Cruze System Using Marker Tracking and Image Stabilization for Ride on Toys

Kyung-bo Hong, Hun-jun Yang, and Dong-Seok Jeong

Dept. Electronic Engineering, Inha University

Summary

This paper presents methods of image stabilization and marker tracking to improve the automatic driving function of electric vehicles for children. Previous methods of automatic driving solely implemented marker tracking, resulting in various malfunctions. Due to the importance of safety regarding electric vehicles aimed at the target audience, this paper presents significant improvements on previous methods of marker tracking with an implementation of a PA algorithm resulting in a reduction of malfunctions in automatic driving systems.

Key words:

image stabilization, Curze system, ride on toys, marker tracking

1. Introduction

Recently, the demand for ride on toys is gradually increasing due to the rapid development of the leisure industry. Unlike in the past, expanded size of the resting area such as a park or a playground around the residence led more people to use ride-on toys at the outside. Because of the gradual augmentation of ride-on toys industry in the trend, the most considerable issues are the safety and the convenience. From the perspective of the parents, on the one hand, they concerns about the safety issue regarding to ride-on toys, on the other hand they pursue the convenience for themselves.

Ride on toys equipped with a simple structure and components at the beginning are now evolving with the convergence of the other technologies. A remote control system which used 27MHz bandwidth in the past is equipped with 2.4GHz and the Bluetooth in order to avoid the crosstalk with other appliances. Furthermore, a control system has been evolved from using a simple circuit configuration which only can perform uncomplicated instructions to applying an embedded system which is more practical.

When we take a close look about the improvement of infant's ride-on toys, it is acknowledged that those toys take the similar direction of enhancement as which the AI home appliance, such as a cleaning robot, does. As a complex embedded system replaces the conventional circuit system, those home appliances gradually possesses the ability to perform more perplex operation in order to accommodate user's convenience.

However, the trend of technology on the automobiles and the home appliances, many techniques are invented with the aid of the camera. In order to catch up this tendency, technology for the ride- on toys which utilizes the camera has to be invented for the sake of the convenience for the parents and the safety of infants.

An automated driving system for the vehicles which utilizes the image inputs from the camera is pervasive in the industry. Yet, this automated technology is only needed for the cars moving on the roadway. Infant's ride-on toys, which never be driven on the road, has to be used in the appropriate places such as a park and a playgrounds with the guidance of the parents to preserve infant's safety. Therefore, ride-on toys not only do not need a complex image system applied on the vehicles, but also needs an automated system which depends heavily on parents. Furthermore, the dimension of the toy is limited, so the size of the composed system also has to be restricted.

Moreover, whole different optimization process compare to the convention is needed. In order to promote children's safety, shorter response time is required for the system to perform in the real-time.

In this paper, for the marker tracking, we suggested an image process system for ride-on toys using a camera which uses fewer operations, runs with a simple algorithm, and makes less error by detecting oscillations and movements compares to the conventional automated system. Also, this system can promote better safety for the children because parents possess all authorities over the machine.

2. Theoretical Consideration

2-1. Digital Image stabilization

Digital Image Stabilization (abbr. DIS) technique is used mainly on preprocessing for the video captures, and the image from a camera in order to eliminate the discomfort on the visualization and minimize the occurrence of error while processing the image.

According to the figure 1, DIS is composed of an image preprocessing phase, an image estimation phase, and a motion stabilization phase. First, An image preprocess

Manuscript received October 5, 2012
Manuscript revised October 20, 2012

phase is preparation phase before processing an image. At this phase, image is converted to grey and divide it to yuv image. Moreover, it determines the user's ROI in the converted image, and estimates the area of the oscillation. Second, an image stabilization phase, which is the most critical process in DIS, determines the performance, accuracy and speed for DIS. Many techniques such as BMA(block matching algorithm), BPM(bit plane matching), and PA(projection algorithm) has been research until now. However, as we mentioned before, each techniques has their own purpose and tendencies, and for this paper, we applied a part of PA which runs in a shortest time to track the motion in order to improve marker tracking.

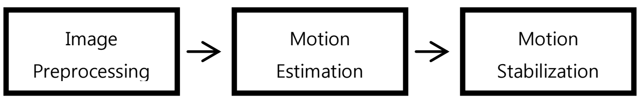
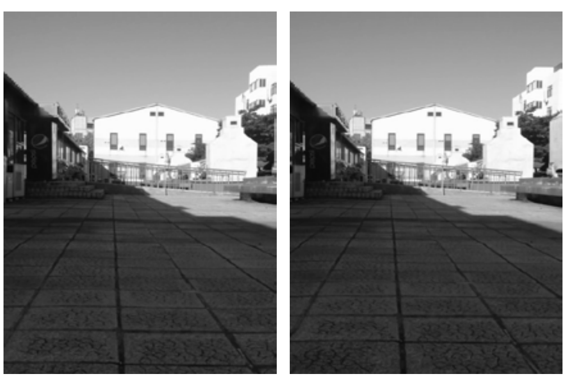


Fig. 1 DIS Image Stabilization system structure

2-2. PA Algorithm

PA is an algorithm that converts input image into 2 projected values. First, PA converts reference image and current image into gray image. Second, it calculates vertically, and horizontally projected values of both images by using equation 1 and equation 2. Projected values mean that it calculates all the gray pixels for each vertical and horizontal line. For examples an image has 640 values in vertical, 480 values for horizontal if the size is 640 x 480.



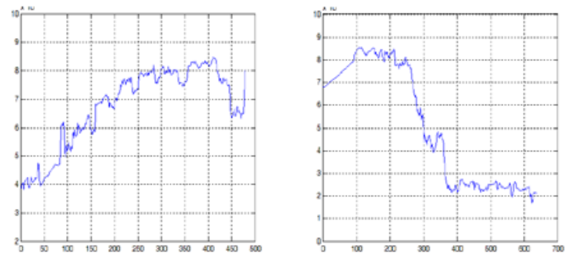
(a) n-1 th frame image (b) n th frame image

Fig. 2 Convert to grey image

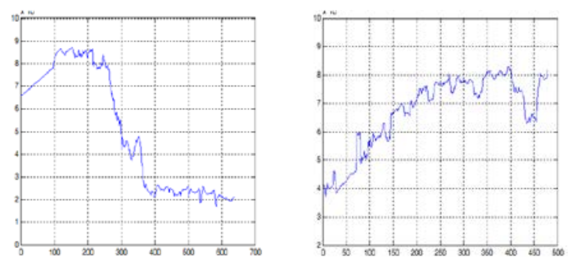
In the figure 2, there are two images which are located in (n-1) th frame and n frame. Referencing (n-1) th frame, an image in n frame will be corrected. We calculate the values of vertical and horizontal lines using the equation (1) and (2).

$$\rho_k^x(j) = \sum_{i=1}^{N} f_k(i,j) \tag{1}$$

$$\rho_k^y(j) = \sum_{i=1}^{N} f_k(i,j) \tag{2}$$



(a) n-1 th frame image



(b) n th frame image

Fig. 3 Projection value

f(i,j) corresponds to the gray values for each pixel, and M and N mean the size of the input image. In figure 3, (a) means the horizontally and vertically projected values of (n-1) frame, and (b) corresponds to the projected values of n frame. For the next, we calculate the estimation value of correlations in vertical and horizontal values.

In this place, the search area is determined by PA, which can be upside and downside of this algorithm. First, the search area is determined by estimating the oscillation of the image. Beside the left and right search area, s value, we set the search block. We calculate the value of correlation of search blocks in (n-1) frame and n frame, and then find the minimum value of this correlation value. With this value, vertical and horizontal motion can be calculated.

$$C(i) = \sum_{j=b}^{B} \left| p_k(j+i-1) - p_{k+1}(j) \right|^2$$
$$(0 \leq i \leq 2s-1) \tag{2}$$

Equation 3 shows the process of calculating the minimum value of the correlation. Value s means the estimation of the oscillation, and value B is the size of search block beside the value s.

In figure 4, it expresses the value s and the search blocks of nth frame and (n-1)th frame.

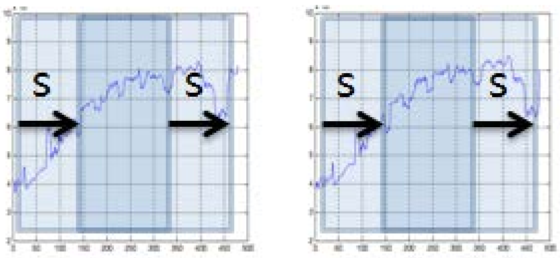


Fig. 4 Search Block

The value we achieved we this process means global motion, and it is used to move the image in nth frame to the other direction of the global motion.

3. Proposed method

Equation 3 shows the process of calculating the minimum value of the correlation. Value s means the estimation of the oscillation, and value B is the size of search block beside the value s.

We want to suggest a method to achieve appropriate image for the marker tracking algorithm by using PA.

One expected defect for the ride-on toy using the marker tracking algorithm is that the movement of the ride-on toy will be awkward because whenever the marker is moving, this moving toy will be following the marker and move left and rightward too many times. In this case, we need as image stabilization technique. It has to be clearly defined that the movement of the marker is caused by the oscillation of the image or actual movement of the marker. In order to notice these subtle differences, the part of PA will be used.

Fig. 5 Image with the marker's movement.

Figure 5 is an image with the marker's movement. Figure (a) is the (n-1) th frame and (b) is the image of the n th frame.

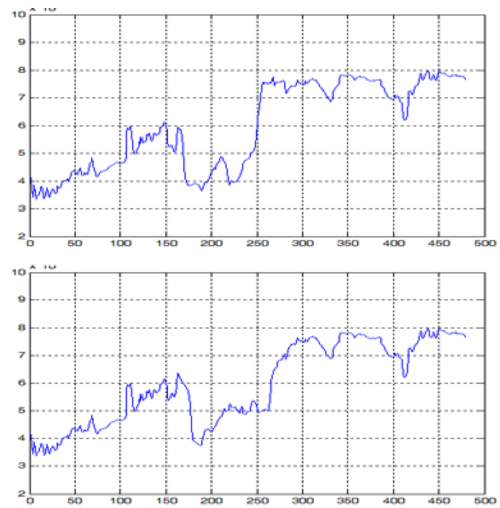


Fig. 6 Projection value graph

Images in figure 6 are the graphs of vertically and horizontally projected values of images in figure 5 achieved by PA. the boxed areas of images are the places for the marker.

Fig. 7 oscillation image

Images in figure 7 represent the oscillation of the camera but no movement of the marker. Image (a) is the image of (n-1)th frame and the other one is the image of nth frame.

Graphs in figure 8 are vertically and horizontally projected values of figure 5. Boxed areas are the places for the marker.

By comparing figure 6 and 8, the oscillation of a camera and the movement of the marker can be distinguished. When the image was considered to be oscillated, changes projected values can be detected in left and rightward side. However, where there was no oscillation, changes of

projected values happen only at the center where the marker was placed.
It can be noticed whether the image is oscillated or not by comparing horizontally projected values of the images of (n-1)th and nth frame. Moreover, when the movement of the oscillation is detected, we compare the both sides of projected values in nth and (n-1)th image, and calculate the global movement of the nth frame. When the movement of the marker is detected, the ride-on toy can detect the location of the marker and sends signal to moves its steering wheel to the amount of the marker's displacement.

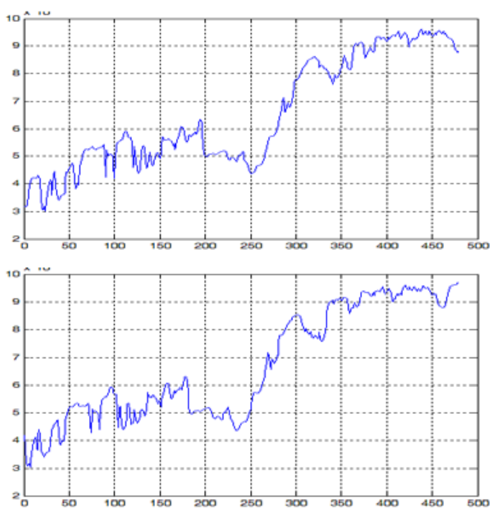


Fig. 8 Projection value graph

4. Test and result

In order to test the thesis we proposed in this paper, we composed an experiment as following.

Fig. 8 test image

In this experiment, we tested the automated drive of the ride-on toy using marker tracking only and using DIS in order to specify the movements. Both tests were composed under the same location and the identical automobile. The test measured when the marker was moving in left and rightward, and when there was no movement on the marker. The result of the test is as follow.

Table 1: Experiment result of fail rate

		Failures / recognized	Fail rate
Straight	Marker tracking	56 / 457	12 %
	Proposed algorithm	19 / 343	5.5 %
Right and Left	Maker tracking	785 / 4564	17 %
	Proposed algorithm	215 / 2513	8.5 %

According to the table 1, it is clear that when the marker tracking algorithm was used solely, Occurrence of malfunction was significantly higher than when both techniques were used together. Even thought the surface of road was not smooth, it is clear that stabilization technique can fix majority number of failures.

5. Conclusion

In this paper, we proposed the marker tracking automated driving system which implemented an image stabilization technique in order to avoid the Malfunction. By using simple PA operations, Shortened time for stabilizing image allowed us to establish a real-time automated marker tracking system which performs twice better than the conventional technique.
According to the result, the usage of a simple image stabilization algorithm can accommodate stable results in the real-time image tracking algorithm.
Furthermore, this image stabilization algorithm must be mounted on ride-on toys for the children because the safety is considered to be the most sensitive issues.

References

[1] Li dong Xu, Xing gang Lin, "Digital Image Stabilization based on Circular Block Matching", IEEE Transactions on Consumer Electronics, vol. 52, no. 2, MAY 2006

[2] Uomori k, Morimura A, Ishii H, Sakaguchi T, Kitamura Y, "Automatic image stabilizing system by full-digital signal processing", IEEE Transactions on Consumer Electronics, vol. 36, no. 3, 1990.

[3] ZHONG Ping, YU Qian-yang, JIN Guang, "Research on estimation algorithm of motion vector of dynamic image sequence", OPTICAL TECHNIQUE, vol. 29, no. 2, pp. 219-222, 2003.

[4] Yin Bin, Duan Hui-chuan, "Image Stabilization by Combining Gray-Scale Projection and Block Matching

Algorithm", IEEE International Symposium on IT in Medicine & Education, vol. 1, pp. 1262-1266, 2009.
[5] S.Erturk, "Digital Image Stabilization with Sub-Image Phase Correlation based Global Motion Estimation", IEEE Transactions on Consumer Electronics, vol. 49, no. 4, 2003.
[6] Sung-Hee Lee, Kyung-Hoon Lee, Sung-jea ko, "Digital Image Stabilizer Algorithms based on Bit-plane Matching", IEEE Transactions on Consumer Electronics, vol. 44, no. 3, 1998.

Kyung-bo Hong received the B.S. degree in Electrical Engineering from Inha University in 2011. M.S. candidate in information engineering from Inha University, Korea, from 2011 to now.

Hun-jun Yang received the B.S. degree in Electrical Engineering from Inha University in 2011. M.S. candidate in information engineering from Inha University, Korea, from 2011 to now.

Dong-Seok Jeong became a Member (M) of IEEE in 1983, a Senior Member (SM) in 2000. He got his BSEE degree from Seoul National University in 1977 and MSEE and Ph.D. degree from Virginia Tech in 1985 and 1988 respectively. He is also the member of SPIE and HKN. From 1977 to 1982, he was a researcher at Agency for Defense Development of Korea and he is currently a professor at Inha University in Korea since 1988. Also he served as the president for the Institute of Information and Electronics Research from 2000 to 2004. His research interests include image and video processing, image and video signature and forensic watermarking.