A Novel Step for the Enhancement of Security in ARIPORTS Using Optical Ideology

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Abstract—The security systems in airports are very important and the detection of entry of unauthorized person must be in high rate so as to have an improved efficient system. The real time systems in airports are implemented based on CCTV cameras. These CCTV cameras are used to record the events for future references. The high rapidity of correlation must be performed for the improvement of security in airports. Firstly, 4f system is introduced into the real time security system of the airport. The introduction of this optical system improves system performance and high speed of correlation. This optical system is designed in the simulation environment of MATLAB. The CCTV images and database images are compared together in MATLAB for various conditions. These conditions help to define the performance of the projected system and to have a better evaluation of the projected architecture. The projected system can outperform conventional correlator based systems with elevated speed of correlation. The projected system enabled by dynamic Fourier plane correlator system was found to have high speed performance.

Keywords- *4f system, optical system, Lens, Fourier transform, correlation, security*

I. INTRODUCTION

The existing correlation based security system has low efficiency and was found to have inefficient detection of inputs. To replace this low efficient system, a high speed and more efficient output producing system is needed. Such a system was designed with the optical principles. The optical systems perform correlation at high speed when compared to other conventional systems. The optical systems have the ability to detect the input at high rate and also supports for better correlation detection. The 4f system has an image plane, Fourier plane and object plane. The Fourier plane of the 4f system is rearranged. This re arrangement makes the system works as a high speed correlator. The performance of the designed system was compared with the existing conventional system.

II. OPTICAL IDEOLOGIES

A. Optical Signal Processing

Optical signal processing has the ability to modify the information content of data signals, at the same time, preserving certain properties of the physical carrier. It also explains the work of Fresnel and Fraunhofer.

B. Fourier Optics

Fourier optics is the study of classical optics using Fourier transform, in which the wave is regarded as a superposition of plane waves that are not related to any identifiable sources. Fourier optics can be seen as the dual of the Huygens Fresnel principle, in which the wave is, regarded as a superposition of expanding spherical waves which radiate outward from actual current sources via a Greens function relationship.

Fraunhofer diffraction is created, which emanates from a single spherical wave phase center. Fresnel diffraction pattern is created, which emanates from an extended source, consisting of a distribution of spherical wave sources in space.

C. Diffraction of Light

When an optical wave is transmitted through an aperture in an opaque screen and travels some distance in free space, its intensity distribution is called as diffraction pattern. If light were treated as rays, the diffraction pattern would be a shadow of the aperture. Because of the wave nature of light, the diffraction pattern may deviate slightly or substantially from the aperture shadow, depending on the distance between aperture and observation plane, the wavelength and the dimensions of the aperture.

D. High Speed Detection

The optical system works much faster than the conventional system, for performing correlation. The light rays are passed through the aperture present in object plane. The aperture can be of any shape including an outline of an

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image. The light rays take the properties of the image present in the object plane to the Fourier plane. This takes places with the help of diffraction principle. The diffraction is performed with the help of biconvex lens. The system works faster as it depends on the optical performances and the speed of light 3*10^8 m/s has been considered for the process of correlation.

III. Analytical Study On Optical Fourier Transform Architecture

A. *Bi Convex Lens*

A lens is a transmissive optical device that focuses or dispersive a light beam by means of refraction. It consists of a piece of transparent material. Lenses are made from materials such as glass or plastic, and are ground and polished or moulded to a desired shape. If a lens is a biconvex or Plano-convex (figure 1) , a collimated beam of light passing through the lens converges to a spot behind the lens.

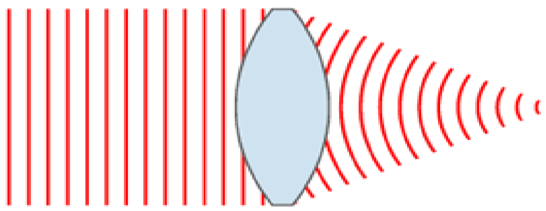

Figure 1. Biconvex lens

B. *4f System*

The 4f system (figure 3) is an imaging system with unity magnification which can be verified by ray tracing. The 4f correlator system consists of two lens and three planes. The planes are object plane, Fourier plane and image plane. The lenses used in this system are biconvex spherical lens. The system involves two subsystems. The first subsystem between the object plane and the Fourier plane, performs Fourier transform and the second subsystem between the Fourier plane and the image plane, performs inverse Fourier transform.

C. *Projected Optical Architecture*

The projected optical architecture figure 2., is based on the 4f system. The projected system alters the Fourier plane of the system. The Fourier plane is re arranged by including a biconvex lens and a telescopic lens. The telescopic lens helps for the better projection of the multiplied images of the input and the database image on to the Fourier plane. The projected system produces output at high rate and the detection of the output is made easier with the projected system.

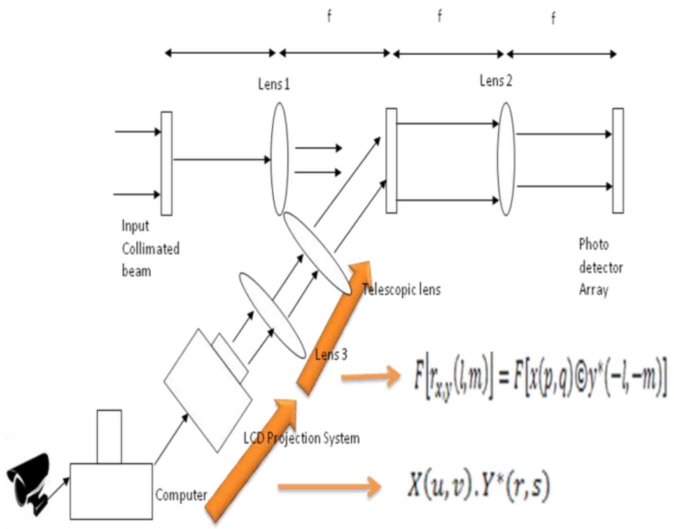

Figure 2. Projected Architecture

D. *Correlation Based Signal Processing*

The correlator signal processing takes two functions such as x(a,b) and y(c,d). The correlation between these two functions is expressed as

$$r_{x,y}(l,m) = \sum\sum x(p,q).y^*(p-l,q-m)$$

The above equation can be rewritten as

$$r_{x,y}(l,m) = \sum\sum x(p,q).y^*(-(l-p),-(m-q))$$

The convolution sum is given by

$$r_{x,y}(l,m) = x(p,q) © y^*(-l,-m)$$

The Fourier transform of the above convolution sum is given as

$$F[r_{x,y}(l,m)] = F[x(p,q) © y^*(-l,-m)]$$

On rearranging the above equation the right hand side of the equation becomes

$$X(u,v).Y^*(r,s)$$

IV. Practical Analysis of the Projected Architecture Using MATLAB

A. *Working of Basic 4f System*

An ideal image formation is an optical system that replicates the distribution of light in the object plane into the image plane. The image is magnified and also there is blur resulting from imperfect focusing and from the diffraction of optical waves. Consider a two-lens imaging system.

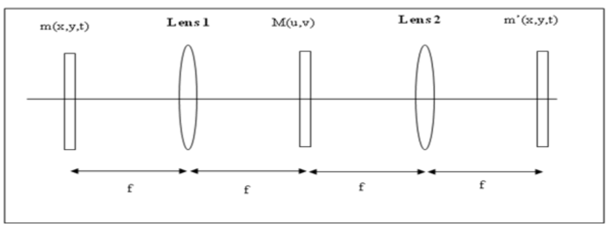

Figure 3. 4f system

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This system is called as 4f system, which serves as a focused imaging system with unity magnification, as can be easily verified by ray tracing. The analysis of wave propagation through this system is by cascading two Fourier-transforming subsystems. The first subsystem, between the object plane and the Fourier plane, performs a Fourier transform and the second subsystem, between the Fourier plane and image plane, performs Inverse Fourier transform. As a result, in the absence of an aperture the image is a perfect replica of the object.

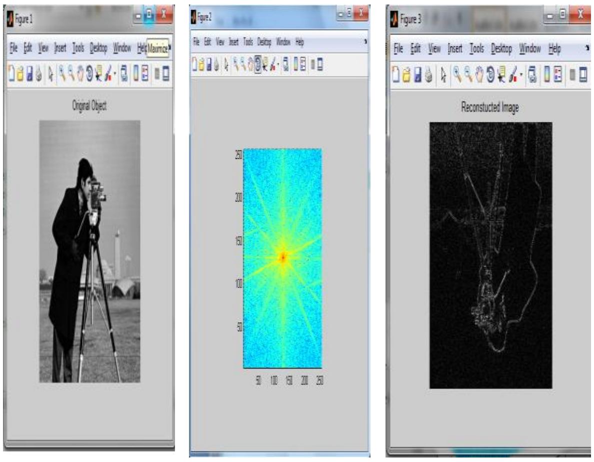

Figure 4. Image Present at the Plane

Figure 4 shows the image present at the object plane and the diffraction pattern obtained at the Fourier plane and the pattern recognized output at the image plane.

B. *Projected Architecture Working*

The projected system re arranges the existing 4f system by including a telescopic lens and a biconvex lens. The projected system helps for the easy detection of legal and illegal entry of the person into airports. A high speed of detection is required in such areas for providing high end security. The high speed detection is made possible with the help of 4f system. The projected system is altered and a database of images is created. The database holds the images of persons who are to be caught by the security in charges.

The telescopic lens helps for the better projection of the images on to the image plane. The image captured by the camera and the images in the database are compared. If a better match is detected, then the images are taken optical Fourier transform. The optical Fourier transformed images are multiplied with the database images and then been projected to the Fourier plane with the help of telescopic lens. The third biconvex lens helps in taking the optical Fourier transform of the images.

1. *Analysis of the system for same input images*

To analysis the projected system, the simulation environment is created with the help of MATLAB. Initially, the database of images are created. When the input image and the database image are perfectly matched, then a correlation peak has to be detected at the image plane. To verify the projected system, a MATLAB code has been simulated. When the input image found a better match with the database image, the correlation peak is detected as shown in the figure 5.

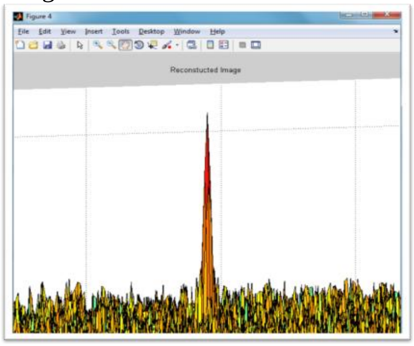

Figure 5. Peak detected for same input images

2. *Analysis of the system for two different images*

The projected system is verified for different conditions. When the input image is not able to detect a better match with the database image then the correlation peak is not detected. Then for such a case an uncorrelated peak is detected as shown in the figure 6.

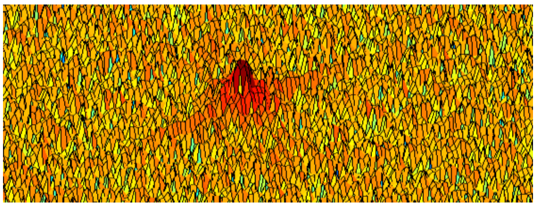

Figure 6. Peak detected for different input images

3. **Analysis of the system for images which are flipped**

The projected system is verified for the flipped image conditions. The system is found to work well for this existing condition with the perfectly detected correlation peak. The input images are flipped in a way that is stored in the database. This condition has been verified to check the proper working condition of the projected system.

Figure 7. Peak detected for flipped input images

The pattern obtained in the Fourier plane defines the flipped images conditions. The diagonal changes in the Fourier plane are analyzed by the figure 8 given below.

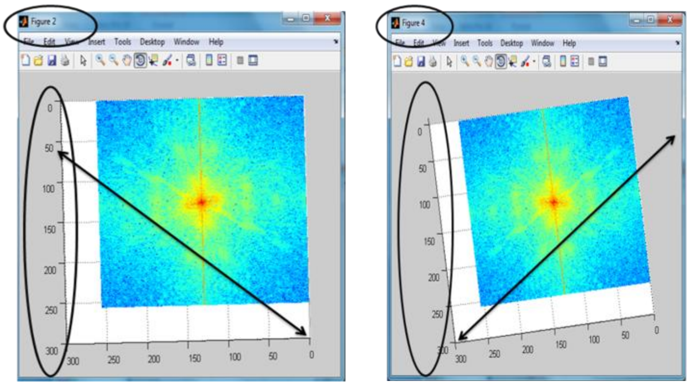

Figure 8. The comparison of Fourier plane output of flipped images.

V. SYSTEM PERFORMANCE ANALYSIS

The existing system uses CCTV camera for surveillance purposes. The CCTV camera records the events or the entry of the person. The recorded information is communicated to the security chief with the help of the wireless RF module. For the identification of the unauthorized person, the direct correlation is done with the help of computers which take 20 seconds to perform correlation. Thus a system with advanced optical principles are designed and utilized for performing correlation. There are various trails done with different set of images to calculate the elapsed time. The Table I. shows the various trials and the corresponding elapsed time.

TABLE I.

Test	Elapsed time (Second)
Trail 1	2.308452
Trail 2	2.267509
Trail 3	2.805930
Trail 4	2.351014
Trail 5	2.351304
Trail 6	2.963413
Trail 7	2.316202
Trail 8	2.247267
Trail 9	2.122813
Trail 10	2.106929

From the above Table I, elapsed time for the proposed architecture lies between 2-3 seconds which is highly efficient than the existing system. Thus the proposed system can be utilized in airports, Railway stations and bus stations to avoid the entry of the unauthorized person which serves as high security.

VI. CONCLUSION

The projected system performs at high speed enabled by dynamic Fourier plane correlator system. The preliminary studies indicate that the dynamic 4f system can outperform conventional correlator based systems. The projected system has simplicity in its implementation and performs detected at very high speed.

VII. APPLICATIONS

The projected system helps in detecting the entry of unauthorized person into a secured area. So the projected system can suit the requirements in airport for providing an improved security system. The application can also be extended to hospitals, industries and educational institutions.

VIII. FUTURE SCOPE

The projected architecture in this paper is verified by the simulation environment. The implementation analysis will be required for the further proof of the concept. The implementation analysis is found to be costly and the bench setup of the projected architecture requires more study.

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