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Artificial Neural Network-based Image-cleaning Method for Atmospheric Cerenkov Imaging Telescopes

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Abstract. A novel image-cleaning method, based on the utilization of Artificial Neural Network (ANN) is shown here to 'correctly' select more pixels in a Cerenkov image than in the conventional approach.

Keywords : Atmospheric Cerenkov image cleaning, Artificial Neural Net.

1. Introduction

The sensitivity of ground-based atmospheric Cerenkov imaging telescopes used for detecting cosmic γ-rays of energy in the TeV domain critically depends on the procedure adopted for image-cleaning. Monte-Carlo simulation results indicate that the standard method of image-cleaning, employing the conventionally used 'picture' and 'boundary' pixel threshold concept, selects significantly lesser number of pixels with genuine Cerenkov signal than are actually present in the raw image (Lessard et al, 2002). This results in an inaccurate reconstruction of the true Cerenkov image and its associated moments, especially at energies close to the threshold energy of the telescope. Results based on employing a properly trained ANN using standard back- propagation network for cleaning raw Cerenkov images produced by the CORSIKA code, are presented in this paper.

2. Results and Discussion

Simulation study has been done for γ-rays of energy 1.3 TeV, with, core distances upto 200m and considering a truncated TACTIC imaging camera (Bhat., 1997) consisting of a 13×13 ma-

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trix of pixels each of dia. 0.31°. A standard back-propagation model (Rumelhart, 1986) with a configuration of 169:50:169 and tanh x type of activation function is used for training the net, with a dataset of 500 events. Training consists of presenting the 169 input nodes of the net with noise-superimposed, CORSIKA-generated (Heck, 1998), Cerenkov signal counts in photoelectron units, recorded by each pixel. The corresponding 169 output nodes are defined as 1 or 0 during the training procedure, depending upon whether that particular pixel is a part of the noise-free Cerenkov image or not.

Plots marked 'a' and 'b' in Fig. 1 show the differences in the number of pixels recording the Cerenkov images for the ANN and the conventional technique respectively, from the number actually participating in the clean image for ~ 300 events. In plot 'a' the differences are distributed symmetrically around zero line, whereas in plot 'b', a large number of pixels are supressed in the clean image. The validity of this procedure must, however, await the results for other γ-ray energies and proton induced showers.

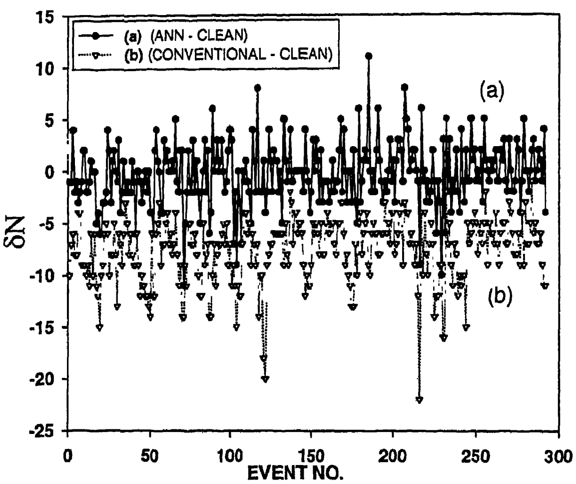

Figure 1. Differences (δN) in the number of clean pixels for the ANN and the conventional technique from the number actually present, as a function of the Event No.

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