Visual Saliency Detection of Stereoscopic 3D Images using ACO

Rakesh Y[1], K.Srilatha[2], MD.Althamas[3], M.Nadhiya[4], B. Ashok Kumar[5], P. Narayana Murthy [6]

Asst. Professor[1], B TECH Students, [2, 3, 4, 5, 6]

Department of Electronics and Communication Engineering, URCET[1, 2-6], Vijayawada

Abstract – It is the era of rapidly growing digital image usage automatic image categorization has become prominent research area. Saliency detection is a pre-processing step for a wide area of applications which includes object detection and recognition, face recognition, image compression, visual tracking, object retargeting, image categorization and image segmentation. Here we propose a fast and compact saliency detection method to meet the essential application requirement of salient object detection task. In this paper, we present a novel saliency detection model by exploiting ACO technique to measure the image's saliency via depositing the pheromone on the 3D image in view of highlight difference from luminance, color and depth. Experimental results are presented to demonstrate the performance of the proposed approach.

Keywords: Saliency detection, ACO, Stereoscopic 3D image, Luminance, Depth.

I. INTRODUCTION

Saliency detection is a fundamental problem in computer vision that aims to highlight visually salient regions or objects in an image. Visual attention models have been successfully applied in many domains, including multimedia delivery, visual retargeting, quality assessment of images and videos, medical imaging, and 3D image applications. Today, with the development of 3D display technologies and devices, various applications are emerging for 3D multimedia, such as 3D video retargeting, 3D video quality assessment, and so forth. Overall, the emerging demand for visual attention-based applications for 3D multimedia has increased the need for computational saliency detection models for 3D multimedia content. The existing approaches are classified into two categories: bottom-up and top down. The former is associate image-driven approach to pick out visual info based on the prominence within the image itself, whereas the latter could be a goal-driven approach supported a user-defined task. Top-down methods are task-driven and require supervised learning with manually labelled ground truth. To better distinguish salient objects from background, high-level information and supervised methods are incorporated to improve the accuracy of saliency map. In contrast, bottom-up methods usually exploit low-level cues such as features, colors and spatial distances to construct saliency maps. The bottom-up strategy of saliency detection is pre-attentive and data-driven. It is usually fast to execute and easy to adapt to various cases compared to top-down approaches, and therefore has been widely applied. One of the most used principles, contrast prior, is to take the color contrast or geodesic distance against surroundings as a region's saliency. Saliency is resulted from visual contrast as it intuitively characterizes certain parts of an image that appear to stand out relative to their neighbouring regions or the rest of the image. Thus, to compute the saliency of an image region, the technique should be able to evaluate the contrast between the considered region and its surrounding area as well as the rest of the image. Here we focus on the bottom-up approaches.

II. RELATED WORK

Itti et al. [5] introduced a biologically-inspired saliency model. They proposed to use a collection of feature maps from three complementary channels as intensity, colour, and orientation. The normalised feature maps from every channel were then sent into a 'Winner-take-all' competition to select the foremost conspicuous image locations because the overall prominence map. Ma and Zhang [6] projected a neighborhood contrast-based saliency model that is obtained from summing variations of image pixels with their individual encompassing pixels in a very little neighbourhood. A fuzzy-growing technique then segments salient regions from the saliency map. Wu et al. projected to work out the saliency map optimisation low-level features, as well as luminousness, color and region information, then thresholding these feature maps employing a simply noticeable distinction (JND) model and desegregation them into a final saliency map.

Bottom-up vision based saliency detection and training models to estimate the eye fixation behaviour of humans, either based on local patch or pixel information which is still of interest today. In contrast to using fixation maps as ground-truth, proposed a large dataset with bounding-box annotations of salient objects.

Having two photos capturing at an instant is the vital part in creating an anaglyph image. Both photos must be focussed on the same object, sliding the camera horizontally between 3 and 5 cm for the next picture. Anaglyph delivers a marginally distinct perspective to individual eyes. From the variance between the two viewpoints and other visual indications, the human optical system can provoke the stereoscopic depiction of spatial correlation in the scene. To generate an anaglyph image, the left and right images of a stereo image pair are superimposed in discrete colour planes. The two images will be isolated from the amalgamated picture by colour filtering and fed to each eye. The red channel of the left image and the blue and green channel of the right image are fused to produce a red-cyan colour anaglyph image. It is essential to have coloured glasses which is devised by two unlike colours red and cyan. These glasses act as filters and permit each eye to see only what it deserves, thus, creating an illusion.

III. ANT COLONY OPTIMISATION

ACO is a meta-heuristic approach and the algorithm is based on the behaviour of the real ants while moving to their food source. Ants deposit pheromones on the path on which they move. So the decision pattern of the ants is controlled by the pheromones that they leave on the path which they follow. This helps them to communicate with each other via environment. Initially ants can choose any random path from their initial position to the food source but eventually the shortest path would have more pheromone level. This in-turn leads the complete ant colony to follow the shortest path from source to destination. The main features of ACO are as follows:

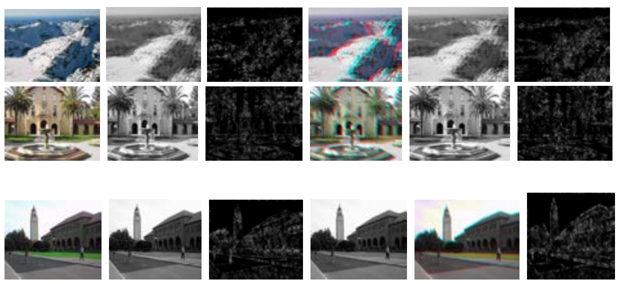
- Colony based multi agent approach: The optimization process in ACO based approaches is carried out by a collective system of ants. Each ant contributes to the solution but convergence to the solution is possible by the collective behaviour of ants.
- Distributed and Concurrent System: The ants work in parallel towards obtaining the solution of any problem. This approach leads a way for solving NP hard problems. Also the ants can exchange information between them to obtain a better solution.
- Iterative system: Each iteration in ACO is designed to improve the solution and thus with each passing iteration solution gets better. The reinforcement used after each iteration of ACO helps to achieve this objective.
- Search Capabilities: ACO can explore the entire search space to achieve global search capabilities. Also the pheromones are updated by each ant on each arc while constructing a partial solution. So a local search could be applied in ACO which helps to improve the solution. This step of local search is an optional step but it improves the overall performance of the algorithm.

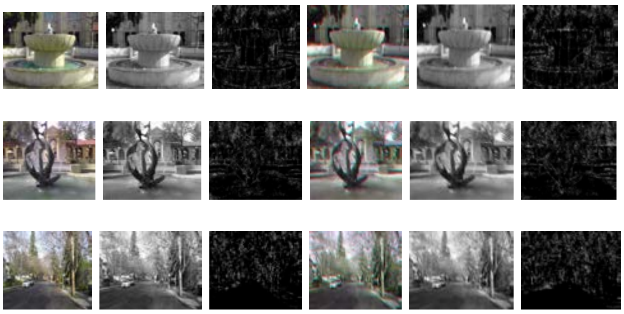
Any optimization problem could be solved using ACO if the problem could be represented using a graph in the discrete search space with all the transitions represented in a valid way. Among other necessary factors are:

- The mechanism to update pheromones in order to accommodate the positive feedback,
- Mechanism to represent and construct the solutions,
- Constraints defined over the problem so that the method constructs only feasible solutions,
- An evaluation function which serves as a measure for the generated solutions, and
- Termination condition.

The approaches based on ACO have the potential to overcome these limitations by parallel implementations which makes them evitable for distributed systems as well. The edge detection techniques based on ACO use a number of ants to move on the image. This movement leads to the construction of a pheromone matrix. Edge information at each pixel is represented by an entry in the pheromone matrix. Variation of the intensity values in the image is the key to the movement of ants. In a simple ACO based approach has been applied successfully to extract the edges of the image. Initially certain number of ants is distributed randomly on the image. These ants update their pheromone intensity in each of the iteration. This approach uses simple set of rules to update the pheromone intensities. An image vision model has been designed in16 for effective extraction of edges in an image. A variation of ACO has been used in17 in order to derive a relationship between the size of the image and the parameters of the algorithm. A number of extensions of ACO have been emerged since its development. A new technique for edge detection has been given in [4] based upon the distinguishing features of ant colony systems. In this, a pheromone matrix is established by movement of ants and pseudorandom proportional rules are used for updating the matrix.

IV. SIMULATION RESULTS





(a) (b) (c) (d) (e) (f)

Figure (a) 2D Input images, (b) 2D Grey images, (c) 2D_ACO_Output images, (d) 3D Input images, (e) 3D Grey images, (f) 3D_ACO_Output images

TABLE 1. RUN TIME CALCULATIONS

S. No.	Images	Run Time	
		2D Image	**3D Image**
1.	Snow Hills	14.77ms	14.87ms
2.	House	15.96ms	14.49ms
3.	Tower	14.44ms	14.15ms
4.	Fountain	14.76ms	14.53ms
5.	Water Fountain	14.23ms	14.73ms
6.	Road	14.34ms	14.56ms

V. CONCLUSION

ACO has immense potential in solving various image processing tasks including edge detection, edge linking, feature extraction, segmentation and image compression. The proposed approach exploits the local coherence of the image to guide the movement of a set of ants that deposit the secretion on the image and alter measurement of the image's saliency. The proposed approach is in a position to produce a saliency map of 2D and 3D images.

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