Upgrade of a Vehicle Detection System based on the CENTINELA

Karlos Tarajano[1]
Technological Development Unit
TECNOBIT S.L.U.
Madrid
carlos.tarajano@tecnobit.es

Gustavo I. Marrero Callicó[2]
DSI – IUMA
Las Palmas de Gran Canaria University
Las Palmas de Gran Canaria
gustavo@iuma.ulpgc.es

Abstract—**in this work, a novel vehicle detection algorithm has been designed in order to provide a cue to the CENTINELA's tracking system. Mixtures of techniques are used in this work as Optical Flow, Canny edge detection and others. The results outperform the original algorithm in terms of vehicle detection.**

Keywords: vehicle detection, optical flow, canny, edge detection, movement vector

I. INTRODUCTION

TECNOBIT SLU is a lead Spanish Defense company. One of its main business areas is the optronics line. Tecnobit has developed a movable observation and surveillance system for tactical operations named CENTINELA. As it is shown in Figure. 1, CENTINELA is composed of several electro-optical sensor fitted in a protective case (a) and on a pan & tilt platform (b). The complete system is controlled via a portable console composed of a ruggedized PC (c), a joystick panel (d) and a connection box (e). CENTINELA's Tracking System is presently outdated and the need to upgrade this system was the original reason of this work.

Figure 1. TECNOBIT's CENTINELA System

II. STATE OF THE ART

Tracking systems has a very wide range of application, and is widely studied in many different areas [1]. Tracking systems can involve many different kinds of sensors [2]. In this work, the sensor used was a FLIR camera.

In an active tracking system [3], the process can be split in four stages: engage, prediction, aiming and evaluation. In the first stage, the object to track has to be locked in order to generate a signature. Then, a prediction is made and once it is finished, command the platform to aim at the objective. After that, a new search for the signature is done. The tracking-error is a new input for the predictor that starts the cycle again. This work studies and upgrades the detection stage.

The study of the state of the art on detection for tracking systems was focused on the techniques developed for artificial vision systems (visible or infrared cameras) in order to detect vehicles that are inside the field of vision of the camera.

The majority of the methods reported in the literature follow two basic steps:

a) **Hypothesis Generation (HG)**, where the locations of possible vehicles in an image are hypothesized
b) **Hypothesis Verification (HV)**, where tests are performed to verify the presence of vehicles in an image.

The second step HV is not considered due the future use of the system on military situations where unknown vehicles should be detected.

Inside of the HG step, a lot of different techniques had flourished. They can be classified into three main categories:

a) Knowledge-Based methods
b) Stereo Vision-Based methods
c) Motion-Based methods

In the first category, the methods try to verify some assumption such as the vehicles should have some symmetry, vertical or horizontal edges, location of shadows or some kind of texture [4].

In the second one, there are two main kinds of methods: based on a disparity map or based in an Inverse Perspective Mapping [5].

In the last category, the methods compute more than one frame. Through the differences that exist between frames, the methods can detect the vehicles. Three sub-categories arise:

a) Background Subtraction [6]

[1]TECNOBIT S.L.U. - Technological Development Unit
www.tecnobit.es
[2]Integrated System Division – Applied Microelectronics Institute
Las Palmas de Gran Canaria University
www.iuma.ulpgc.es

b) Temporal Difference [7]
c) Optical Flow [8]

III. Solution Developed

The current algorithm for vehicle detection that is found in CENTINELA is based on two stages: dynamic and static detection. In the first stage applies a temporal difference between two frames. If no vehicle is detected, the second stage is run. The static stage performs a closed edge detection.

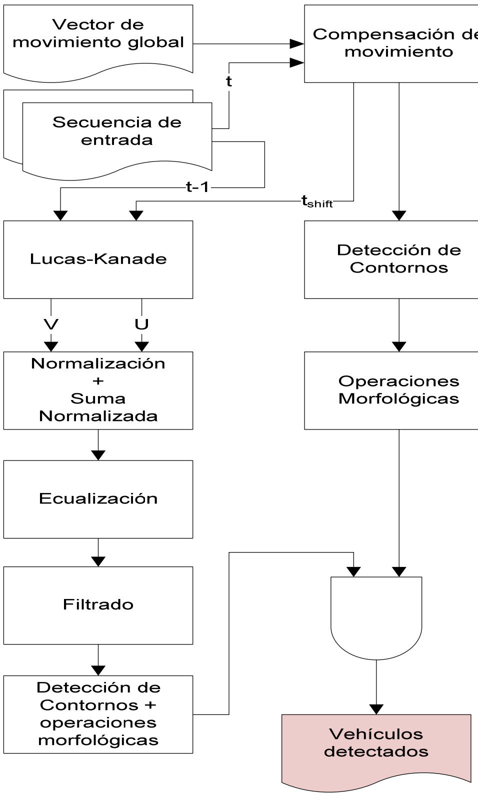

Figure 2. New Algorithm Flow Chart

This method does not obtain an outstanding performance for all possible situations that the system could be involved and so a new improved solution is needed.

The algorithm was designed in an iterative way. A first version of the algorithm was implemented and validated using all the test sequences. The results were studied and several modifications on the algorithm was applied at every iteration.. The result on all iterations was back-annotated.

The final version of the algorithm is shown in Figure 2. Two consecutive frames are needed, where the newest one is compensated by the global compensator. The Optical Flow estimator (Lucas-Kanade method) is executed. After normalizing the vectors and the sum of the two components, an equalization of the matrix is performed. The result is filtered with a Gaussian filter. In this stage, the Canny edge detector is applied to the filtered matrix. The resultant binary image is closed by a morphological close lines function and the blobs are labeled.

At the same time, a Canny edge detection is performed on the newest frame of the test sequence. Then the edges are closed by the same function and the blobs are also labeled. The blobs that are in both images are the detected vehicles.

IV. Results

30 test sequences were used to test the performance of the different iterations of the algorithm. In Figure 3 the first frames of the first two sequences are shown.

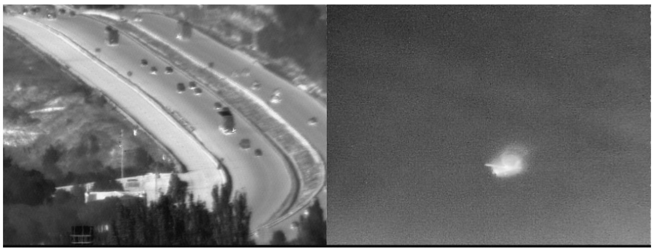

Figure 3. Two of the test sequences used

A total of 40 iterations were executed in order to reach the final version of the algorithm. In every iteration, the quality of the detection is measured.

The proposed algorithm improves the detection performance by a 20% against the original algorithm and gets a decrease of 50% of the false positives detected objects.

V. Conclusions

The initial CENTINELA's detection algorithm is outperformed by the designed algorithm. The novelty of the algorithm relies on the use of an edge detection operation over the sum of the intensity of the movement vectors estimated by the Lucas-Kanade operation.

Some improvement must be follow to continue this work. A new automatic parameters detector should be the first step. In second place, a better close contours algorithm.

References

[1] S. Blackman, R. Popoli, "Design and Analysis of Modern Tracking Systems" Artech House Publishers, 1999

[2] Yaakov. Bar-Shalom, Xiao-Rong Li, "Multitarget-Multisensor Tracking: Principles and Techniques", YBS Publishing, 1995.

[3] Ayala-Ramirez, V.; Parra, C.; Devy, M.; , "Active tracking based on Hausdorff matching," Pattern Recognition, 2000. Proceedings. 15th International Conference on , vol.4, no., pp.706-709 vol.4, 2000.

[4] C. Goerick, N. Detlev, and M. Werner, "Artificial Neural Networks in Real-Time Car Detection and Tracking Applications," Pattern Recognition Letters, vol. 17, pp. 335-343, 1996.

[5] H. Mallot, H. Bulthoff, J. Little, and S. Bohrer, "Inverse Perspective Mapping Simplifies Optical Flow Computation and Obstacle Detection," Biological Cybernetics, vol. 64, no. 3, pp. 177-185, 1991.

[6] J. W. T. H. J. M. G. O. B. R. S. R. D. Koller, «Towards Robust Automatic Traffic Scene Analysis in Real-time,» de Proc ICPR, 1994.

[7] A. Lipton, H. Fujiyoshi y R. Patil, «Moving Target Classification and tracking from real-time video,» de Proc. IEEE Worshop Applications of Computer Vision, 1998.

[8] B. Lucas y T. Kanade, «An Iterative Image Registration Technique with an Application to Stereo Vision,» de Proc. Imaging Understanding Workshop, 1981.