Pedestrian Detection in Thermal Images: An Automated Scale based Region Extraction with Curvelet Space Validation

A. Lakshmi, A.G.J. Faheema, Dipti Deodhare

PII: S1350-4495(15)30152-3
DOI: http://dx.doi.org/10.1016/j.infrared.2016.03.012
Reference: INFPHY 1980

To appear in: *Infrared Physics & Technology*

Received Date: 13 November 2015
Revised Date: 22 March 2016
Accepted Date: 24 March 2016

Please cite this article as: A. Lakshmi, A.G.J. Faheema, D. Deodhare, Pedestrian Detection in Thermal Images: An Automated Scale based Region Extraction with Curvelet Space Validation, *Infrared Physics & Technology* (2016), doi: http://dx.doi.org/10.1016/j.infrared.2016.03.012

Pedestrian Detection in Thermal Images: An Automated Scale based Region Extraction with Curvelet Space Validation

A. Lakshmi, A.G.J. Faheema and Dipti Deodhare

Abstract

Pedestrian detection is a key problem in night vision processing with a dozen of applications that will positively impact the performance of autonomous systems. Despite significant progress, our study shows that performance of state-of-the-art thermal image pedestrian detectors still has much room for improvement. The purpose of this paper is to overcome the challenge faced by the thermal image pedestrian detectors, which employ intensity based Region Of Interest (ROI) extraction followed by feature based validation. The most striking disadvantage faced by the first module, ROI extraction, is the failed detection of cloth insulted parts. To overcome this setback, this paper employs an algorithm and a principle of region growing pursuit tuned to the scale of the pedestrian. The statistics subtended by the pedestrian drastically vary with the scale and deviation from normality approach facilitates scale detection. Further, the paper offers an adaptive mathematical threshold to resolve the problem of subtracting the background while extracting cloth insulated parts as well. The inherent false positives of the ROI extraction module are limited by the choice of good features in pedestrian validation step. One such feature is curvelet feature, which has found its use extensively in optical images, but has as yet no reported results in thermal images. This has been used to arrive at a pedestrian detector with a reduced false positive rate. This work is the first venture made to scrutinize the utility of curvelet for characterizing pedestrians in thermal images. Attempt has also been made to improve the speed of curvelet transform computation. The classification task is realized through the use of the well known methodology of Support Vector Machines (SVMs). The proposed method is substantiated with qualified evaluation methodologies that permits us to carry out probing and informative comparisons across state-of-the-art features, including deep learning methods, with six standard and in-house databases. With reference to deep learning, our algorithm exhibits comparable performance. More important is that it has significant lower requirements in terms of compute power and memory, thus making it more relevant for depolyment in resource constrained platforms with significant size, weight and power constraints.

Keywords:
Pedestrian Region of Interest, Pedestrian Validation, Curvelet Transform

1. Introduction

Pedestrian detection is a very active computer vision research area whose importance has been increasing during recent years. Computer vision applications such as surveillance, automatic recognition of people in rescue missions, content based indexing, automotive safety can be strongly benefited from accurate pedestrian detection technologies. The role of automatic pedestrian detection in a variety of autonomous robotic vehicles to complete their cognitive limitations has also contributed to the spurring interest and progress in this area of machine vision. Detection of pedestrians in optical images offers solutions primarily for day time or well lit situations. As far as night situations go, pedestrian detection relies on the images captured by a thermal camera, the output of which is the emission of objects in the far infrared spectrum. As the utility of the benefited computer vision areas such as robotics, surveillance improves in night times as well, more reliable night time pedestrian detection is becoming mandatory.

Infra-red Images: Optical and infra red images share few common characteristics. One such is the change in appearance with view point change. The most salient feature of thermal imaging over visible spectrum imaging is its lack of dependency on external ambient light. The most advantageous consequence of this ability, to operate in no or low light condition has been taken advantage of in the surveillance domain. Absence of shadow in infra red scenes eliminates the need for shadow removal. This is often a major challenge in visible images. Moreover, the very valuable advantage of infrared images over optical images is that they eliminate the influence of color, texture and illumination on appearance variability. On the downside, besides all their advantages, detecting pedestrians from thermal images is far from trivial as *i*) extremely low temperature will help the clothes to shield the heat emission and only the exposed parts of pedestrians may be pictured and *ii*) conditions of high temperature can strongly heat the background non-human objects which have inherent passive heat radiation behavior and make the scene look much cluttered and complex (4).

Pedestrian Detection in Optical Images: Detection of pedestrians in visible spectrum range is not trivial as they can appear with fairly random shapes, dress color and textures. There are very rich research bibliographies as far as pedestrian detection using visible range light cameras are concerned. Most of the literature follows key-point based, segmentation based or