Session 7

Posters:

LIGHT DRIVEN RECONFIGURABLE PLASMA ANTENNA

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We report on a solid-state plasma antenna, which can be switched on and off by optical means. The antenna is transparent (and has very low radar cross section) when not illuminated. However, when the antenna is illuminated by laser light it becomes highly reflective for microwave radiation. The antenna is based on semiconductor materials. These have an enormous range of conductivity spectrum, which makes them attractive for many photonic and electronic applications. Specifically, high resistivity silicon wafers, which normally are transparent to RF radiation, may acquire high conductivity by photoconductive processes and become good reflectors.

In our experiments, a silicon wafer is illuminated by an intense laser beam, and as a result of absorption, free charge carriers are generated within a thin layer of the material. This plasma layer acts as a reflector for incoming RF radiation. The reflection can be switched on and off by switching the light. We discuss the theoretical background and show results from experiments demonstrating the principle. Using pulsed laser diodes we were able to reach high reflectivity that was comparable to the reflectivity of conventional antennas made of aluminum or copper. These results, which are significant for the realization of a reconfigurable plasma antenna, are discussed in the context of military and civil applications.

Abstract For Bayer MTF Model

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We present a model for calculating the Spatial Frequency Response (SFR) for Bayer pattern color detectors. The model is based on the color detector response for B/W scenes. When a Bayer color detector is compared to a B/W detector, The SFR difference results from the interpolation process. This process exists only in the Bayer pattern detectors. In this work we ascribe the MTF and the spurious response to the interpolation process.

The model may be applied to any linear interpolation. Although the interpolation is linear it is not Shift Invariant (SI). Therefore, calculating the interpolation MTF is not a trivial task. Furthermore, the interpolation creates a spurious response. In order to calculate the interpolation SFR we introduced a separable constraint (for x and y directions) by using a scene that varies only on one axis and is fixed on the other. We further assumed that the human eye also integrates in the direction of the fixed axis. By using these two assumptions, we have been able to separate the response into two axes and calculate the SFR.

For long range scenes, colors saturation decreases, the colors are less visible and we mostly sense grey colors. In these cases the Johnson Criteria can be roughly applied. In order to apply the Johnson Criteria, we need to know the MTF of the sensing system. The sensing system MTF includes the interpolation MTF. We show that the interpolation process degrades the system performance compared to B/W sensor. Another application of the model is in comparing different interpolation algorithms.

Turbulence Compensation Implementation for Embedded Systems

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Long Range Observation Systems (LOROS) is a domain, which carries a lot of interest in many fields such as remote sensing, intelligence and homeland security. In such systems, the major cause for image distortion is atmospheric turbulence.

There is a variety of methods for the enhancement of turbulent captured images[1,2,3,4,5,6]. However, these methods have high computational complexity and require massive memory consumption. The paper presents a method for atmospheric turbulent video enhancement that secures virtually the same quality of compensated video while using less than tenth of the computation power and memory requirements of previously reported turbulence compensation algorithms.

The video enhancement algorithm consists of three building blocks: Estimation of the stable scene, real motion extraction, and generation of stabilized frames. For real motion extraction, a reference image, which is an estimate of the stable image of the scene, is computed. An element-wise rank filtering in a temporal sliding window of each pixel is used for obtaining the reference stable image. For matching real-time requirements, the paper proposes, for this purpose, a fast algorithm for calculating a specific rank corresponding gray-level value.

For each pixel in the incoming frame it is then needed to decide if it is of a moving or a stationary object. As the reference image, obtained by the rank filtering, keeps only the non-moving objects, it can be used for the decision. This paper suggests a real time application oriented solution using separated mechanisms along x and y axes of the image.

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3 H. van der Elst and J.J.D van Schalkwyk, "Modelling and restoring images distorted by atmospheric turbulence", Proceedings COSMIG '92 pp. 162-167.

4 Shai Gepshtein, Alex Shtainman, Barak Fishbain, Leonid Yaroslavsky, "Restoration of atmospheric turbulent video containing real motion using elastic image registration", at The 2004 European Signal Processing Conference EUSIPCO-2004, September, 2004, Vienna, Austria.

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The suggested method separates the motion extraction, analysis and compensation stages, so it dramatically decreases the computational load and memory usage. The new structure of the algorithm can be easily adapted to work in a hyper-threaded environment.

The results show that the difference between the optimal solution restored video and the suggested one is virtually imperceptible, while the difference between the two in computational complexity and memory usage is very significant, which allows real-time video turbulence distortions compensation in embedded implementations, and by that integration of the compensation process into the acquisition system proper.

KEYWORDS:

LOROS, Turbulence-Compensation, Real-Time, Rank-Filtering, Optical-Flow

USING THE MRC AS THE PRINCIPAL METRIC FOR ANALYSIS, DESIGN AND MAINTENANACE OF IMAGING SYSTEMS IN THE VISIBLE SPECTRUM.

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ABSTRACT

The basic requirement of any imaging system is to detect targets. The military is normally interested in detecting and recognizing targets at the greatest possible range. These requirements are usually defined in terms of target size, range, contrast, and atmospheric conditions. These requirements are then evaluated using various metrics, the best known being the Johnson criteria[1]. The basic assumption underlying the Johnson metric is that performance of the imager can be determined solely by the highest spatial frequency visible at the average target to background contrast. Vollmerhausen et al[2] claim that the Johnson criteria are fundamentally flawed and have proposed a new a new target acquisition metric, the targeting task performance (TTP) metric. There are may other metrics that are in use, the National Imagery Interpretability Rating Scale (NIIRS) is considered the standard for rating image quality by most imagery analysts and scientists. An alternative metric, the MRC (Minimum Resolvable Contrast) has become popular in the last few years and can be used as the principal metric for analysis, design, verification and maintenance. This paper describes the MRC theory and model, how to derive the MRC requirements from the operational requirements, test equipment, methods of testing and some experimental results. The paper concludes with a summary of the advantages of using the MRC as the principal metric for measuring performance of imaging systems in the visible spectrum.

Passive mm-wave detector for homeland security applications

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Millimeter-waves attract homeland security specialists since they can penetrate poor weather, dust and smoke far better than infrared or visible systems. These advantages open new facilities in navigating and performing surveillance in conditions of poor visibility. Furthermore, the ability to penetrate dielectrics such as plastic and cloth has opened up the opportunity of detecting weapons and contraband hidden under people's clothing.

Most important element of mm-wave imaging system is a single-pixel detector. The quality of mm-wave image is greatly dependent on performance of array consisting of these detectors. The paper describes a heterodyne configuration of mm-wave single pixel detector designed in the Israeli Centre for Radiation Sources and Applications as a part of the AVNET-37 Program.

The detector is based on a heterodyne configuration with a baseband bandwidth up to 12 GHz and NF = 9-10dB. It can receive like noise signals that are typical for passive mm-wave imaging. The receiving antenna is connected with the W-band pin-diode modulator providing 1 KHz pulse modulation of the received signal. Then the signal comes to W-band LNA (gain about 15 dB) and down-converted by mixer with IMPATT LO operating at 94GHz. The IF signal is then amplified about 70 dB by IF LNA with 6 GHz bandwidth so that the total double-side bandwidth of the received signal is 12 GHz. Wideband HP-423A detector, post detector's video-amp and data acquisition block are synchronized with programmable azimuth-elevation positioner. The number of pixel in one frame can be adjusted in a range 200-6000 depending on required quality of mm-wave image.

Depending of the antenna system the detector can be applied for both in-door and out-door imaging conditions. Programmable azimuth-elevation positioner matched with data acquisition system and MatLab-7 Imaging Toolbox has been designed and fabricated. We have performed comprehensive tests of the detector using in-door and out-door conditions. In-door experiments have been done with lens-horn antenna (gain 30 dB and 3-db beam width 5deg). In out-door experiments we employed 30 cm diameter parabolic dish (gain 45 dB and 3-db beam width 0.7deg). Numerous examples of mm-wave images reconstructed in both conditions are presented.

The designed single-pixel detector can be integrated with optical and IR systems to reach data fusion effects.

A New Target Detection Approach to Multispectral Image Fusion

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With the advance in multispectral imaging, the use of image fusion has emerged as a new and important research area. Many studies have examined human performance in specific fusion methods. The common of these methods was the fused image created objectively by the computer program. This work takes a new, subjective, approach to image fusion. Our computer programs use information given by the user in his or her attempt to detect targets and combine this information in the fusion process. After each detection attempt, similar pixels are emphasized so that the user may differentiate similar objects from the background.

The algorithm is detailed as follows: One IR band of an image that contains targets is presented to the user and he or she tries to detect targets by clicking on suspected target locations. The suspect pixel is used as a target in matched filtering for the entire image. By normalizing the matched filter's output image, we obtain a similarity matrix. This matrix is then used to highlight certain pixels.

We performed the experiment on several groups of students, testing a variety of parameters such as: detection rate, false alarms, detection time and more. A clear conclusion was reached that target detection using fused images is indeed possible and even preferable.

Although future research needs to be done in order to verify our results and improve the algorithm, we believe that subjective fusion can improve target detection performance and should be considered for target detection applications.