Analysis & Development of automatic motion detection and tracking system

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ABSTRACT

The current research article deals with the automatic tracking of a real time moving object. The motion of living things such as human beings, cats, dogs, fishes or any other celestial objects like star, earth, and planets can be tracked using this system. A tracking algorithm is developed in order to analyze whether the motion of the object is chaotic or not. The automatic tracking of object is done in several stages; namely image capturing, image processing, time series extraction and analysis. Here artificial intelligence software is developed to visualize the tracking of the moving object. The simulation and practical results are shown in this paper. The accuracy and reliability of this system is appreciable.

Keyword: - *Euclidean filtering, gray scaling, binarized image, chaos analysis, Hurst exponent, Lyapunov exponent*

1. INTRODUCTION

Recent advances in the field of video-based communication applications, such as videophone and video conferencing systems, concentrate mainly on minimizing the size and the cost of the coding and encoding equipment. Real-time video systems process huge amounts of data and need a large communication bandwidth. Real-time video applications include strategies to compress the data into a feasible size. The automatic tracking of the movement of a moving object is done by simultaneously capturing the image. Then the color of the object must be identified. Another color is filtered. Then, this image becomes a black and white image. Therefore, the position of the moving object can be found. The position of the object on the x axis, y and z is stored in the memory device and is displayed on the computer monitor with the help of the software. The body of the object is covered by a rectangular box. Therefore, the automatic tracking of the moving object is performed. The complete system setup is shown in Fig. 1. Here we choose a fish in a glass tank as a moving object. The webcam is used to capture images continuously and the computer processes the image and shows the path of the fish on the monitor. It can follow his movement and determine that his movement is chaotic or not.

The VO motion-tracking architecture is based on a new algorithm for tracking a VO. It consists of two main parts: a video object motion-estimation unit (VOME) and a video object motion-compensation unit (VOMC). The VOME processes two consequent frames to generate a hierarchical adaptive structured mesh and the motion vectors of the mesh nodes. It implements parallel block matching motion-estimation units to optimize the latency. The VOMC processes a reference frame, mesh nodes, and motion vectors to predict a video frame. It implements parallel threads in which each thread implements a pipelined chain of scalable affine units. This motion-compensation algorithm allows the use of one simple warping unit to map a hierarchical structure. The affine unit warps the texture of a patch at any level of hierarchical mesh independently. The processor uses a memory serialization unit, which interfaces the memory to the parallel units. [1]. An efficient algorithm, Orthogonal Matching Pursuit (OMP) is suitable for device-free motion tracking. Motion tracking based on feedback sparse recovery can directly be determine where the targets are located in the network area and reduce the amount of measurements required for reliable tracking [4]. A low power VLSI architecture for video object motion-tracking that can be used in very low bit rate online video applications. Power has been reduced at both algorithmic and arithmetic levels. The video object motion-tracking architecture consists of two main parts, a mesh-based motion estimation unit and a mesh-based motion compensation unit. The mesh-based motion estimation unit implements parallel block matching motion estimation units to optimize the latency. The mesh-based motion compensation unit uses parallel multiplication-free affine core. [2]. A multi-object motion-tracking method based both on region and feature tracking is possible for the purpose of realtime tracking in video surveillance system [7].

The ability of the VTS to track motion was assessed by comparing its results to those of the Polaris infra-red tracking system (Northern Digital Inc. Waterloo, ON, Canada). The difference in the motions assessed by the two systems was generally less than 1mm. Synchronization was assessed in two ways. First, optical cameras were aimed at a digital clock and the elapsed time estimated by the cameras was compared to the actual time shown by the clock in the images. Second, synchronization was also assessed by moving a radioactive and reflective sphere three times during concurrent VTS and SPECT acquisitions and comparing the time at which motion occurred in the optical and SPECT images. [3]. Stereo vision is essential for 3D motion tracking. Limb motion analysis in small animals can provide useful information for biomedical researches. Intensity-based and colour-based algorithms may be used to find the position [5].

The tracking and recognition of human motion, action, and events using computer vision has recently gained widespread interest in both academic research and industrial, with much emphasis on real-time systems. The motion data of the people are acquired in possible cases such as occlusion or overlapping with each other. This system provides to extract the motion of each player individually from successive image frames. Especially, the trajectories for each player are obtained in the whole video sequence of sport game and in every instance of time for using the sport training system. Singular value decomposition of Gaussian elimination method is applied to determine the matched person from previous image. The motion trajectory of a player is considered not only for normal case but also for overlapping case. From the video stream, fast and accurate method for tracking the motion path of a person was performed by the authors of [6]. Human motion, action, and events using computer vision gained widespread interest in both academic research and industrial. Low power very large-scale integration (VLSI) architecture for motion tracking can be used in online objectbased video applications such as in MPEG and VRML [11].

3D tracking of coarse human models from sequences of synchronized monocular gray scale images in multiple cameras was developed by the authors of [8]. When the system predicts that the active camera will no longer have a good view, tracking will be switched to another camera which provides a better view. The effects of geometric and motion tracking errors on reconstruction image quality was performed by the authors mentioned in [10]. Geometric errors had a greater impact on reconstruction quality than equivalent tracking errors.

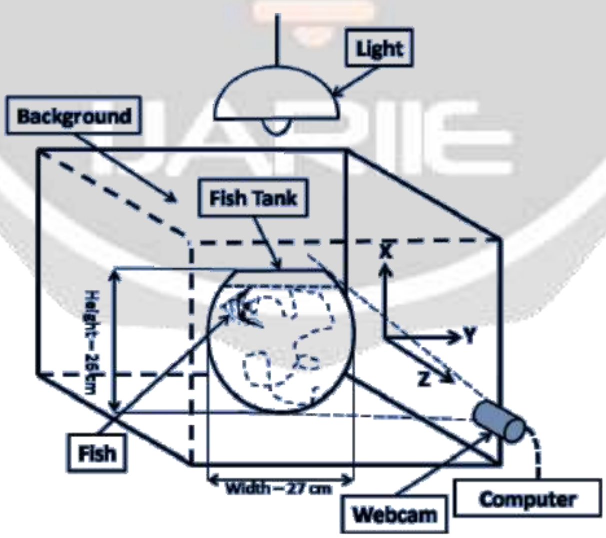

Fig -1: System setup for moving object tracking.

2. DESIGN OF THE SYSTEM

It is more suitable to explain the whole system with the help of a block diagram. The complete block diagram of the whole system is shown in Fig. 2.

The high resolution camera is connected to the computer in the system, such as the webcam. The camera sends images to the computer simultaneously. The software is developed to track the moving object. At the beginning, the Euclidean color filtering of each image is performed. In this process, the body color of the moving object is retained in the image and another color is filtered. Therefore, the body color of the moving object is first given to the software. Then there is a gray scaling of the image. Finally the binarization of the image is performed. From these filtering processes, the color image becomes a completely black and white image. Now position detection becomes very easy. The moving object is covered by a rectangular box and displayed on the computer. Therefore, the tracking of the moving object is completed. The position at each moment is stored in the memory of the computer for further processing.

Two adjacent frames with respect to time are compared. Then the path of object is determined. The path of object is displayed in the screen. The full procedure is presented in Fig. 3.

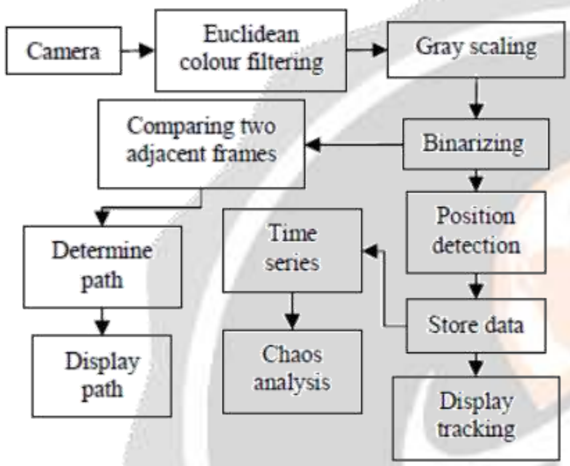

Fig -2: Complete block diagram of the moving object tracking system.

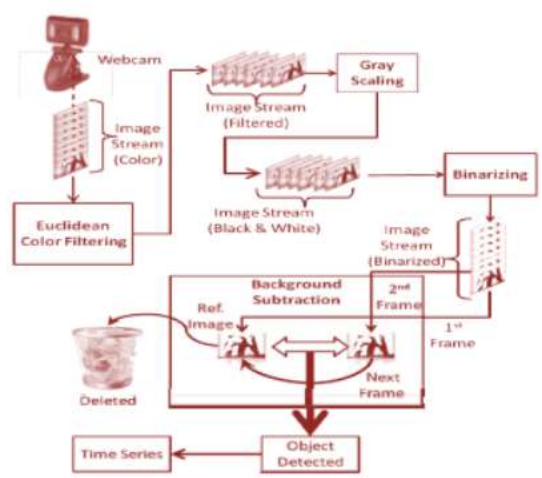

Fig -3: Procedure of the moving object tracking system

Contour tracking: Computer Vision toolset usually provides some contour analysis tools, which can be used to extract contours from a binary image, to match a contour against a template contour, etc. Contour analysis can be helpful in reducing possible detection candidates when the target objects are simple shapes, such as rectangles, circles or ellipses. An object after color analysis can be sent to contour extracting algorithm. Contour analysis is based on the binary image (mask image) output of color thresholding. Contour matching algorithms usually take as input two contours and output a real number indicating the extent to what they match. A threshold can be put on this number to rule out objects whose contours are too far away from the wanted contour. Contour algorithms do not use sliding window, thus is much faster than algorithms that are performed in a sliding window manner. Detecting the presence of chaos in a dynamical system is an important problem that is solved by measuring the auto correlation, Hurst exponent, Lyapunov exponent, correlation dimension, complexity etc. Here to analyze the chaotic nature in motion of living beings, we have dealt only with Hurst exponent and Lyapunov exponent. The Hurst exponent is a statistical measure used to classify time series. H=0.5 indicates a random series while H>0.5 indicates a trend reinforcing series. The larger the H value is the stronger trend. The Hurst exponent provides a measure for long term memory and fractality of a time series. Again, we have known that, H is directly related to fractal dimension (FD), such that FD=2-H.

The values of the Hurst exponent vary between 0 and 1, with higher values indicating a smoother trend, less volatility, and less roughness. To calculate the Hurst exponent, one must estimate the dependence of the rescaled range on the time span n of observation. A time series of full length N is divided into a number of shorter time series of length n = N, N/2, N/4… The average rescaled range is then calculated for each value of n.

For a (partial) time series of length n, $X=X_1, X_2 \ldots X_n$, the rescaled range is calculated as follows:

The mean is calculated from:

$$m = \frac{1}{n}\sum_{i=1}^{n} X_i \quad (1)$$

Then a mean-adjusted series is created as represented:

$$Y_t = X_t - m; t = 1,2, .. n \quad (2)$$

The cumulative deviate series Z is then calculated from:

$$Z_t = \sum_{i=1}^{t} Y_t \;\; t = 1,2,3, \ldots n \quad (3)$$

The range of R is computed from:

$$R_n = \max\left(Z_1, Z_{2,\ldots\ldots}Z_n\right) - \min(Z_1, Z_{2,\ldots\ldots}Z_n) \quad (4)$$

The standard deviation S is computed from:

$$S(n) = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(X_i - m)^2} \quad (5)$$

The rescaled range R (n) / S (n) and average over all the partial time series of length n is calculated:

$$E\left[\frac{R(n)}{S(n)}\right] = Cn^H \quad (6)$$

The usual test for chaos is calculation of the largest Lyapunov exponent. A positive largest Lyapunov exponent indicates chaos.

3. APPLICATION DOMAIN

Some of the applications of object tracking are:

- Automated video surveillieance: In these applications computer vision systems is designed to monitor the movements in an area, identify the moving objects based on color and report any doubtful situation.
- Robot Vision: In robot navigation, the steering system needs to identify different obstacles in the path to avoid collision. If the obstacles themselves are other moving objects then it calls for a real-time object tracking system. It is more accurate for robots tracking objects based on color rather than shapes.
- Animation: It can be extended to gaming portals also.

4. SIMULATIONS AND RESULTS

If many moving object such as Penguins are moved in a group then it is not any problem. The position of binarized image was stored continuously in the memory. The rectangular box was moved with the binarized image. Therefore, the line joining the centre points of the box is the path of the moving object. This movement of the moving object was analysed. The screen shot of the software for moving object tracking is shown in Fig. After starting software, the body colour of the moving object was selected. Then start button was pressed. Software is then connected with the webcam and capture image continuously. Results show that in all the cases the time series is chaotic.

Fig -2: Developed software for real time motion tracking of moving object.

TABLE 1: MOVING OBJECTS TAKEN FOR CONSIDERATION

Name of Fishes	Scientific Name of Fishes	Classes
Angle	Pteropthyllum Scalare	Class 1
Siamese Fighter	Betta Splendens	Class 2
Black Pony Gold Fish	Carassius Auratus	Class 3

TABLE 2: ANALYTICAL RESULTS FOR CHAOS

Set	Coordinate	H	FD	L
Class 1				
Set - 1	x - axis	0.6548	1.3354	0.1875
	y – axis	0.6891	1.3359	0.3542
	z - axis	0.6698	1.3345	0.2310
Set - 2	x - axis	0.6748	1.4354	0.1885
	y – axis	0.6797	1.2359	0.3745
	z - axis	0.6898	1.3325	0.3210
Set - 3	x - axis	0.7546	1.2071	0.3010
	y – axis	0.6975	1.2526	0.3737
	z - axis	0.6772	1.2310	0.1817
Class 2				
Set - 1	x - axis	0.7459	1.4457	0.1743
	y – axis	0.7782	1.2527	0.3984
	z - axis	0.7507	1.3071	0.2014
Set - 2	x - axis	0.7657	1.4356	0.1174
	y – axis	0.6792	1.2378	0.3739
	z - axis	0.6888	1.3342	0.3886
Set - 3	x - axis	0.7771	1.2147	0.3642
	y – axis	0.7750	1.2840	0.3085
	z - axis	0.7582	1.2141	0.1066

Class 3					
Set - 1	x - axis	0.7875	1.4903	0.1738
	y – axis	0.7440	1.2335	0.3908
	z - axis	0.7511	1.3985	0.2082
Set - 2	x - axis	0.7787	1.4322	0.1798
	y – axis	0.6454	1.2846	0.3765
	z - axis	0.6440	1.3003	0.3843
Set - 3	x - axis	0.7515	1.2808	0.3214
	y – axis	0.7849	1.2284	0.3985
	z - axis	0.7193	1.2600	0.2548

5. CONCLUSION

In this paper, an algorithm for real-time object detection based on moving object tracking system is used. The advantages of using artificial intelligence is to achieve object's similarity are robust against the complex, deformed and changeable shape. In addition, it is also scale and rotation invariant, as well as faster in terms of processing time. We used here Euclidian filter which has the advantage that it can be used in dynamic images in arbitrary dimensional space and has linear complexity. By experiments, we also find that the algorithm is very efficient. In the experiments performed both in indoor and outdoor environments, our approaches considerably reduce the detection delay and memory usage. As our algorithm is more efficient and do not rely on any special hardware, they are more appropriate for embedded systems or portable devices.

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