Imaging touch screen and display technology

Contents

- Decision:

Common touch screen engineerings are limited in capableness. For illustration, most are non able to track more than a little figure of objects on the screen at a clip, and typically they report merely the 2D place of the object and no form information. Partially this is due to superficial restrictions of the peculiar hardware execution, which in bend are driven by the accent on emulating arrow input for common GUI interactions. Typically, today ' s applications are merely able to manage one 2D arrow input. A figure of systems have late introduced the construct of imaging touch screens, where alternatively of a little list of distinct points, a full touch image is computed, where each ' pixel ' of the end product image indicates the presence of an object on the touch screen ' s surface. The public-service corporation of the touch image therefore computed has been demonstrated in gesture-based interactions for application on wall and table signifier factors. These systems permit coincident picture projection and surface detection by utilizing a spreading screen stuff which, from the camera position, merely resolves those objects that are on or really near the surface.

The touch image produced by these camera-based systems reveals the visual aspect of the object as it is viewed from behind the surface. Application events may be triggered as the consequence of image processing techniques applied to the touch image. For illustration, the visual aspect or form of an object may unambiguously place the object to the system and trigger certain application events. In this paper we introduce the Touch Light system, which uses simple computing machine vision techniques to calculate a touch image on a plane situated between a brace of cameras and the user. We demonstrate these techniques in combination with a projection show stuff which permits the projection of an image onto a crystalline sheet of acrylic plastic, and the coincident operation of the computing machine vision processes. Touch Light goes beyond the old camera-based systems ; by non utilizing a spreading projection surface, it permits a high declaration touch image. For illustration, a high declaration image of a paper papers may be captured utilizing a high-resolution still camera, or one of the newer high declaration CMOS picture cameras. The absence of a diffusor besides permits the cameras to see beyond the show surface, merely as they would if placed behind a sheet of glass. This allows a assortment of interesting capablenesss such as utilizing face acknowledgment techniques to place the current user, oculus to- oculus picture conferencing, and other procedures which are typically the sphere of vision-based perceptual user interfaces.

Touch Light physical constellation: DNP HoloScreen with two IR cameras and IR Illuminant behind screen.

TOUCHLIGHT Configuration:

The physical constellation of Touch Light is illustrated in Figure. A brace of normally available Firewire web cameras is mounted behind the show surface such that each camera can see all four corners of the show. The importance of the distance between the cameras is discussed subsequently. The DNP Holo Screen stuff is applied to the rear surface of the acrylic show surface. The Holo Screen is a particular refractile holographic movie which spreads light from a rear projector when the incident visible radiation is at a peculiar angle. The stuff is crystalline to all other visible radiation, and so is suited for applications where traditional projection show surfaces would be overwhelmed by ambient visible radiation. Typical applications include retail shopfronts, where ambient visible radiation streaming through Windowss precludes traditional rear-projection screens.

Additionally the screen is crystalline in the near-infrared scope. Per maker ' s instructions the projector is mounted such that the jutting visible radiation strikes the show at an angle of about 35 grades. In a typical perpendicular, eye-level installing, this constellation does non ensue in the user looking straight into the " hot topographic point " of the projector. We note that many projectors are non able to rectify for the anchor deformation when the projector is mounted at this utmost angle. In our execution, we use the NVKeystone digital anchor deformation rectification public-service corporation that is available on NVidia picture cards. Experience with the HoloScreen stuff suggests that while the visible radiation reflected back from the rear of the screen is significantly less than the visible radiation scattered out the forepart, the projected image will still interfere with the image captured by any seeable light-based cameras situated behind the show. In the present work we avoid troubles with seeable light contemplations by carry oning image based feeling in the infrared (IR) sphere. An IR illuminant is placed behind the show to light the surface equally in IR visible radiation. Any IR-cut filters in the stock camera are removed, and an IR-pass filter is applied to the lens. If necessary, an IR-cut filter may be applied to the projector. By curtailing the projected visible radiation to the seeable spectrum, and the perceived visible radiation to the IR spectrum, the ensuing images from the camera do non include artefacts from projected visible radiation reflected backwards from the HoloScreen movie. In future work we plan to look into the application of antireflection movies applied to the dorsum and besides possibly the front surface of the show to extinguish contemplations from the projector. This would let the cameras to feel seeable visible radiation and possibly extinguish the demand for a separate illuminant. Subsequently, we describe applications which benefit from visible-light based detection. While for our initial execution we have chosen to mount the show vertically such that the user may stand, it is besides possible to mount the show surface horizontally to do a tabular array. In this instance a “ short throw ” projector such as the NEC WT600 may be desirable. Finally, a mike is stiffly attached to the show surface to enable the simple sensing of “ strike harding ” on the show. Except for the mike, there are no wires attached, doing TouchLight more robust for public installing.

Image Processing:

Introduction:

The end of TouchLight image processing is to calculate an image of the objects touching the surface of the show, such as the user ‘ s manus. Due to the transparence of the show, each camera position shows the objects on the show and objects beyond the surface of the show, including the background and the remainder of the user. With two cameras, the system can find if a given object is on the show surface or above it.

The touch image is produced by straight uniting the end product of the two picture cameras. Depth information may be computed by associating binocular disparity, the alteration in image place an object undergoes from one position to another position, to the deepness of the object in universe co-ordinates. In computing machine vision there is a long history of working binocular disparity to calculate the deepness of every point in a scene. Such deepness from stereo algorithms is typically computationally intensive, hard to do robust, and restrain the physical agreement of the cameras. Often such general stereo algorithms are applied in scenarios that in the terminal do non necessitate general deepness maps. Here we are interested in the related but easier job of finding what is located on a peculiar plane in three dimensions (the show surface) instead than the deepness of everything in the scene. The algorithm detailed here runs in existent clip (30Hz) on a Pentium 4, runing on 640×480 images.

Image Rectification:

The TouchLight image processing algorithm returns by transforming the image from the left camera left I and the image from the right camera right I such that in the transformed images points) , (y ten Ileft and) , (y x Iright refer to the same physical point on the show surface. Second, this transform is such that the point) , (y ten may be trivially mapped to existent universe dimensions (i. e. , inches) on the show surface. For both standards, it suffices to happen the homography from each camera to the show surface, which we obtain during a manual standardization stage. In the instance of utilizing broad angle lenses to do a compact apparatus, it is of import to take the effects of lens deformation imparted by broad angle lenses. Given the lens deformation parametric quantities, we undistort the input image by bilinear insertion. Sample images are shown in Figure 3b. During a manual standardization stage, the 4 corners of the show are manually located in each position. This specifies a projective transform conveying pels in the lens deformation corrected image to expose surface co-ordinates. Together with the lens deformation rectification, the projective transform completes the homography from camera position to expose co-ordinates. Sample ensuing images are shown in Figure 3c. We note that it is desirable to unite the lens deformation rectification and projective transform into a individual nonlinear transmutation on the image, therefore necessitating merely one resampling of the image. Furthermore it is straightforward to execute this full computation on a artworks treating unit (GPU) , where the transmutation is specified as a mesh.

Image Fusion:

After rectification the same point) , (y ten in both left I and right I refer to the same point on the show surface. Therefore, if some image characteristic degree Fahrenheit is computed on left I and right I, and) , ( ) , (y x f Y x degree Fahrenheit right left a‰ , we may reason that there is no object nowadays at the point) , (y x on the show surface. The touch image mask is computed by executing such pixel-wise comparings of the left and right images. This is basically the disparity is constrained to zero, and the rectification procedure serves to aline image rasters.

In the instance where a strong IR illuminant is available, and the end is to place custodies and other IR brooding stuffs on the show surface, it may do to merely pixel-wise multiply the two rectified images. Regions which are bright in both images at the same location will last generation. Sample ensuing amalgamate images are shown in Figure 3d. We note that it is possible to implement this image comparing as a pixel shader plan running on the GPU. As with traditional stereo computing machine vision techniques, it is possible to confound the image comparing procedure by showing a big uniformly textured object at some tallness above the show. Indeed, the tallness above the surface at which any bright parts are matched is related to the size of the object and to the baseline, the distance between the cameras. For the same size object, larger baselines result in merger at a smaller tallness above the surface, accordingly leting a finer differentiation as to whether an object is on the show, or merely above the show. Similarly, it is possible to set up two distinguishable bright objects above the show surface such that they are mistakenly fused as a individual object on the surface. More sophisticated characteristic fiting techniques may be used to do different trade-offs on hardiness and sensitiveness. For illustration, one possibility is to first calculate the border map of the rectified image before multiplying the two images. Figure 4 illustrates the consequence of using a Sobel border filter on the rectified images. Merely edges which are present in the same location in both images will last the generation. Therefore, big unvarying bright objects are less likely to be matched above the surface, since the borders from both positions will non cover one another. In the instance of utilizing borders, it is possible and possibly desirable to cut down the baseline, ensuing in better overall declaration in the rectified images due to a less utmost projective transform. The usage of border images takes advantage of the typical distribution of borders in the scene, in which the inadvertent alliance of two borders is improbable. Similarly, gesture magnitude, image differences and other characteristics and combinations of such characteristics may be used, depending on the nature of the objects placed on the surface, the coveted hardiness, and the nature of subsequent image processing stairss. It should be noted that the touch plane is randomly defined to co-occur with the show. It is possible to configure the plane such that it lies at an arbitrary deepness above the show. Furthermore, multiple such planes at assorted deepnesss may be defined depending on the application. Such an agreement may be used to implement “ hover ” , as used in pen-based theoretical accounts of interaction. The image rectification and image comparing processes do non necessitate the physical presence of the show. In fact, it is possible to configure TouchLight to run without the HoloScreen, in which instance the “ touch ” interaction is performed on an unseeable plane in forepart of the user. In this instance, it may be unneeded to execute imagination in IR.

Image Standardization:

A farther image normalization measure may be performed to take effects due to the non- uniformity of the light. The current touch image may be normalized pixel-wise by

Where lower limit and maximal images min I and max I may be collected by a standardization stage in which the user moves a white piece of paper over the show surface. This normalization measure maps the white page to the highest allowable pel value, corrects for the non-uniformity of the light, and besides captures any fixed noise forms due to IR beginnings and contemplations in the environment. After standardization, other image processing algorithms which are sensitive to absolute grey degree values may continue. For illustration, binarization and subsequent connected constituents algorithm, template matching and other computing machine vision undertakings rely on unvarying light.

Touch Image Interpretation:

Figure 5 shows three different visual images of the touch image as it is projected back to the user. Figure 5a shows the user ' s manus on the surface, which displays both left and right undistorted positions composted together (non a simple contemplation of two people in forepart of the show) . This shows how an object fuses as it gets closer to the show. Figure 5b shows a manus on the surface, which displays the computed touch image. Note that because of the computed homography, the image of the manus indicated by bright parts is physically aligned with the manus on the screen. Soon we have merely begun researching the possibilities in construing the touch image. Figure 5c shows an synergistic drawing plan that adds shots derived from the touch image to a pulling image while utilizing a cycling colour map.

Applications:

Visible Light Surface Scanning

Video Conferencing

Minority Report Interfaces

Augmented Reality and Spatial Displays

Decision:

A fresh synergistic surface and touch screen engineering is presented. TouchLight utilizations two cameras in combination with a commercially available projection screen engineering which allows projection onto an otherwise crystalline surface. This agreement allows for certain fresh applications and flexibleness which go beyond old related engineerings. We have presented image treating techniques to bring forth a touch image utile for many gesture-based and perceptual computer science scenarios. A figure of applications which take advantage of the alone features of TouchLight have been suggested ; we hope to research some of these in the hereafter.