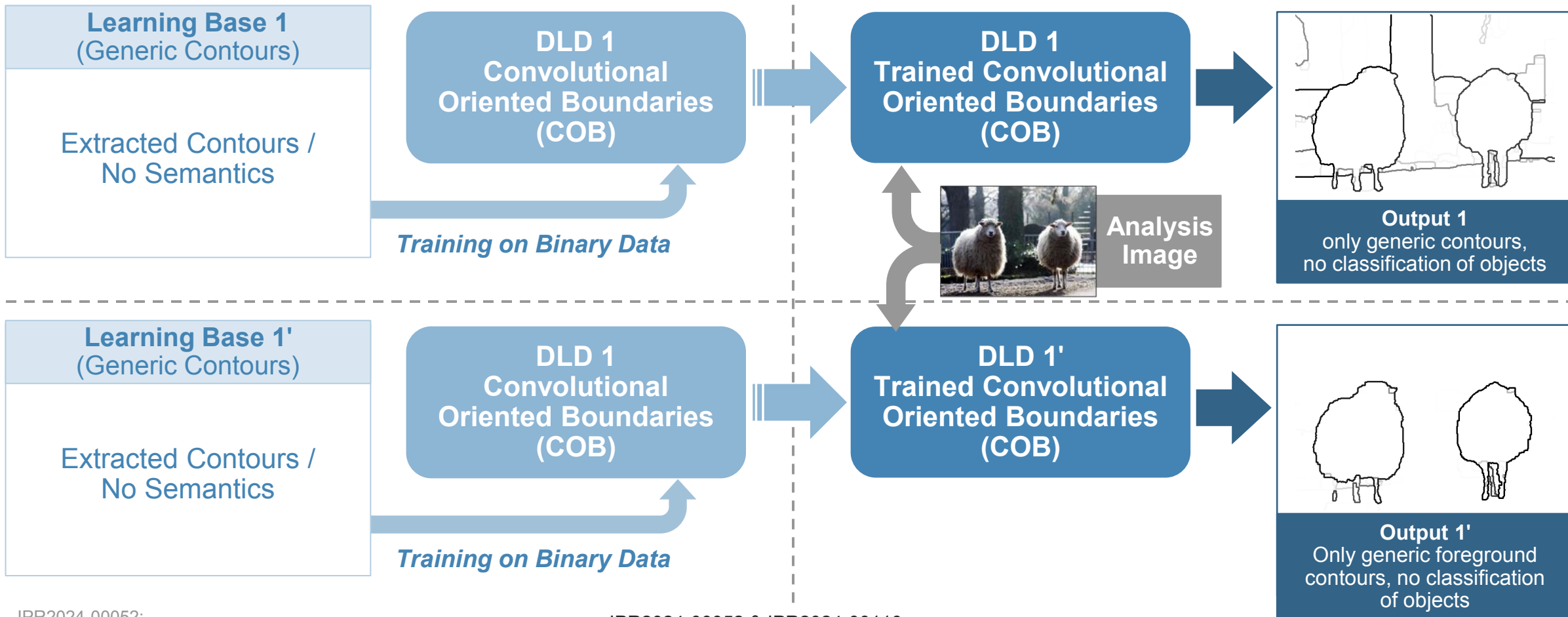


At best, COB can be trained to output only generic contours of objects in the foreground, but COB is **incapable** of determining the class of any objects in the image

Petitioner's Combination Is Fatally Flawed

Maninis's COB is trained on generic contours to output generic contours

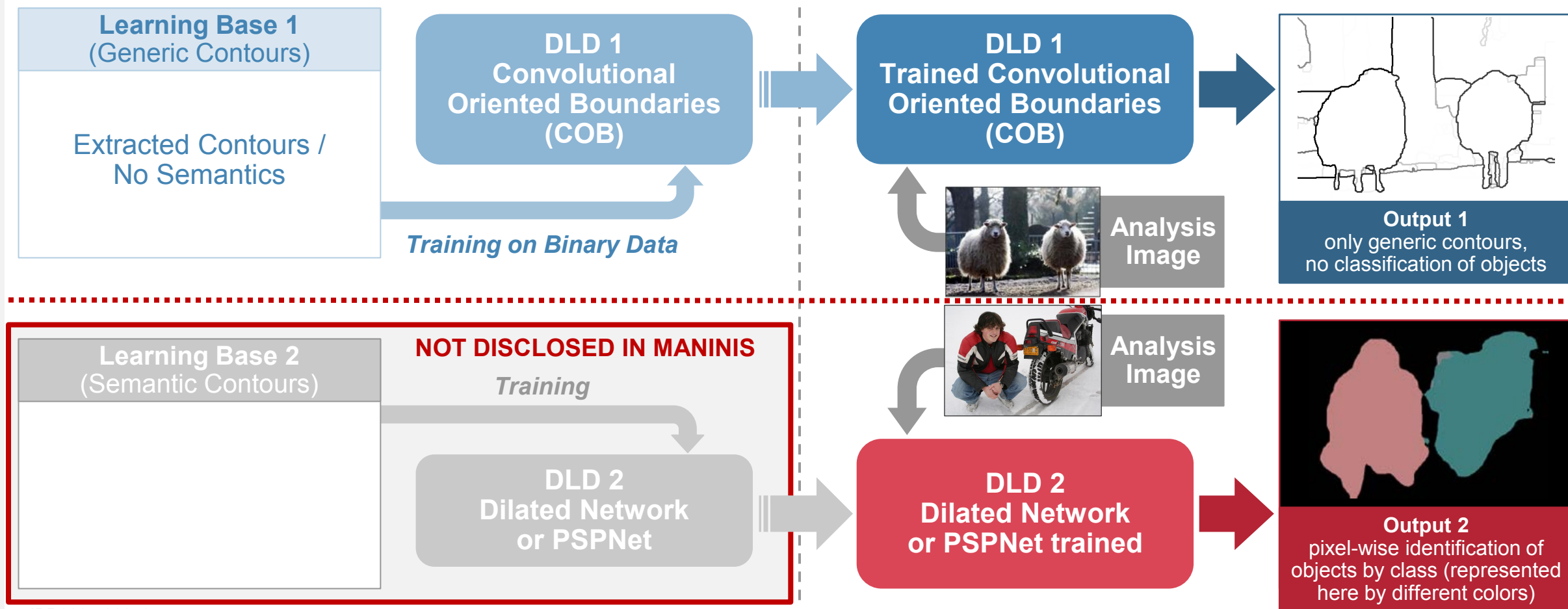
Output of Maninis's COB: **Contours only, no identification of any objects**



Petitioner's Combination Is Fatally Flawed

Maninis's COB is trained on generic contours to recognize generic contours

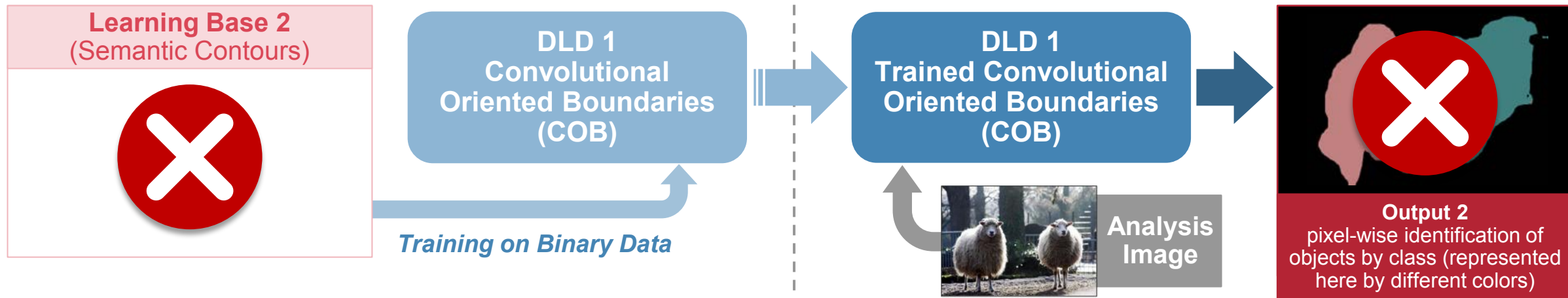
Maninis uses a **second different neural network** to determine semantic contours



Petitioner's Combination Is Fatally Flawed

The combination in the Petition: elements from two totally different and incompatible neural networks

Undisputed **COB** cannot be trained as alleged in the Petition to perform analysis relied on in the Petition



Petitioner's Combination Is Fatally Flawed

The combination in the Petition: elements from two totally different and incompatible neural networks

Undisputed **COB** cannot be trained as alleged in the Petition to perform analysis relied on in the Petition

Learning Base 2
(Semantic Contours)



Petition (IPR2024-00052, Paper 2), 37

“Maninis’s deep learning device is trained on a ‘training dataset’ (i.e., a ‘learning base’ as recited in the ’248 patent).
EX1007 at 3.”

Training on Binary Data

DLD 1
Trained Convolutional
Oriented Boundaries
(COB)



Output 2

Pixel-wise identification of
objects by class (represented
by different colors)

Petition (IPR2024-00052, Paper 2), 36

“Applicable deep learning techniques for contour and object detection are taught by Maninis. . . . Maninis’s ‘contour detection’ produces ‘multiscale oriented contours and region hierarchies’ using ‘Convolutional Neural Networks (CNNs).’
Maninis’s ‘deep learning architecture,’ illustrated below . . .”

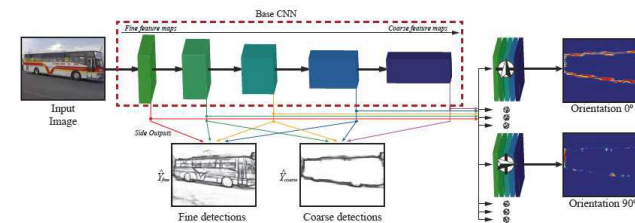
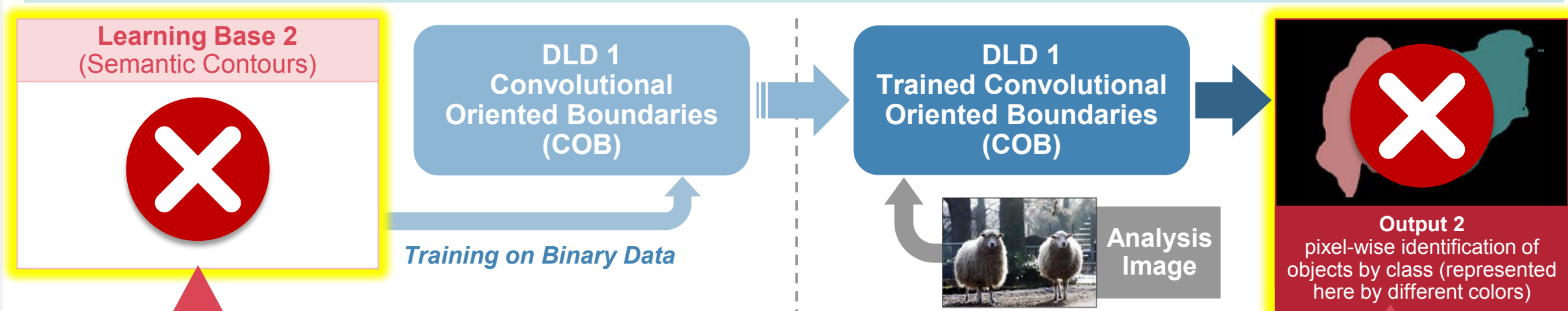


Fig. 2. Our deep learning architecture (best viewed in color). The connections show the different stages that are used to generate the multiscale contours. Orientations further require additional convolutional layers in multiple stages of the network.

Petitioner's Combination Is Fatally Flawed

The combination in the Petition: elements from two totally different and incompatible neural networks

Undisputed **COB** cannot be trained as alleged in the Petition to perform analysis relied on in the Petition



Petition (IPR2024-0005, Paper 2), 38

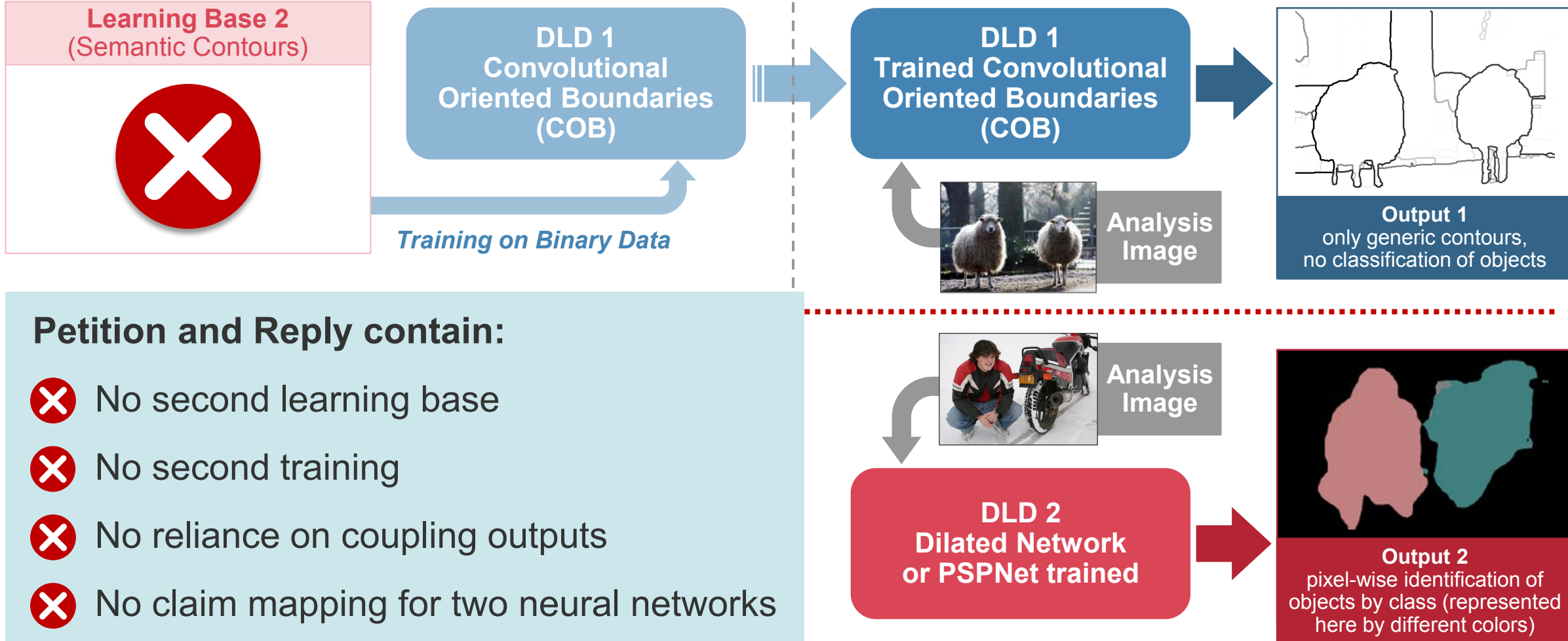
“[A]n appropriately annotated training set and . . . labels used to identify the locations of teeth, aligners, and the gaps between them.”

Petition (IPR2024-0005, Paper 2), 40-41

“Maninis’s contour detection detects hierarchies of regions containing objects. EX1007, Abstract, 3-5. . . . Additionally, this analysis would generate tooth attributes, including the locations of the surfaces of the tooth and aligner (corresponding to detected contours), as well as the measured separation between them (the distance between the contours).”

Petitioner's Reply Combination Is Equally Flawed

The combination in the Petition: elements from two totally different and incompatible neural networks



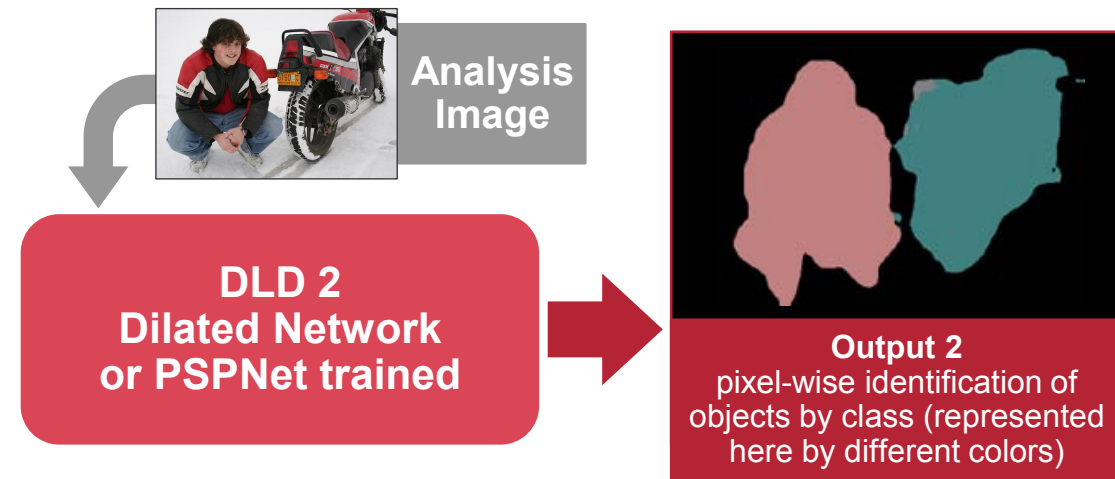
Petitioner's Reply Combination Is Fatally Flawed

Petitioner's sole motivation relies on the use of Maninis's COB

Petitioner provides **no motivation to use any other neural network** without COB

Petition (IPR2024-00052, Paper 2), 25

“For example, Maninis teaches that the ‘latest wave of contour detectors takes advantage of deep learning to obtain state-of-the-art results.’ EX1007, 2. Further, Maninis provides a flexible, ‘modular’ technique that ‘can incorporate and benefit from future improvements in the base CNN.’ *Id.* Maninis’ technique also achieves improvements relative to ‘recent approaches to contour detection using deep learning.’ EX1007, 3, 9 (‘Overall, comparing to previous state-of-the-art, we get a significant improvement at a fraction of the computation time (24.37 to 0.79 seconds).’), 11-12 (improved object identification); EX1002, ¶77.”

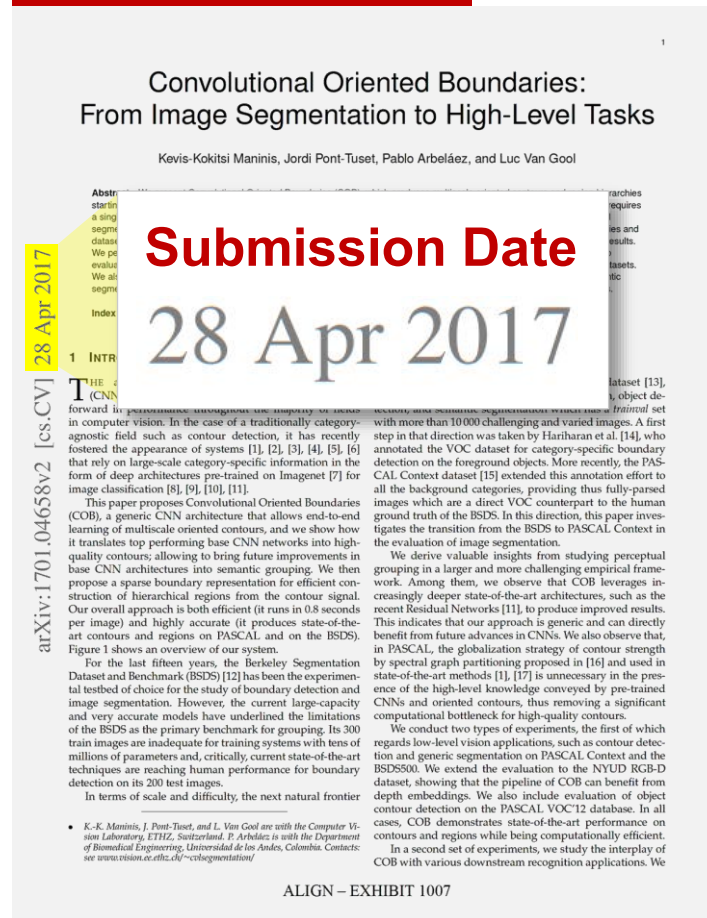


Alleged advantages **not attributable** to Dilated Network or PSPNet

▶ State of the Art for Aligner Fit Assessment	3
▶ '248 Patent	8
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▶ Level of Skill in the Art	51
▶ Semantic Contours Are Not “Tooth Attributes” (Claims 7 and 14)	63
▶ Petitioner Identifies No Deep Learning Device That Can Train On or Output “Image Attributes” (Claim 8)	72
▶ '945 Patent	74

Maninis Is Not Prior Art

Maninis (EX1007)



- Maninis bears only its **submission** date
- Petitioner cannot identify Maninis's publication date

Maninis Is Not Prior Art

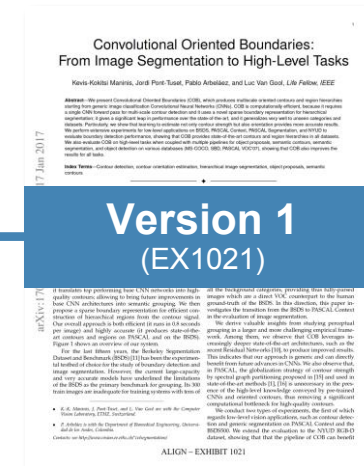
The archived links are not probative of publication

Foroosh's Declaration (IPR2024-00052, EX1002), ¶58

58. The public availability of Maninis to interested persons prior to July 21, 2017, is also corroborated by archived webpages of both arXiv.org and the authors of Maninis. As of May 3, 2017, the university website featuring the author's Convolutional Oriented Boundaries software included a link (to <https://arxiv.org/abs/1701.04658>) for downloading a PDF copy of Maninis from arXiv.org. EX1024 (archived May 3, 2017). Additionally, as of July 8, 2017, the arXiv.org author search webpage for Prof. Luc Van Gool, the last author listed on Maninis, listed Maninis as one of his recent papers that was available on arXiv.org, providing links to both the abstract page (<https://arxiv.org/abs/1701.04658>) and a link to directly download Maninis (<https://arxiv.org/pdf/1701.04658>). EX1025 (archived July 8, 2017). Thus, Maninis was available openly to general public and

Patent Owner's Response (IPR2024-00052, Paper 20), 41

Second, Petitioner cites an archived copy of the author's institutional web page prior to July 21, 2017, which links to the arXiv.org URL for Maninis. EX1024; EX1002, ¶67. However, **there was an earlier version of Maninis, on which Petitioner does not rely in this IPR**. EX1002, ¶62. Both versions of Maninis's paper share the same URL, so **the existence of a link to that URL suggests only that one of the two versions had published as of the archived date—i.e. the first version**. EX2048, 235:5-236:8.



Maninis Is Not Prior Art

Petitioner's evidence of arXiv.org's alleged policies is not admissible

Subject to Patent Owner's Motion to Exclude



- The arXiv.org webpage exhibits are hearsay as to any alleged policy (FRE 801, 802)
- Dr. Foroosh lacks personal knowledge of what arXiv.org did with the Maninis submission (FRE 602)
- Dr. Foroosh's opinions regarding arXiv.org's practices and Maninis's publication date are unqualified (FRE 701, 702)

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▶ '945 Patent	74

Level of Skill in the Art

The parties agree that a POSA would have dental expertise at least where “appropriate”

Petitioner:

“A POSA could be a member of an interdisciplinary team including persons with backgrounds such as electrical engineering, computer science, optical imaging, and **dentistry or orthodontics**, and could call upon the knowledge of other team members **as appropriate.**”

Patent Owner:

“A POSA would have also worked as part of a multi-disciplinary team, which would have included individuals familiar with medical imaging, **dental imaging, dentistry, and/or orthodontics.**”

Level of Skill in the Art

There is no dispute that Kim, Invisalign, and Salah all address problems in the dental and orthodontic field

Kim (EX1005), [0001], [0008]-[0009]



[0001] The present invention relates to a method and system for providing remote teeth alignment services, and a computer-readable medium on which the method is recorded and, more particularly, to a method and system for providing remote teeth alignment services to remotely advise an appropriate step of a clear aligner using a smartphone of an orthodontic patient, and a computer-readable medium on which the method is recorded.

* * *

[0008] Using the conventional clear-aligner treatment method, an orthodontic patient should regularly visit a dental clinic for a long period of time to allow a dentist to accurately check the state of his/her teeth and determine a currently appropriate step of a clear aligner.

[0009] However, if the dental clinic is far, if the orthodontic patient is not capable of frequently visiting the dental clinic, or if the orthodontic patient cannot visit the dental clinic any more due to going abroad to study, traveling, moving out, or the like, the orthodontic patient stops visiting the dental clinic. As such, a large number of problems occur.

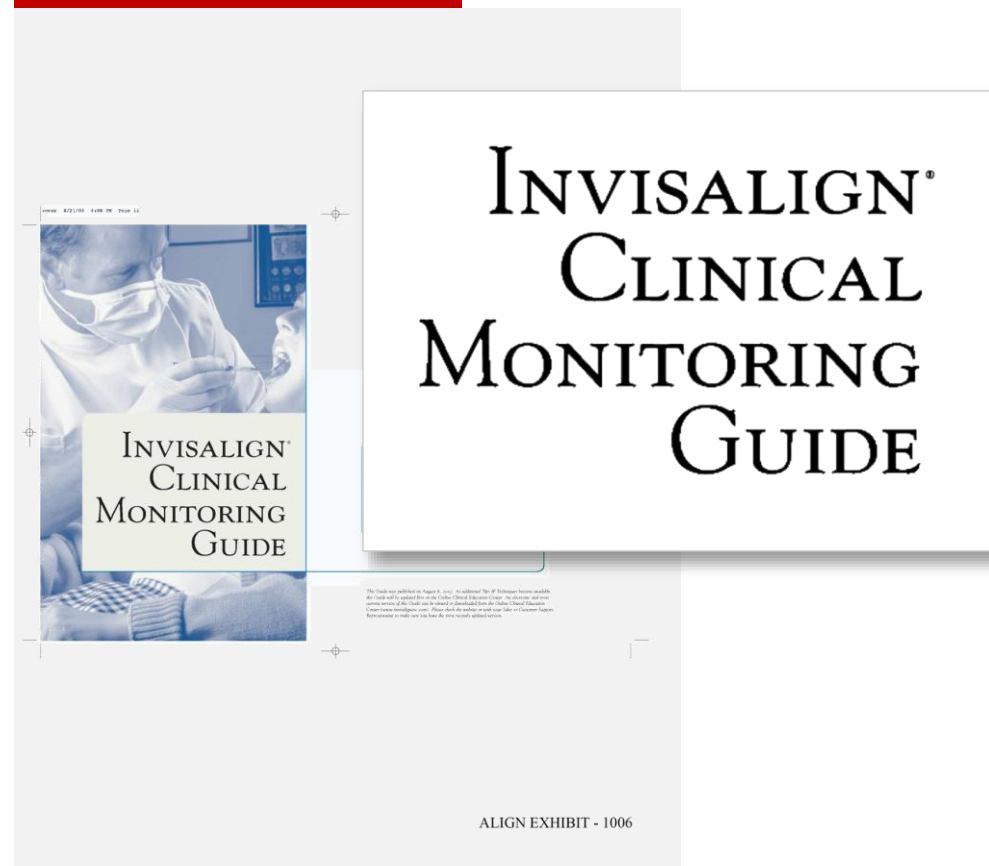
IPR2024-00052:
EX1002, ¶¶72-74; EX1005, [0001], [0008]-[0009]; EX2028, ¶¶68-86; EX2030, ¶¶70-79; Paper 20, 4, 21-22
IPR2024-00110:
EX1002, ¶¶59-61; EX1005, [0001], [0008]-[0009]; EX2028, ¶¶66-83; EX2030, ¶¶70-79; Paper 16, 4-5, 20-21

IPR2024-00052 & IPR2024-00110
DEMONSTRATIVE EXHIBIT – NOT EVIDENCE

Level of Skill in the Art

There is no dispute that Kim, Invisalign, and Salah all address problems in the dental and orthodontic field

Invisalign (EX1006), i



THIS GUIDE IS INTENDED TO HELP THE INVISALIGN PRACTITIONER successfully monitor Invisalign treatments and address issues that may arise between receipt of Aligners from Align to the completion of treatment.

Special attention has been given to possible root causes of issues that may be encountered, solutions to these issues, and measures that can be taken to prevent the issue from re-occurring in the future.

Invisalign is a technique. Invisalign is more than a set of Aligners; it is the Aligners plus other auxiliaries used to achieve desired results. Just as with fixed appliances, a clinician should carefully monitor, adjust and plan for use of auxiliaries for successful treatment outcomes with Invisalign.

IPR2024-00052:
EX1002, ¶¶72-74; EX1006, i; EX2028, ¶¶87-96; EX2030,
¶¶58-69; Paper 20, 4, 23-26
IPR2024-00110:
EX1002, ¶¶59-61; EX1006, i; EX2028, ¶¶84-93; EX2030,
¶¶58-69; Paper 16, 4-5, 27-29

IPR2024-00052 & IPR2024-00110
DEMONSTRATIVE EXHIBIT – NOT EVIDENCE

Level of Skill in the Art

There is no dispute that Kim, Invisalign, and Salah all address problems in the dental and orthodontic field

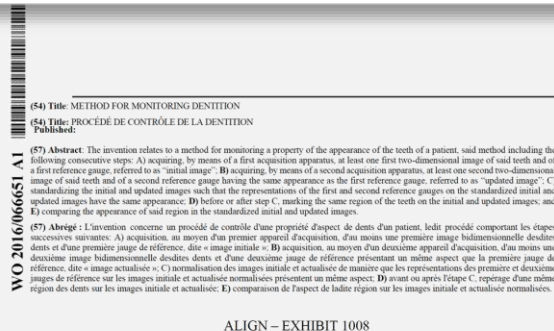
Salah (EX1008), 2:2-6, 12-24



METHOD FOR MONITORING DENTITION

Technical area

The present invention provides a method for monitoring the positioning and/or shape and/or appearance of a patient's teeth and a computer program for implementing this method.



During orthodontic treatment, any unfavorable progression may lead to a change in treatment. After orthodontic treatment, such an unfavorable evolution, known as “recurrence”, may lead to a repeat of treatment. Lastly, more generally, and independent of any treatment, a person may wish to monitor any possible movement and/or any change in the shape and/or appearance of the teeth.

Traditionally, checks are carried out by an orthodontist or a dentist, who are the only persons with the appropriate equipment. This monitoring is expensive. Additionally, the visits are restrictive.

US 2009/0291417 describes a method for creating and then modifying three-dimensional models, in particular for the manufacture of orthodontic appliances.

One aim of the present invention is to solve, at least in part, the above-mentioned problems.

IPR2024-00052:
EX1002, ¶¶72-74; EX1008, 2:2-6, 12-24, EX2028, ¶¶97-98, 122-124; EX2030, ¶¶80-84; Paper 20, 4, 28-29
IPR2024-00110:
EX1002, ¶¶59-61; EX1008, 2:2-6, 12-24, EX2028, ¶¶94-95, 120-122; EX2030, ¶¶80-84; Paper 16, 4-5, 33-34

IPR2024-00052 & IPR2024-00110
DEMONSTRATIVE EXHIBIT – NOT EVIDENCE

Level of Skill in the Art

Drs. Mongan and Kusnoto have the requisite experience



Dr. John Mongan,
MD, Ph.D.

*Patent Owner's
Technical Expert*

- Professor in Department of Radiology and Biomedical Imaging at UCSF
- Involved in machine learning, deep learning, and neural networks for his entire career
- Consulted with Dr. Kusnoto in forming his opinions



Dr. Budi Kusnoto,
D.D.S., M.S.

*Patent Owner's
Dental Expert*

- Practicing clinician, researcher, and academic in orthodontics for twenty-five years
- Personal experience with relevant dental imaging and equipment

Level of Skill in the Art

Dr. Foroosh is not a POSA under either party's definition



Dr. Hassan
Foroosh, Ph.D.

***Petitioner's
Only Expert***

- Dr. Foroosh has with **no professional training or experience** dentistry or orthodontics
- Dr. Foroosh **did not consult** with a team member with that experience in forming his opinions
- Dr. Foroosh's **one** engagement analyzing dental images is inadequate

Level of Skill in the Art

Dr. Foroosh has no practical dental or orthodontic experience



Dr. Hassan
Foroosh, Ph.D.

***Petitioner's
Only Expert***

Foroosh Tr. (EX20650), 46:22-47:4

- Q.** And outside of your work for this case, have you ever had an occasion to look at an aligner and make a judgment call of whether an aligner is seating well or not?
- A.** I'm not a dentist. I'm not an orthodontist. So, therefore, I have not been involved in making those judgment calls.

Level of Skill in the Art

Dr. Foroosh does not know how orthodontists assess separation in-person



Dr. Hassan
Foroosh, Ph.D.

***Petitioner's
Only Expert***

Foroosh Tr. (EX2054), 74:9-16

Q. Does Invisalign tell an orthodontist how to measure whether a gap is within or over 1 millimeter?

A. Again, how an orthodontist makes that measurement is out of the scope of my expertise, out of, I'm going to say, my pay grade. But how orthodontists make those measurements, I don't know.

Level of Skill in the Art

Dr. Foroosh admitted to having “no idea” if Figure A in Invisalign is representative



Dr. Hassan
Foroosh, Ph.D.

**Petitioner's
Only Expert**

Foroosh Tr. (EX2054), 60:18-61:4 & 45:8-19

- Q.** How common is it for an orthodontist to see an aligner that looks like this in this position during a regular checkup?
- A.** Again, you want me to provide an opinion of how things may be seen in a dentist's office. I'm not a dentist. I've never practiced as a dentist. I don't know how common it is, as you refer to it, to see this particular situation. I don't know. I have no idea.
- Q.** Is it your view that the figure you just referred to on page 1 of Invisalign is representative of what an orthodontist would encounter for an aligner that is fitting poorly?
- A.** Again, the people who have drafted this document, I know that some of them are probably dentists or orthodontist. I don't know what an orthodontist would encounter. I mean, I don't know the answer to a question.

Level of Skill in the Art

Dr. Foroosh disregarded portions of the references that he could not understand



Dr. Hassan
Foroosh, Ph.D.

***Petitioner's
Only Expert***

Foroosh Tr. (EX2054), 66:8-15

- Q.** And if you don't know how a dentist would use a scaler to check retention, how did that teaching factor into your opinions?
- A.** **It didn't.** I said that that's in-office operations or treatments, and I said that I consider Invisalign not a remote treatment disclosure . . .

Level of Skill in the Art

Dr. Valley's declaration *from a different IPR* cannot fill the gap



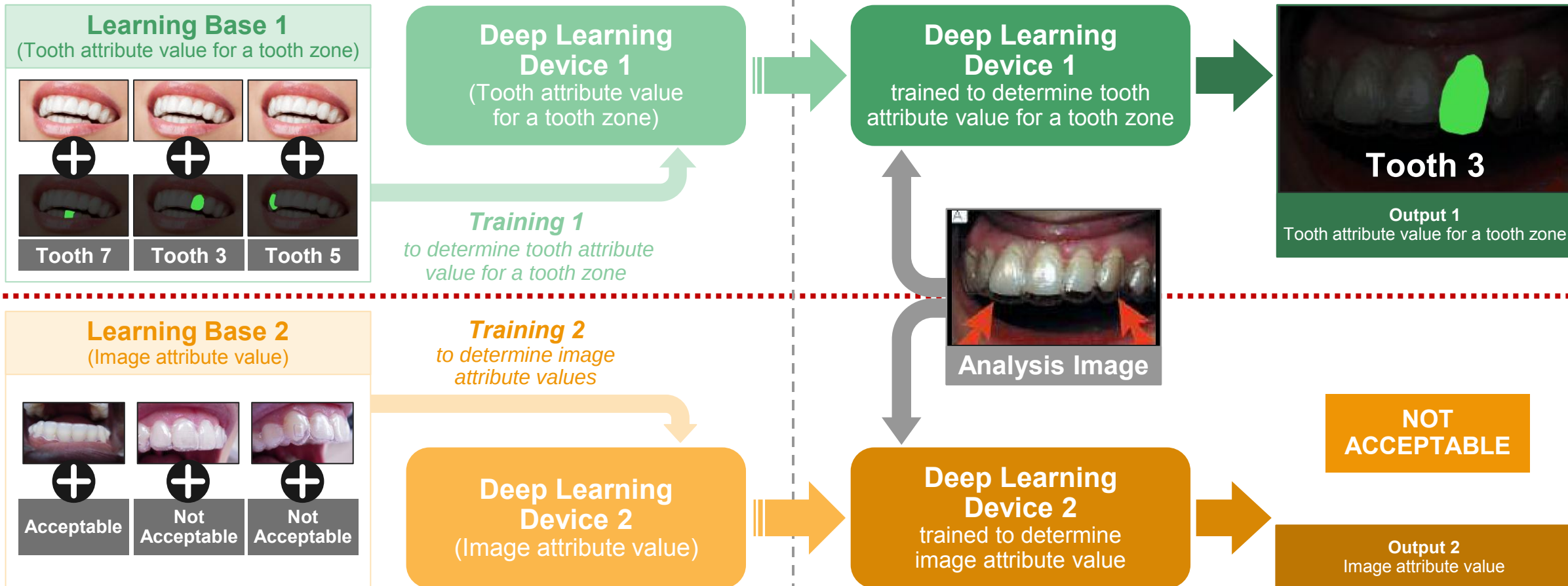
- Petition is not supported by any dental expert
- Petitioner improperly refers to declaration of its dental expert in a different IPR that is **not** evidence here and should be disregarded
- Dr. Valley's prior testimony does not address Kim, Invisalign, or assessing aligner treatment
- Dr. Foroosh did not consult Dr. Valley (or any orthodontist or dentist) in forming his opinions

▶ State of the Art for Aligner Fit Assessment	3
▶ '248 Patent	8
▶ No Motivation to Assess Aligner Fit from Aligner Images	11
▶ No Motivation to Combine Kim, Invisalign, and Salah with Maninis	25
▶ Maninis is Not Prior Art	47
▶ Level of Skill in the Art	51
▶ Semantic Contours Are Not “Tooth Attributes” (Claims 7 and 14)	63
▶ Petitioner Identifies No Deep Learning Device That Can Train On or Output “Image Attributes” (Claim 8)	72
▶ '945 Patent	74

Petitioner's Combination Is Fatally Flawed

'248 Patent discloses and separately claims detailed and global analysis methods

Detailed analysis method (claims 7 and 14)



Global analysis method (claim 8)

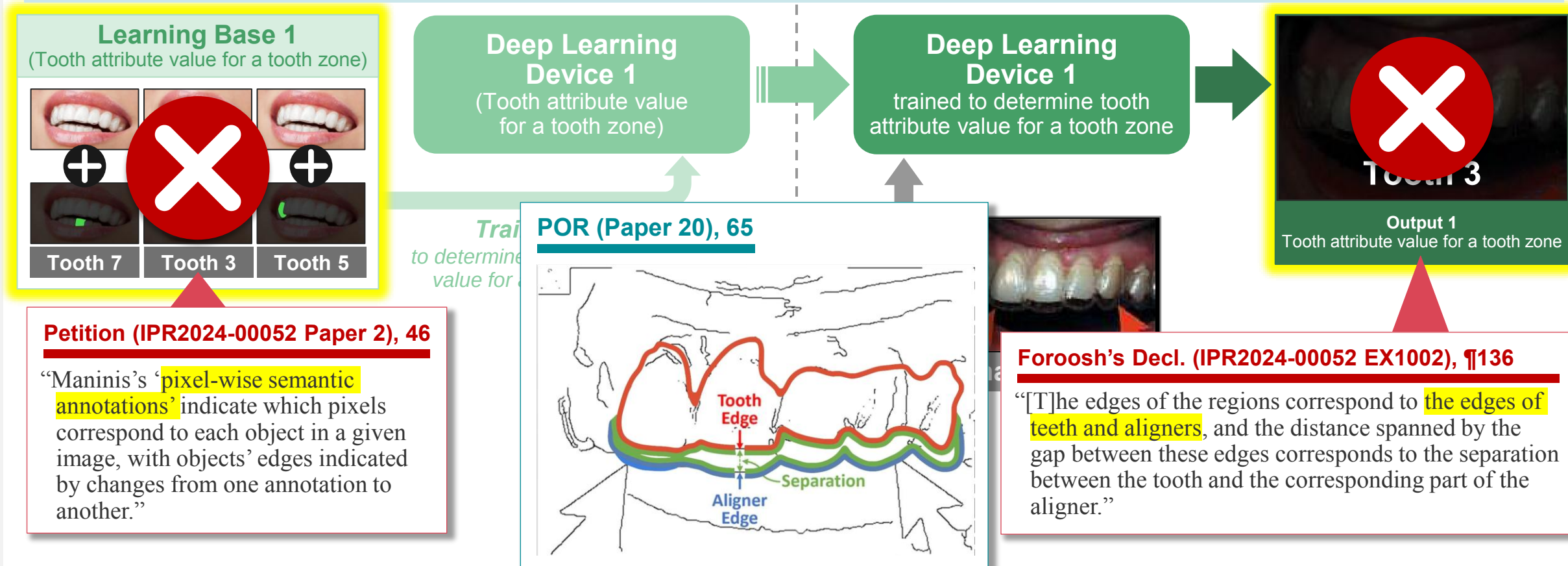
IPR2024-00052: EX2028 ¶¶125-140, 172-83, 221-223; Paper 20, 11-14, 30-39, 42-43, 63-66; Paper 30, 4-6, 23-26; EX2055; EX2063; EX1006, 1

IPR2024-00052 & IPR2024-00110
DEMONSTRATIVE EXHIBIT – NOT EVIDENCE

Petitioner's Combination Is Fatally Flawed

Petitioner's combination relies on pixel-wise semantic annotations of images

Petitioner's pixel-wise semantic contours are not a tooth attribute value



Detailed analysis method (claims 7 and 14)

IPR2024-00052: EX2028 ¶¶125-140, 172-83, 221-223; Paper 20, 11-14, 30-39, 42-43, 63-66; Paper 30, 4-6, 23-26; Paper 2, 46; EX1002 ¶136; EX2055; EX2063; EX1006, 1

IPR2024-00052 & IPR2024-00110
DEMONSTRATIVE EXHIBIT – NOT EVIDENCE

Claim Construction – Contours Cannot Be “Tooth Attributes”

Petitioner’s construction is overly broad by including “respective positions or edges”

Petitioner’s Construction (Paper 2), 16

The “tooth attribute” recited in claim 1 includes any attribute of a tooth that may relate to the tooth’s separation from an aligner, including attributes specific to the tooth or to the aligner, such as their **respective positions or edges**, which may bear a relation to the separation between the tooth and the aligner.

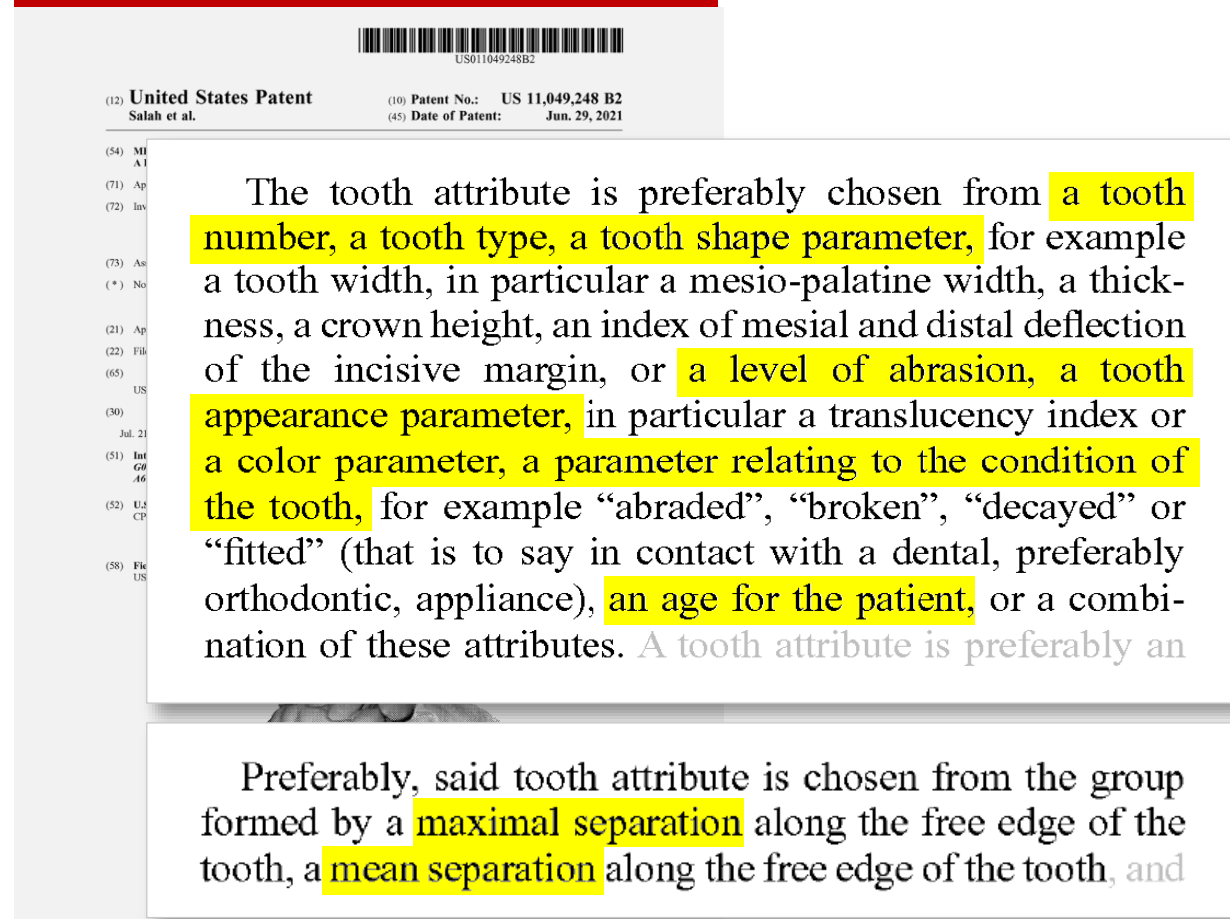
Patent Owner’s Construction (Paper 20), 14

Petitioner’s construction equating “tooth zone” and “tooth attribute” should be rejected, and “tooth attribute” construed as: attribute of a tooth.

Claim Construction – Contours Cannot Be “Tooth Attributes”

All “tooth attributes” in the '248 Patent are attributes of a tooth

'248 Patent (EX1001), 7:64-8:7, 28:48-50



Tooth attributes include:

- tooth number
- tooth type
- tooth shape
- tooth condition or appearance
- maximal or mean separation between the tooth and corresponding aligner

Tooth attributes do not include:

- contours
- tooth or aligner edges

Claim Construction – Contours Cannot Be “Tooth Attributes”

Petitioner conflates the distinct “tooth zone” and “tooth attribute”

'248 Patent (IPR2024-00052, EX1001), Cl. 7

7. The method as claimed in claim 1, in which the step b") comprises the following steps:

- 1) creation of a learning base comprising more than 1000 images of dental arches, or “historical images”, each historical image representing an aligner worn by a “historical” patient and comprising one or more zones each representing a tooth, or “historical tooth zones”, to each of which, for at least one tooth attribute relating to a separation between the tooth represented by the historical tooth zone considered, and the aligner represented, a tooth attribute value is assigned;
- 2) training of at least one deep learning device, by means of the learning base;
- 3) submission of the analysis image to the deep learning device for it to determine at least one probability relating to:
 - the presence, in a location of said analysis image, of an analysis tooth zone, and
 - the attribute value of the tooth represented on said analysis tooth zone;
- 4) determination, as a function of said probability, of the presence of a separation of the aligner and of the tooth represented by said analysis tooth zone.

tooth zone = area or region

tooth attribute = attribute of a tooth

Petitioner's Combination Is Fatally Flawed

In *detailed* image analysis, the deep learning device is trained on *tooth* attribute values

'248 Patent (EX1001), 15:16-16:63

Detailed Image Analysis Method

The method for detailed analysis of an "analysis image" of a dental arch of a patient according to the invention comprises the steps 1) to 4).

In the step 1), a learning base is created comprising more than 1000, preferably more than 5000, preferably more than 10 000, preferably more than 30 000, preferably more than 50 000, preferably more than 100 000 historical images. The

to other methods, for example be created manually. To create a historical image of the learning base, an operator, preferably an orthodontist, identifies one or more "historical" tooth zones on an image, called then assigns, to each identified historical tooth zone, a value for at least one tooth attribute.

In the step 2), the deep learning device is preferably trained by a learning process called "deep learning". By presenting, as input for the deep learning device, historical images (images+descriptions), the deep learning device progressively learns to recognize patterns on an image, and to associate them with tooth zones and with tooth attribute values, for example tooth numbers.

In the step 3), the image that is to be analyzed, or "analysis image", is submitted to the deep learning device.

Through its training in the step 2), the deep learning device is capable of analyzing the analysis image and of recognizing said patterns therein. It may in particular determine a probability relating to:

the presence, at a location in said analysis image, of a zone representing, at least partially, a tooth, or "analysis tooth zone",
the attribute value of the tooth represented on said analysis tooth zone.

For example, it is capable of determining that there is a 95% chance that a form of the analysis image represents an incisor.

Preferably, the deep learning device analyses all the analysis image and determines probabilities for all the analysis tooth zones that it has identified.

In the step 4), the results of the preceding step are analyzed to determine the teeth represented on the analysis image.

Petitioner's Combination Is Fatally Flawed

In *global* image analysis, the deep learning device is trained on *image* attribute values

'248 Patent (EX1001), 17:8-34

Global Image Analysis Method

The method for global analysis of an updated image of a dental arch of a patient according to the invention comprises the steps 1') to 3').

The method is similar to the detailed analysis method described above, apart from the fact that, according to the global analysis, it is not necessary to analyze the individual situation of each tooth. The analysis is global to all the image. In other words, the deep learning device determines the value of an "image" attribute without having to previously determine tooth attribute values.

The step 1') is similar to the step 1). The historical images however include a description specifying an image attribute value for each image.

In the step 3'), the analysis image is submitted to the deep learning device.

Through its training in the step 2'), the deep learning device is capable of analyzing the analysis image and of recognizing said patterns therein. Based on these patterns, it may in particular determine a probability relating to the value of the image attribute considered.

Petitioner's Combination Is Fatally Flawed

The patent claims these analyses separately

'248 Patent (EX1001)

Detailed Image Analysis

7. The method as claimed in claim 1, in which the step b") comprises the following steps:

- 1) creation of a learning base comprising more than 1000 images of dental arches, or "historical images", each historical image representing an aligner worn by a "historical" patient and comprising one or more zones each representing a tooth, or "historical tooth zones", to each of which, for at least one tooth attribute relating to a separation between the tooth represented by the historical tooth zone considered, and the aligner represented, a tooth attribute value is assigned;
- 2) training of at least one deep learning device, by means of the learning base;
- 3) submission of the analysis image to the deep learning device for it to determine at least one probability relating to:
the presence, in a location of said analysis image, of an analysis tooth zone, and
the attribute value of the tooth represented on said analysis tooth zone;
- 4) determination, as a function of said probability, of the presence of a separation of the aligner and of the tooth represented by said analysis tooth zone.

Global Image Analysis

8. The method as claimed in claim 1, in which the step b") comprises the following steps:

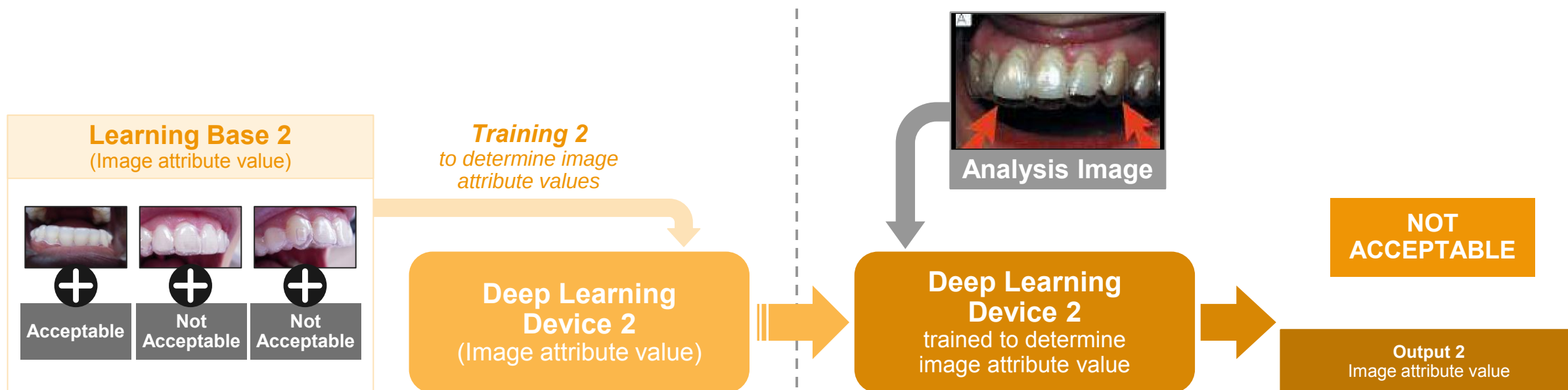
- 1') creation of a learning base comprising more than 1000 images of dental arches, or "historical images", each historical image comprising an attribute value for at least one image attribute, or "image attribute value", the image attribute relating to a separation between the tooth or teeth and the aligner represented on the historical image;
- 2') training of at least one deep learning device, by means of the learning base;
- 3') submission of the analysis image to the deep learning device for it to determine, for said analysis image, at least one probability relating to said image attribute value.

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▶ '945 Patent	74

Petitioner's Combination Is Fatally Flawed

'248 Patent discloses and separately claims detailed and global analysis methods

- Petitioner identifies **no** deep learning device that can be trained on image attribute values to output image attribute values
- Petitioner relies on pixel-wise annotations that are regional attributes, **not** image attributes



Global analysis method (claim 8)

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▶ '945 Patent	74

The '945 Patent claims new and improved methods to assess aligner fit using image analysis

US01109945B2

(12) United States Patent
Salah et al.

(10) Patent No.: US 11,109,945 B2
(45) Date of Patent: Sep. 7, 2021

(54) METHOD OF EVALUATING AN ORTHODONTIC ALIGNER

(71) Applicant: DENTAL MONITORING, Paris (FR)

(72) Inventors: Philippe Salah, Bagneux (FR);
Thomas Pellissard, Clichy (FR);
Guillaume Ghyselsnick, Cautin (FR);
Laurent Debraux, Paris (FR)

(73) Assignee: DENTAL MONITORING, Paris (FR)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 605 days.

(21) Appl. No.: 16/001,049

(22) Filed: Jun. 6, 2018

(65) Prior Publication Data
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(30) Foreign Application Priority Data

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A61C 7/00 (2006.01)
A61C 7/08 (2006.01)
(Continued)

(52) U.S. CL
CPC **A61C 7/002** (2013.01); **A61C 7/008** (2013.01); **A61C 9/0053** (2013.01);
(Continued)

(58) Field of Classification Search
CPC **A61C 7/002**; **A61C 7/008**; **A61C 9/0053**;
A61C 7/14; **A61C 7/00**; **A61C 7/02**;
(Continued)

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Primary Examiner—Mahendra R Patel
(74) Attorney, Agent, or Firm—Cooper Legal Group, LLC; Ronald M. Kachmark

(57) ABSTRACT

A method for evaluating the shape of an orthodontic aligner worn by a patient. Acquisition of at least one two-dimensional image of teeth of the patient as “updated image.” At least one updated image as “aligner image,” at least partially representing the aligner in a service position. At least one updated image as “dentition image,” representing the teeth. If the dentition image is different from the aligner image, conversion of the dentition image so that it represents the teeth as seen under the acquisition conditions used during the acquisition of the aligner image. Determination, for each of a plurality of teeth represented on the dentition and aligner images, of interior and exterior tooth outlines representing the outline of the free end of the tooth on the dentition and aligner images. Comparison of the interior and exterior tooth outlines, followed by determination of at least one score according to the comparison.

10 Claims, 4 Drawing Sheets

1. A method for evaluating the shape of an orthodontic aligner worn by a patient, said method comprising the following steps:
 - 1) acquisition of at least one two-dimensional image of teeth of said patient, referred to as “updated image”, under actual acquisition conditions;
at least one updated image referred to as “aligner image”, at least partially representing the aligner in a service position in which it is worn by said teeth; and at least one updated image referred to as “dentition image”, identical to or different from the aligner image, representing said teeth,
 - 2) if the dentition image is different from the aligner image, conversion of the dentition image so that it represents said teeth as seen under the acquisition conditions used during the acquisition of the aligner image in step 1);
 - 3) determination, by means of image processing software, for each of a plurality of teeth represented on the dentition and aligner images, of interior and exterior tooth outlines representing the outline of the free end of said tooth on the dentition and aligner images, respectively;
 - 4) comparison of the interior and exterior tooth outlines, so as to determine at least one score according to said comparison.

Kim (EX1005)



- Petitioner's ground references do not:***

- ✗ suggest remotely assessing aligner fit
- ✗ suggest taking images of aligners in a service position
- ✗ suggest analyzing image with an aligner in a service position

Claim Construction – “Interior And Exterior Tooth Outlines” “For Each of a Plurality of Teeth”

Petitioner agrees the method must distinguish tooth and aligner outlines for each tooth

Patent Owner:

- Claims require “not only the use of image processing software to determine contours, but also that the contour belongs to a tooth or an aligner, and that the interior and exterior tooth outlines correspond to the same tooth”

Petitioner:

- Petitioner says this “makes no difference to the case presented in the petition” and “the petition expressly proposed detecting outlines of the free ends of each tooth (and the corresponding parts of the aligner)”

Petitioner's Combination Is Fatally Flawed

Petitioner agrees the method must distinguish tooth and aligner outlines for each tooth

- Petitioner relies on Salah's detection of generic contours
- Petitioner identifies **no** way to distinguish tooth and aligner outlines for each tooth

1. A method for evaluating the shape of an orthodontic aligner worn by a patient, said method comprising the following steps:

1) acquisition of at least one two-dimensional image of teeth of said patient, referred to as "updated image", under actual acquisition conditions;

at least one updated image referred to as "aligner image", at least partially representing the aligner in a service position in which it is worn by said teeth; and at least one updated image referred to as "dentition image", identical to or different from the aligner image, representing said teeth,

2) if the dentition image is different from the aligner image, conversion of the dentition image so that it represents said teeth as seen under the acquisition conditions used during the acquisition of the aligner image in step 1);

3) determination, by means of image processing software, for each of a plurality of teeth represented on the dentition and aligner images, of interior and exterior tooth outlines representing the outline of the free end of said tooth on the dentition and aligner images, respectively;

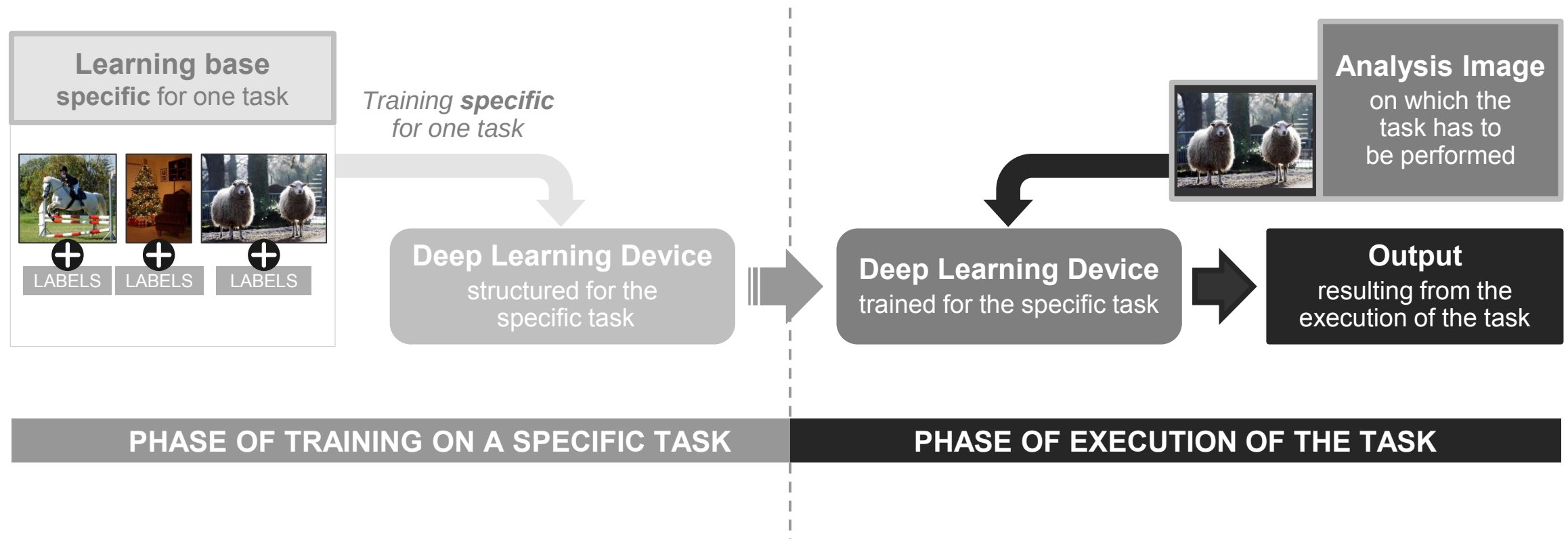
4) comparison of the interior and exterior tooth outlines, so as to determine at least one score according to said comparison.

Alternative Slides (31-38)

Petitioner's Combination Is Fatally Flawed

A deep learning device must be trained to perform a specific task

A deep learning device is designed for **a specific task**. It is structured to receive **a specific type of training**, based on **a specific labeled dataset** (the learning base).



Petitioner's Combination Is Fatally Flawed

A deep learning device must be trained to perform a specific task

A deep learning device is designed for **a specific task**. It is structured to receive **a specific type of training**, based on **a specific labeled dataset** (the learning base).



Mongan Decl. (IPR2024-00052, EX2028), ¶61

“In other words, it was known that each neural network trained for an image recognition task is unique and specific to the annotated images on which it has been trained, and its success (then and now) depends on the quality of that training and the challenge(s) of the attributes it is tasked with recognizing.”



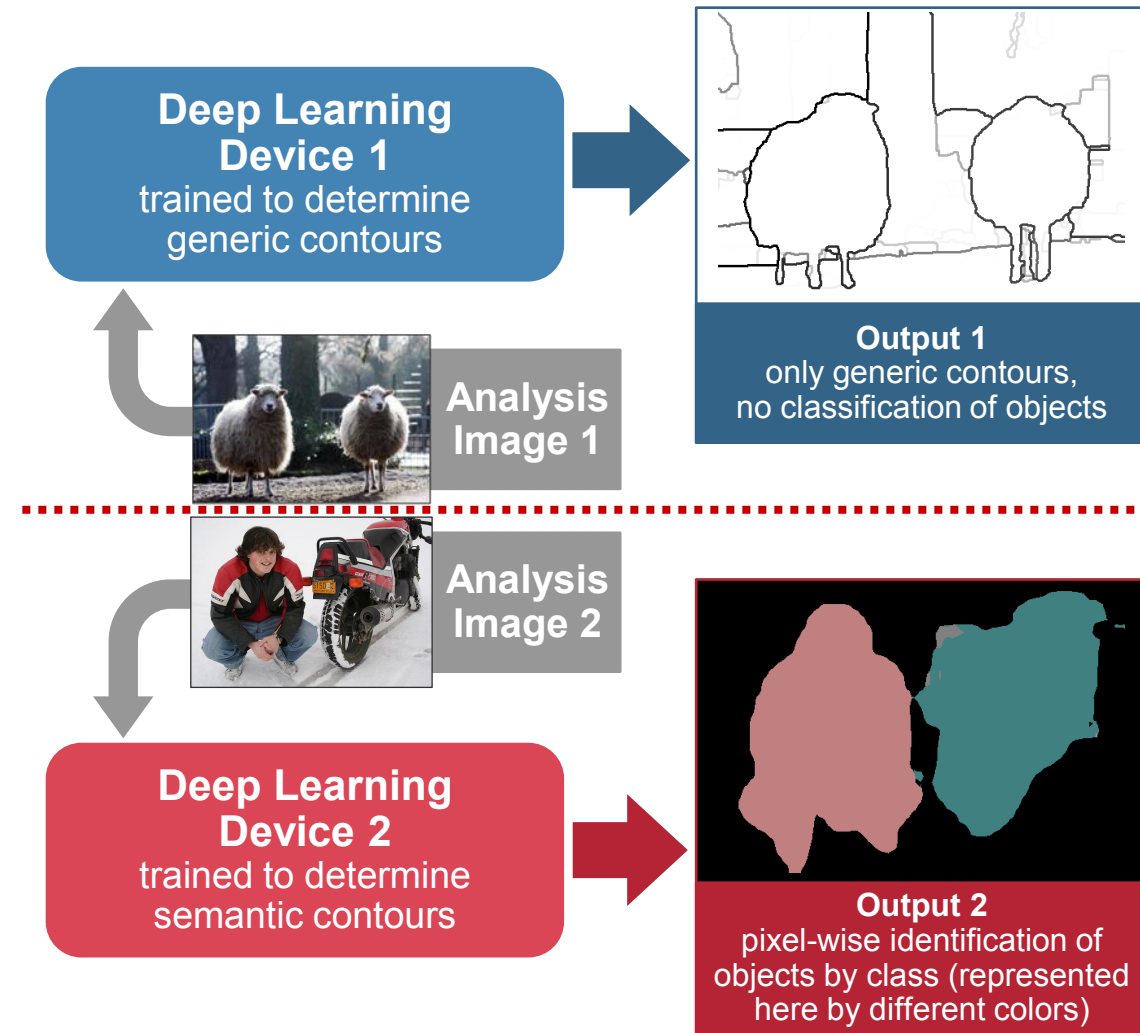
Foroosh Tr. (IPR2024-00052, EX2054), 169:22-171:11

“[G]enerally speaking, deep learning needs to be either trained or be a pretrained model to perform the task that you’re looking for. That task might be anything. It could be recognizing a pattern, but it could be many other things.”

Petitioner's Combination Is Fatally Flawed

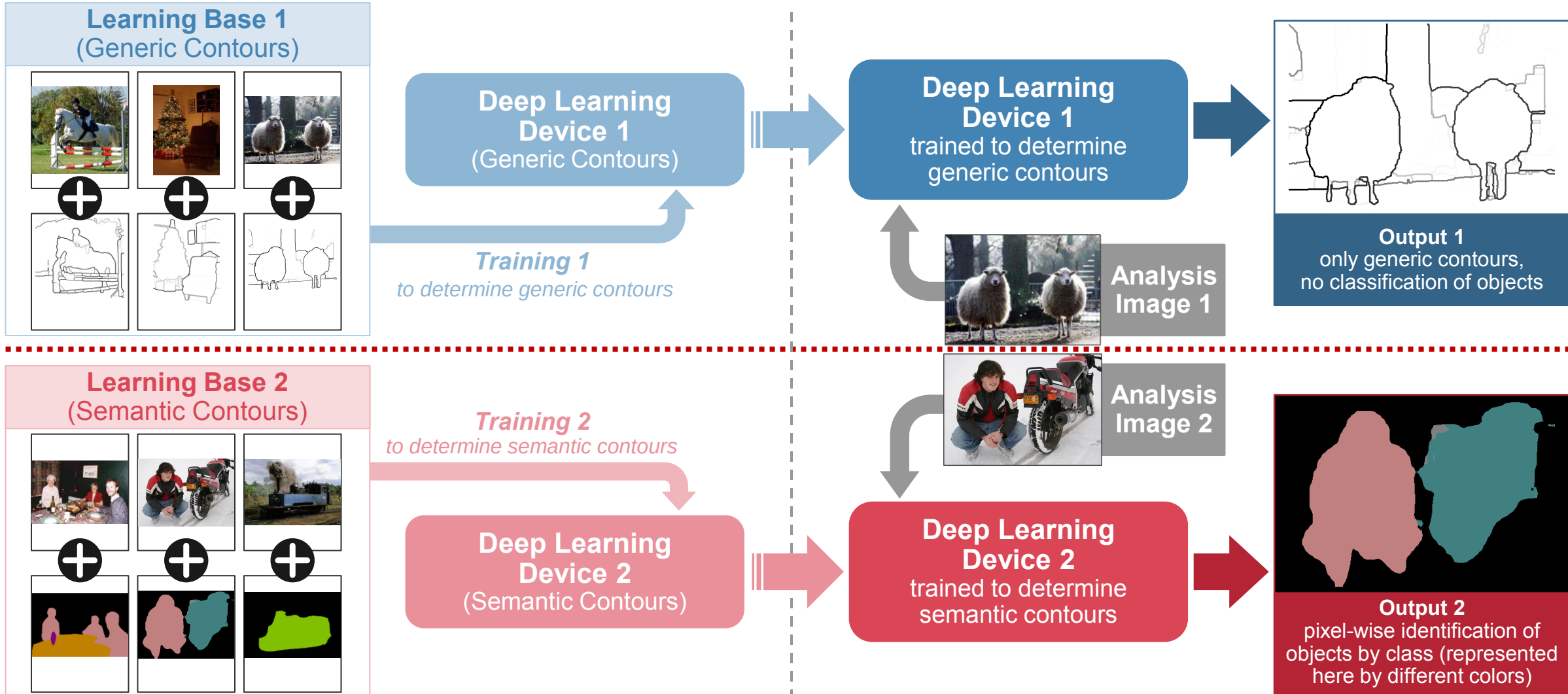
The training and functionality of deep learning devices are determined by their architecture

A deep learning device must be **trained** to perform a **specific task**



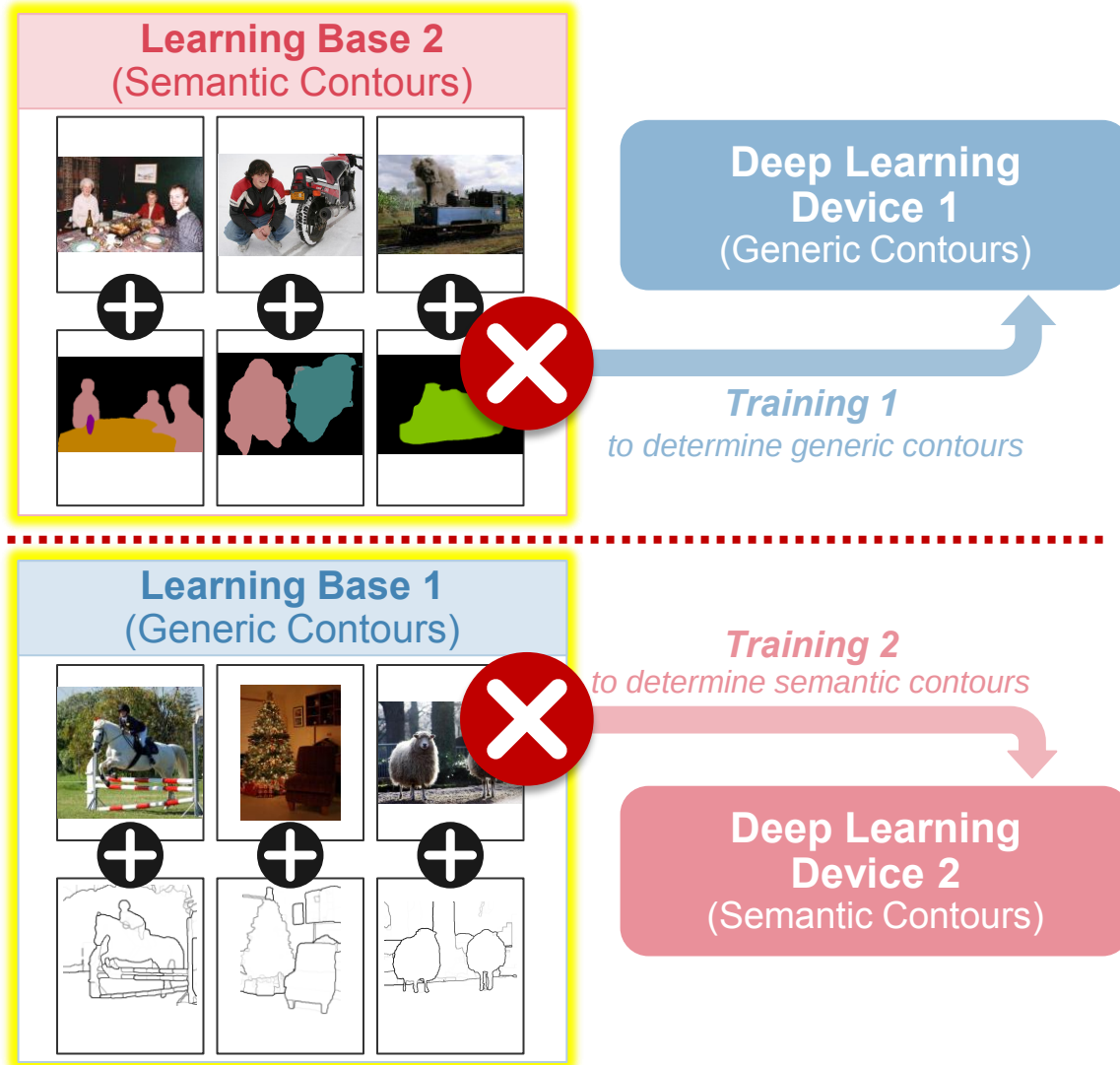
Petitioner's Combination Is Fatally Flawed

The training and functionality of deep learning devices are determined by their architecture



Petitioner's Combination Is Fatally Flawed

Deep learning devices are not generic or interchangeable

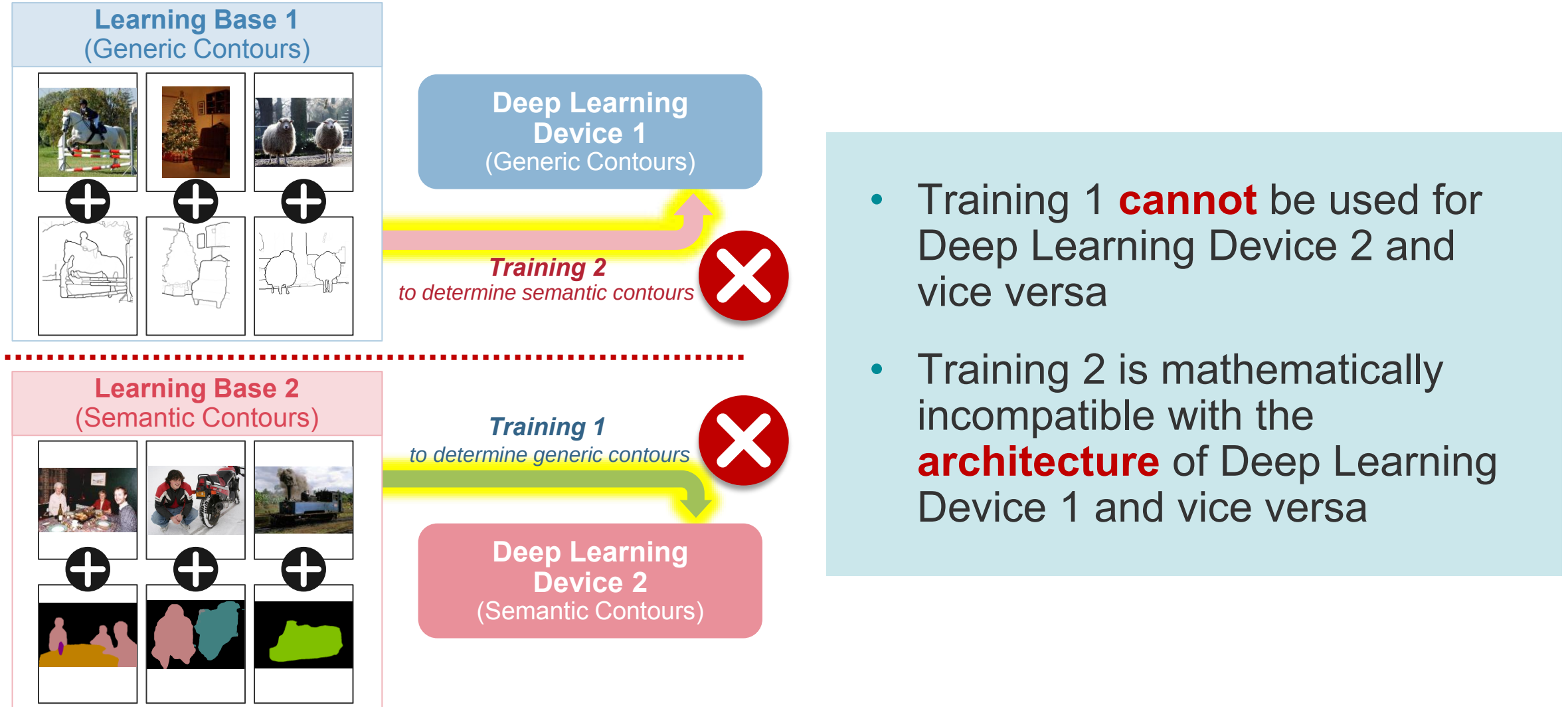


Learning Base 1 **cannot** be used for Training 2 and vice versa

- **Learning Base 1: binary** (1, 0) pixel-wise annotations (i.e., contour, not contour)
- **Learning Base 2:** pixel-wise **class** specific annotations (i.e., cat, flower, background)
- Learning Base 2 **cannot** be used for Training 1 because it includes information that cannot be accepted
- Learning Base 1 **cannot** be used for Training 2 because it lacks necessary information

Petitioner's Combination Is Fatally Flawed

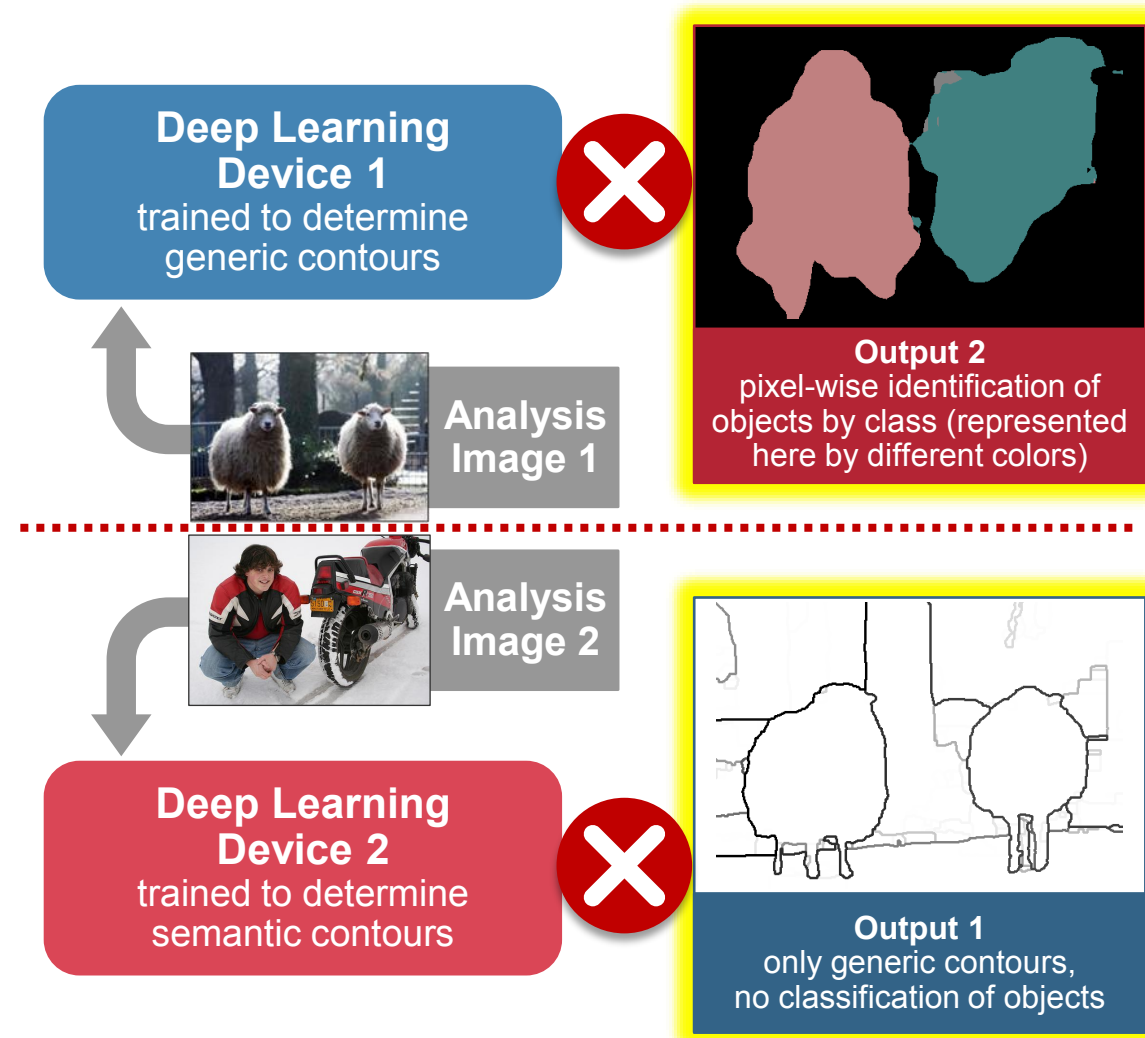
Deep learning devices are not generic or interchangeable



Petitioner's Combination Is Fatally Flawed

Deep learning devices are not generic or interchangeable

Deep Learning Device 1
cannot determine Output 2
and vice versa



Petitioner's Combination Is Fatally Flawed

Deep learning devices are not generic or interchangeable

Deep Learning Device 1 is **fundamentally incapable** of generating semantic contours

