

# Comics-Like Motion Depiction from Stereo

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## ABSTRACT

In this paper, we present an algorithm to depict motion in comics-like form, with an artistic drawn-like representation of the scene, from a stereo image sequence. The input to the algorithm is a natural scene, along with a user-defined set of parameters that define the tone and stylistic properties of the image to be produced. The algorithm uses a dense disparity map, computed from the input stereo video, to preserve the perspective perception of the stylized image by drawing each stroke in a direction determined by the stereo derived disparity layers. To outline important features in the image, we utilize the contour edges provided by the Edge Combination algorithm. In the next step, we detect motion of the objects in the scene by tracking points that are close to the dominant edges of the Edge Combination image. The extracted dominant structure is further used to obtain a larger variety of styles for visualizing the motion trajectories. The output of the algorithm is a drawn-like form of the original scene with the motion highlighted in imitation of comics produced by hand.

**Keywords:** Real scene, stereo, Edge Combination, image-based rendering, motion depiction, tracking.

## 1 INTRODUCTION

*The heart of comics lies in the space between the panels where the reader's imagination makes still pictures come alive! [McC00]*

Although there is an ongoing discussion about the historical roots of comics and their artistic contribution, reputed to be the first comic strip magazine is "Ally Sloper's Half Holiday" published in 1884. It was one of the most famous and most popular of all Victorian comics, featuring a regular character, Ally Sloper. However, the great boom that prompted the beginning of comics as an ongoing popular art form was Richard Fenton Outcault's cartoon series "Hogan's Alley" for Joseph Pulitzer's New York World in 1895. The Yellow Kid, as he later came to be known for his yellow nightshirt, became the first comic character to serve as a marketing tool for the sale of newspapers. This set the bases for a new kind of art with the adventures of superheroes and monsters in stories written in a powerful language of visual symbols. [Sab01, Har99]

Comic books lost a lot of their popularity with the development and expansion of 3D animation and new media. Today a great variety of commercial applications give to the user the ability to create interesting artwork even without the requirement of good drawing

skills. Contrary to this, comic books are usually created by skilled and creative artists who use a style of drawing unique for this type of art.

Comic books can be compared to silent movies, having dialogs in a written form and telling a story through sequences of images with a very important difference: comics use one image to present a sequence of frames. The form to visually depict the motion in just one image has been a big challenge for artists through history and resulted in different methods like: dynamic balance, multiple stroboscopic images, affine shear, photographic blur, and action lines [Cut02]. Today, pictorial description of the motion is particularly interesting for image stylization and initiated the development of a number of systems [MSS99, BE01, CRH03, KE05].

In this work we concentrate on a comic books' style of motion expression, where few lines suggest an action in the scene through motion lines and multiple contours. Similar to our work, Masuch et al. [MSS99] depict motion, but different to our system they use a 3D scene as input, having access to the 3D geometry and precise motion information of objects. The overall goal of our system is to enable a user to generate effective and attractive illustrations of dynamic natural scene recordings from stereo as input.

## 2 ALGORITHM

Images of a natural, real scene usually contain texture, noise, or other features such as shadowing that set the accurate extraction of object boundaries to a complex task. A simple approach of using only the output of an edge detector for most real scene's images induces the problem of distinguishing object boundaries from the other features edges. To overcome this problem, one of the most valuable sources of information about

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Figure 1: Example 1 from the “Alan Ford” comic book series. © Copyright 2005 by Max Bunker Press. Used by permission.

the objects present in the scene is the depth information. To obtain this information, from the images of the real scene, we use the depth-from-stereo approach. The output of the stereo matching process delivers a disparity map, which is directly related to the depth. In most cases, however, the object contours cannot be perfectly recovered from the disparity map alone, due to matching errors along the depth discontinuities. To suppress errors produced in the matching process we suggest the Edge Combination algorithm [MSG05], which uses disparity edges to identify corresponding edges in the original edge image to obtain more accurate information of the object boundaries. The result of this process, dominant edges that highlight the principal structure of the scene, is further used to stylize the image in a drawn-like form and to depict the motion through motion lines and multiple contours. Generally, our approach consists of two major steps: image representation in a drawn-like form and comics-like depiction of motion. These steps are further explained in the following sections.

## 2.1 Drawn-like image representation

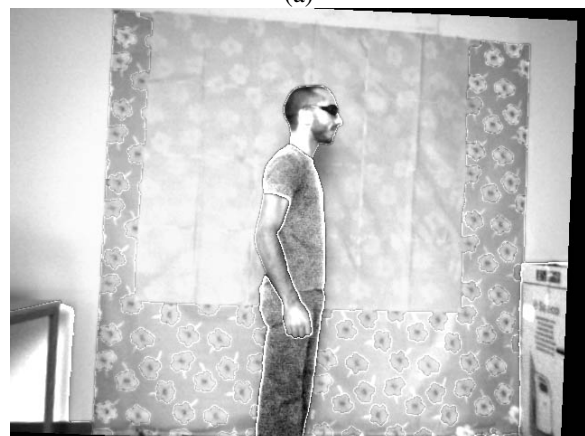
As we previously mentioned, comic books are usually created by skilled and creative artists who use a language of visual symbols for drawing, unique for this type of art. A very strong distinctive feature of comics is a tight connection between a story and a style of drawing: this results in funny stories having characters drawn like caricatures or “saving the world” stories with superheroes drawn in a way to show the power. Our system does not intend to replace an artist, although the result can be used as final artwork, but to assist an artist in technical aspects and support him in routine tasks. It can also be very useful in a learning process because the final output preserves the position, proportion and shape of objects. Since we are dealing with recordings of a natural scene, the drawn representations

keep the aspect of real.

To present an image in a drawn-like form, we make use of our previous work [MG05]. The computed stroke density varies according to the tone of the intensity image region, from dense strokes in dark to no strokes in light areas. To better convey the shape of objects in natural scene images, which usually suffer from a bad contrast, we first perform a local image contrast enhancement, which is driven by the color segmentation result of the original image. This produces an image with newly revealed details, as presented in Fig. 2. We then draw each stroke in a direction determined by the stereo derived disparity layers with the stroke density and distribution derived from a Poisson disc distribution. The disparity maps that we use in this work are results of the graph-cut based stereo-matching algorithm [BG05], which represents disparity by a set of planar layers. Such a representation of enhanced images using disparity to orient strokes results in a good distinction and shape depiction of objects in the scene.



(a)



(b)

Figure 2: (a) Original image, (b) enhanced original image, prepared for further stylization.

## 2.2 Tracking the motion

For tracking the motion of objects in the scene we employed the KLT tracker [ST94]. To depict motion in comics-like style, we need only information of distinct discontinuities in motion, which usually go along with depth discontinuities. By following this idea, among the point set selected automatically by the KLT tracker, we track only those points found to be close to edges in the Edge Combination image through all the frames of the user selected sequence.

## 2.3 Depicting motion

In comics, motion is usually represented using either motion lines, multiple contours or their combination, which results in a variety of styles. An example of motion depiction in a real comic through motion lines is given in Fig. 1, and using both motion lines and multiple contours is shown in Fig. 3.

**Motion lines:** also known as action lines or speed lines, is the most common style of representing motion in comic books. Depicting motion in comics has a meaningful purpose in story telling and strongly depends on an artist's imagination. Usually, motion for each object is presented through one path in several motion lines (see Fig. 1 and Fig. 3). In a natural scene, one or more objects can be sources of motion. Representing just the motion of the object with, for instance, the longest path would be a great limitation. As a remedy, we give control to the user to select a desired object and type of motion to depict by selecting one of the object's tracked points. Fig. 4 (b) shows a tracked point and its path selected from the tracking points in Fig. 4 (a). To preserve the usual simple motion illustration in comics, we fit primitives (i.e. circle, ellipse, straight line) to the path of the tracked point to get the final motion path and to have a possibility to extend its length. An example of fitting a primitive, in this case a circle, is shown in Fig. 4 (c). By further selecting points on the contour in the Edge Combination image, Fig. 4 (d), close to the tracked point, the user passes the same shape of the motion path to these points, and in this way more motion lines can be created from a tracked path. For a more natural, hand-drawn look, the number of points in the final motion path, for each motion line, is reduced by removing a small random number of points at the beginning of the path.

**Multiple contours:** is another, very important, style of motion representation which uses a complete or a part of a moving object's contour. To imitate this style we use Edge Combination images extracted from the frames in a regular interval and draw them on the final result. Regularity in frame selection gives a good impression of the object's motion speed. The variety of styles can be even larger by changing the transparency of contours through frames.



Figure 3: Example 2 from the "Alan Ford" comic book series. © Copyright 2005 by Max Bunker Press. Used by permission.

## 3 EXPERIMENTAL RESULTS

Example results of motion depiction using multiple contours, motion lines and their combination are given in Figs. 5 - 9. The initial stereo image pair of the image sequence, in epipolar geometry, is presented in Fig. 5 (a) and (b). Their resulting disparity image computed by employing the stereo matching algorithm presented in [BG05] is given in Fig. 5 (c), along with the labeled disparity layers shown in Fig. 5 (e). The color segmentation result, see Fig. 5 (f), is used in order to locally enhance the contrast to better convey the shape of the natural scene before further processing. Fig. 5 (h) illustrates the output of our algorithm in the style of motion depiction using motion lines together with the drawn-like representation of the natural scene from Fig. 5 (g). Another example of the same motion depiction style is given in Fig. 9 (c).

Two sets of images, presented in Fig. 6 and Fig. 7, demonstrate various styles of motion depiction through multiple contours and multiple contours joined with motion lines, respectively. The corresponding frames from the original sequence are shown in Fig. 8. The multiple contours styles that we illustrate in these figures are obtained by changing the transparency of contours through frames, using a complete or a part of a moving object's contour and their combination.

## 4 SUMMARY AND OUTLOOK

In this paper we have presented an algorithm to depict motion in comics-like form, with an artistic drawn-like representation of the scene, from a stereo image sequence. We have devised several motion depiction styles using motion lines and/or multiple contours. We have shown how silhouettes extracted by the Edge Combination algorithm can serve in motion depiction and also to portray the impression of the change of an object's speed.

In future steps, we intend to experiment with a spline representation of the motion path. This should give more flexibility and the possibility of depicting more complex motions, but it may also raise problems in motion path length extension. We also plan to experiment with other stylistic properties of comics and explore additional techniques of motion illustration in still images.

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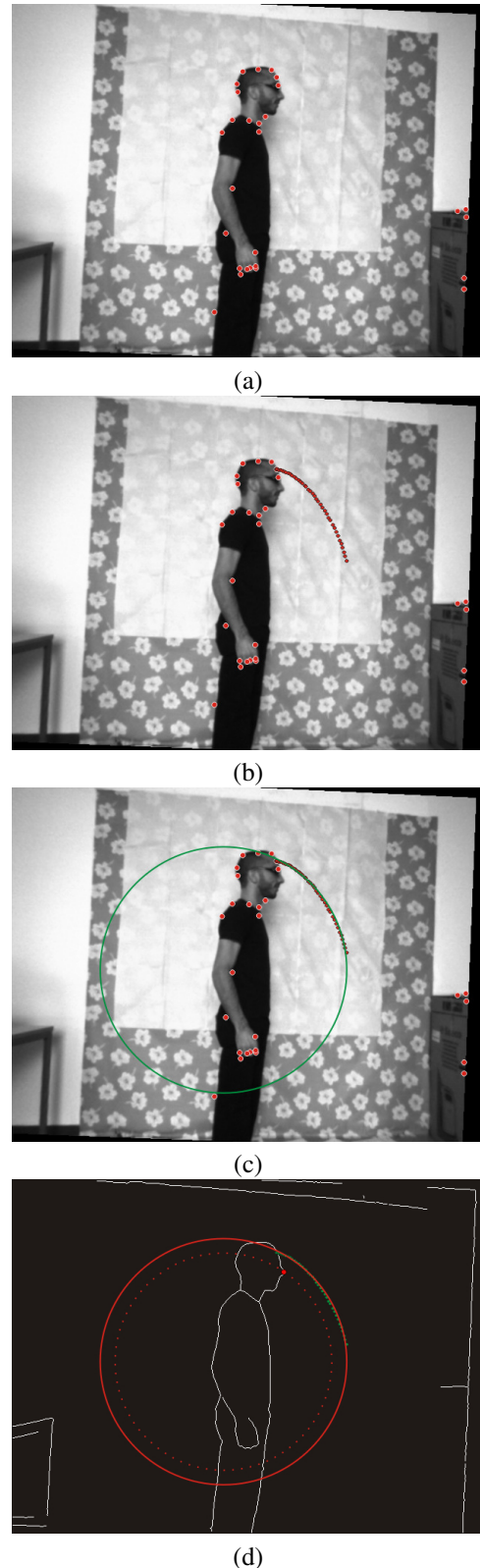


Figure 4: (a) Points to track, (b) motion path of the selected point, (c) fitted circle to the motion path, (d) selected new point on the contour in the Edge Combination image and its path.

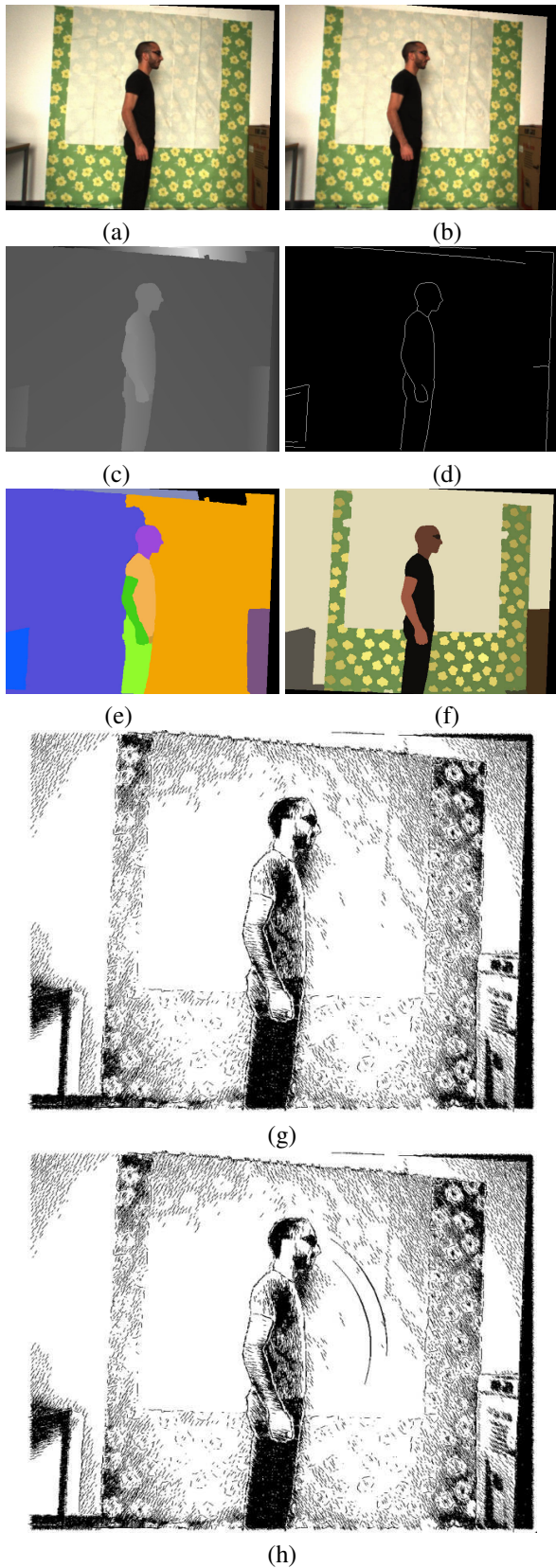


Figure 5: (a) Left camera image, (b) right camera image, (c) disparity image, (d) Edge Combination image, (e) layers image, (f) color segmented image, (g) drawn image, (h) drawn image with depicted motion.



Figure 6: Results of motion depiction through multiple contours.

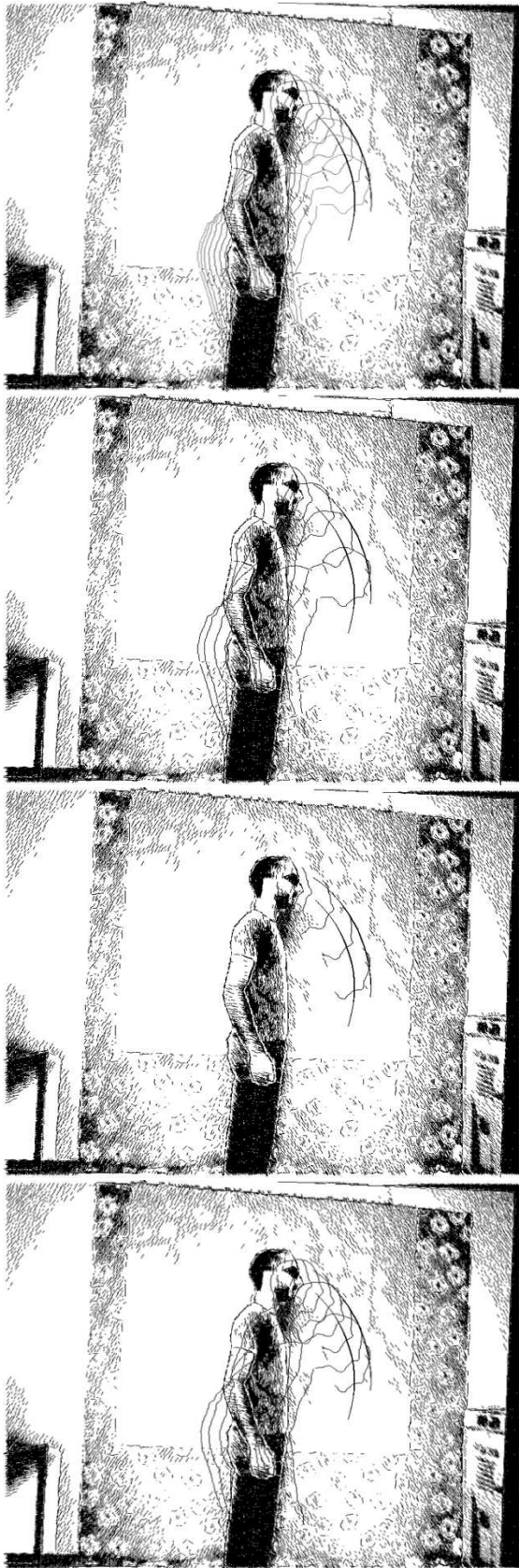


Figure 7: Results of motion depiction through multiple contours and motion lines.

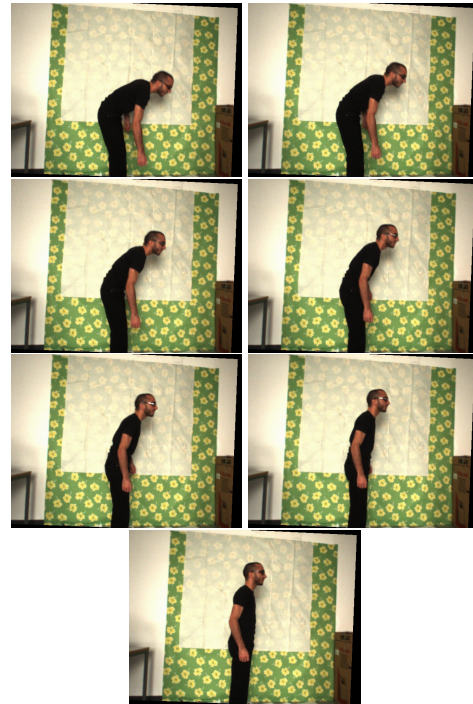
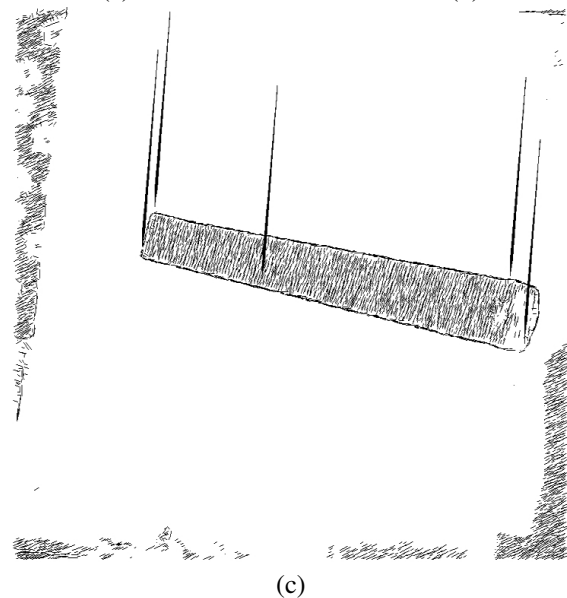


Figure 8: Intermediate frames (from top left to bottom) used for computation of the contours in Figs. 6 and 7.



(a)

(b)



(c)

Figure 9: (a) Left camera image, (b) right camera image, (c) drawn image with depicted motion.