PATROLL Winning Submission

U.S. Patent 7,035,461

U.S. Patent 7,035,461 ("*Monument Peak*" or the "patent-at-issue") was filed on August 22, 2002 and claims priority on the same date. Claim 1 of the patent-at-issue is directed to a method of detecting objects such as faces in a digital image. The method includes generating a color segmentation map where a non-object specific criterion or a color homogeneity criterion, specifically a skin-like average color, is applied. The image is also processed in an object-specific criterion, specifically a skin color associated with a facial object, to generate a second color segmentation map. The two segmentation maps are then combined to identify and locate objects in the image.

The primary reference, U.S. Patent 7,035,456 ("*Canon*"), was filed on May 31, 2002, and claims an earliest priority date on June 1, 2001. The patent is directed to a method of detecting human faces in a colored image. The method includes generating human skin-colored segments in the image and determining which of the segment contains a face. The method of identifying the face includes determining features in the segment and forming groups of the features. Each group is then analyzed whether the group is bounded by contour lines, representing a human face.

The secondary reference, a publication entitled "A novel approach for human face detection from color images under complex background" ("*Wang*"), was published on July 6, 2001. The publication presented a method of detecting faces and eyes in colored images. The method includes a segmentation algorithm to find skin-like pixels and locate each face-like region. Following the segmentation of the face-like regions, a wavelet decomposition is done to each segment to identify potential facial features. It is recognized as a human face if the features are arranged like a face model or if an eye is present.

A sample claim chart comparing claim 1 of *Monument Peak* to *Canon* and *Wang* is provided below.

US7035461 ("*Monument Peak*")	**A. US7035456** (*"Canon"*) **B. A novel approach for human face detection from color images under complex background** (*"Wang"*)
[1.pre] A method for **detecting objects in a digital image**, comprising the steps of:	**A. US7035456** "1. A method of **detecting one or more human faces in a colour image**, said method comprising the steps of: . . . ." *Canon* at claim 1 **B. A novel approach for human face detection from color images under complex background** "This paper proposes a novel fast approach to the **detection, segmentation and localization of human faces in color images** under complex background." *Wang* at p. 1983 "The approach first utilizes evolutionary computation technique to **detect and locate the face-like regions**." *Wang* at p. 1983
[1.a] a) **generating a first segmentation map of the digital image according to a non-object specific criterion**;	**A. US7035456** "2. A method as claimed in claim 1, wherein step (a) comprises the sub-steps of: (a1) **over-segmenting said image into a plurality of first segments, each first segment having a substantially homogenous colour**; (a2) determining, for **each first segment**, **a probability of colours contained therein being human skin colour**; . . . ." *Canon* at claim 2 **B. A novel approach for human face detection from color images under complex background** "A number of color-sensitive agents are uniformly distributed in the 2-D image environment to **cluster the skin-like color pixels** and **segment each face-like region** **by activating their evolutionary behaviors**." *Wang* at p. 1983-1984 "More specifically, it can sense its local position, **evaluate the color value of a pixel, mark the skin-like point**, and exhibit a number of evolutionary behaviors, such as self-reproduction, diffusion, etc." *Wang* at p. 1985

[1.b] b) **generating a second segmentation map of the digital image according to a object specific criterion**; and	**A. US7035456** "3. A method as claimed in claim 2, wherein step (a2) comprises the sub-steps of: (a2i) determining for each pixel of said image **a probability of said pixel having a colour of human skin**; and . . . ." *Canon* at claim 3 "6. An apparatus for detecting one or more human faces in a colour image, said apparatus comprising: means for **forming human skin coloured segments in said colour image**; and . . . ." *Canon* at claim 6 **B. A novel approach for human face detection from color images under complex background** "First, a number of evolutionary agents are uniformly distributed in the 2-D image environment to **detect the skin-like pixels and segment each face-like region** by activating their evolutionary behaviors. Then **wavelet decomposition is applied to each region to detect the possible facial features and a three-layer BP neural network is used to detect the eyes among the features**." *Wang* at p. 1983
[1.c] c) **detecting objects in the digital image using both the first and second segmentation maps**.	**A. US7035456** "7. An apparatus as claimed in claim 6, wherein said means for forming human skin coloured segments comprises: means for over-segmenting said image into a plurality of first segments, **each first segment having a substantially homogenous colour**; means for determining, for each first segment, **a probability of colours contained therein being human skin colour**; means for **merging adjacent first segments** in which said probability is above a first predetermined threshold; and means for **grouping the merged first segments to form said human skin coloured segments**." *Canon* at claim 7 "Another property of human skin is that the colour of human skin is distinctive from the colour of many other natural objects. Hence, **skin colour is a feature that is used for face detection**." *Canon* at col. 6:18-21 **B. A novel approach for human face detection from color images under complex background** "Therefore, **regions merging is needed in order to determine how many face-like regions are there in the image**. The basic idea for merging regions in the proposed method is that **if**

	two regions are linked at more than a certain number of points (5 is chosen after a large number of experiments) **the two regions are merged into one bigger one**." *Wang* at p. 1986