Ground target positioning method applied into video monitoring system

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Abstract

The invention provides a ground target positioning method applied into a video monitoring system. A monitoring network is divided into smaller-scale sub networks by the aid of constraint of the ground plane, local reference coordinate systems are built for the sub networks, a ground reference point is set, and ground coordinates are calculated via observed values of the position of a target image by the aid of projection relationships of nodal points of various cameras and the ground plane. Parameters of angels, positions and the like of the cameras do not need to be accurately measured in the method, and the method only depends on the constraint of the local ground plane, can be used for most of monitoring systems utilizing fixed cameras, and is particularly used for common application places such as squares, streets and the like.

Description

A kind of positioningly appearance calibration method being applied in video monitoring system

Technical field

The invention belongs to technical field of video monitoring, particularly a kind of positioningly appearance calibration method being applied in video monitoring system.

Background technology

In video monitoring research field, moving target real time position is on the ground that abnormal behaviour detects, effective supplementary of the collaborative contour level application of video camera; The target image being captured by video camera array determines that corresponding target floor position is an important research content. Up till now, major part has dropped into practical video monitoring system and has adopted single fixed cameras monitoring mode, under this condition, the localization method that an existing class is measured based on video camera, require to accurately measure when mounted the parameters such as position, angle of every video camera, according to the side-play amount localizing objects of the relative optical axis of target on image. To having equipped the monitor network of a large amount of video cameras, the method has certain limitation in actual measurement operation, not only measures inconvenient and is difficult to accurately measure. Another kind of localization method is used laser or the infrared distance sensor information auxiliary positioning that initiatively fathoms, and cost is higher, is difficult to extensive practicality.

Many application scenarioss, as square, street, ground is within the specific limits more smooth, and shape approximation is plane; Target rest on the ground, and has interior in, constant structured features at ground level of goal constraint; And there is projection relation between ground level and video camera. Utilize this feature, can make the corresponding same positioningly plane of video camera in same sub-network region by camera network is carried out to network division, measured zone reference point geographic coordinate is with Primary Location sub-network; Each video camera to every sub regions, by

a plurality of reference point are set on ground, measures the projection relation matrix of camera coordinate system and earth axes, and then is ground coordinate by target image coordinate conversion, determines the ground location of target.

Summary of the invention

The object of the invention is to: a kind of simple and effective positioningly appearance calibration method in video monitoring system that is applied to is provided; Utilize target in scene to be positioned at the external restraint on ground level, camera supervised network is divided into the sub-network that scale is less, set up the local earth axes of sub-network, ground reference point is set, in sub-network, carry out directly location, part; Utilize the projection relation of each camera node and ground level, by the observed reading of target image position, calculate areal coordinate partly, the true ground location that finally represents target with geographic coordinate and the areal coordinate partly in region of sub-network.

For realizing this object, the technical scheme that the present invention proposes is: a kind of positioningly appearance calibration method being applied in video monitoring system, the method, by dividing monitor network and realizing terrain object in conjunction with the single camera localization method based on reference point and locate, the steps include:

Step (1) is divided into monitor network to have the sub-network of plane restriction uniformly;

Step (2) arranges the position reference point of locator network, measures its regional geography coordinate;

Step (3) is set up local earth axes, and one group of ground reference point is set, and measures the transformational relation between single camera coordinate system and local earth axes;

Step (4), according to the transformational relation of step (3), is converted to the target observation position on single camera image the areal coordinate partly of target, uses regional geography coordinate and local ground coordinate to represent the true ground location of target;

Wherein, the described single camera localization method based on reference point, by set reference point on monitoring scene ground, the reference point that utilization measures is the image coordinate in areal coordinate and single camera coordinate system partly, calculates the transformational relation matrix between single camera coordinate system and local earth axes; Afterwards, by the target image coordinate conversion observing, be areal coordinate partly; When single camera is fixedly time, transformational relation matrix is constant, unique, and its parameter can obtain with the one group of ground reference point measurement that is no less than 4.

In described step (1), observation camera node monitor area ground shape distributes, by the node division that is arranged in same ground level to same sub-network.

In described step (2), to each sub-network, on its ground, region, select any as the position reference point of sub-network, utilize satnav instrument to measure its geographic coordinate, and as the ground reference point under local earth axes.

In described step (3), the region ground level of sub-network of take is set up local earth axes O-XY as XY plane, and the position reference point of step (2) is local earth axes initial point O, and the image

coordinate of ground reference point and local ground coordinate are respectively (x, y) and (X, Y); Set world coordinate system O_w-$X_wY_wZ_w$ $x_wy_w$plane is identical with local earth axes, the world coordinates of ground reference point is (X, Y, 0), according to video camera perspective transform principle, can obtain image coordinate (x, y) the transformational relation matrix and between local ground coordinate (X, Y), expression formula is as formula (1), wherein each parameter forms transformational relation matrix, as formula (2); To N ground reference point, obtain one group and measure equation, expression formula, as formula (3), solves this equation and obtains transformational relation matrix, determines transformational relation;

$$C_{11} X + C_{12} Y + C_{13} - C_{31} Xx - C_{32} Yx = C_{33} x \quad C_{21} X + C_{22} Y + C_{23} - C_{31} Xy - C_{32} Yy = C_{33} y - - - (1)$$

$$C = C_{11} C_{12} C_{13} C_{21} C_{22} C_{23} C_{31} C_{32} C_{33} - - - (2)$$

$$X_1 Y_1 1 0 0 0 - X_1 x_1 - Y_1 x_1 0 0 0 X_1 Y_1 1 - X_1 y_1 - Y_1 y_1 \cdot \cdot \cdot \cdot \cdot \cdot \cdot \cdot \cdot \cdot \cdot \cdot \cdot \cdot \cdot \cdot X_N Y_N 1 0 0 0 - X_N x_N - Y_N x_N 0 0 0 X_N Y_N 1 - X_N y_N - Y_N y_N \quad C_{11} C_{12} \cdot \cdot C_{31} C_{32} = C_{33} x_1 C_{33} y_1 \cdot \cdot C_{33} x_N C_{33} y_N - - - (3)$$

In formula, C_{ij} for transformational relation matrix element value, wherein, i=1,2,3, j=1,2,3; C_{33} be made as constant.

Principle of the present invention is:

Utilize ground plane constraint, monitor network is divided into the directly sub-network of local positioning, geographic coordinate is put and measured to the position reference that locator network area is set; To appearing at the target in sub-network camera node, use the areal coordinate partly of the single camera localization method acquisition target based on ground reference point; With sub-network geographic coordinate and target partly areal coordinate combine the true ground location that represents target.

Advantage of the present invention and good effect:

(1) simple and flexible.Lower to camera deployment request, without the parameters such as angle, position that accurately measure camera, only need one group of ground reference be set to each camera puts and measures its ground coordinate and image coordinate;

(2) mainly rely on plane restriction partly, can be used for most of common application scenarios such as supervisory system, especially square, street etc. that uses fixing camera.

Accompanying drawing explanation

Fig. 1 is target localization process flow diagram in embodiment.

Embodiment

In order to make object of the present invention, technical scheme and advantage clearer, below with reference to accompanying drawing, the present invention is further elaborated.

Basic thought of the present invention is: within the specific limits, monitoring scene ground is approximately plane, when camera transfixion, transformational relation between earth axes and camera

coordinate system can represent with a normal value matrix, and available a plurality of ground reference point is demarcated this transition matrix element value, then calculates the coordinate under local earth axes by target image coordinate survey value; So, to comprising the fairly large monitor network of numerous camera node, by marking off, be subject to the structuring sub-network of ground plane constraint and carry out local area localization in sub-network, can realize on a large scale, ubiquitous positioning requirements in the supervisory system such as location continuously when long.

Fig. 1 is the process flow diagram of target localization in the specific embodiment of the invention, has shown committed step and execution sequence that target localization relates to.First, from monitor network, mark off structuring sub-network W $^{(i)}$, i is sub-network numbering; On the ground level of each sub-network, set up local earth axes O $^{(i)}$-XY, and select a ground point, as coordinate origin, as position reference point mark sub-network, measure its geographic coordinate then, to each camera node in sub-network, one group of ground reference point is set, calibrates the transition matrix C between camera coordinate system o-xy and earth axes O-XY; To the supervision target on camera review, utilize transition matrix that the image coordinate observed reading (x, y) of target is converted to the ground coordinate (X, Y) under local earth axes; Finally, use the geographic coordinate of target region sub-network combine with local ground coordinate (X, Y) the true ground location that represents target.A kind of positioningly appearance calibration method being applied in video monitoring system of the present invention, the method is by dividing monitor network and realizing terrain object in conjunction with the single camera localization method based on reference point and locate, wherein, the described single camera localization method based on reference point, by set reference point on monitoring scene ground, reference point ground coordinate and image coordinate that utilization measures, calculate the transformational relation matrix between single camera coordinate system and earth axes; Afterwards, by the target image coordinate conversion observing, be ground coordinate; When single camera is fixedly time, projective transformation matrix is constant, unique, and its parameter can measure by the one group of reference point that is no less than 4, the steps include:

Step (1) is divided into monitor network to have the sub-network of plane restriction uniformly; Concrete: field exploring monitoring scene, adjacent, the approximate video camera that is arranged in same ground level is divided into same sub-network, determine its regional extent, in the monitor area of current time target place sub-network, carry out local positioning;

Step (2) arranges the position reference point of locator network, measures its geographic coordinate; Concrete: to the sub-network marking off, at its ground level, set up earth axes.According to actual conditions, take warp and weft tangent line as coordinate axis, direction is made by oneself, is being easier to, under the principle of measuring, to choose flexibly origin position; Use GPS or big-dipper satellite positioning system to measure the geographic coordinate of initial point, for mark sub-network;

Step (3) is set up local earth axes, and ground reference point is set, and measures the transformational relation between camera coordinate system and earth axes; Concrete: to each camera node, on its ground, visual field, arrange be no less than 4 and not on straight line, scatter one group of reference point relatively opening, can use the center simulation ground reference point of the black and white target of easy making, the ground coordinate of field survey reference point under sub-network local coordinate system, manually mark or obtain reference point image coordinate by characteristics of image point detecting method, calculating camera coordinate system and earth axes transformational relation matrix; Wherein,

In step (3), the region ground level of sub-network of take is set up local earth axes as x-y plane, the location reference point of step (2) is local earth axes initial point, image coordinate and the ground coordinate of ground reference point are respectively (x, y) and (X, Y), both meet the Transformation Relation of Projection, expression formula is as formula (1), and wherein transition matrix is as formula (2).To N ground reference point, obtain one group and measure equation, expression formula, as formula (3), solves this equation and obtains transition matrix.

$$C_{11} X + C_{12} Y + C_{13} - C_{31} Xx - C_{32} Yx = C_{33} x \quad C_{21} X + C_{22} Y + C_{23} - C_{31} Xy - C_{32} Yy = C_{33} y \quad - - - (1)$$

$$C = C_{11} C_{12} C_{13} C_{21} C_{22} C_{23} C_{31} C_{32} C_{33} \quad - - - (2)$$

$$X_1 Y_1 1 0 0 0 - X_1 x_1 - Y_1 x_1 0 0 0 X_1 Y_1 1 - X_1 y_1 - Y_1 y_1 \cdot \cdot \cdot \cdot \cdot \cdot \cdot \cdot \cdot \cdot \cdot \cdot \cdot \cdot \cdot \cdot \cdot \cdot X_N Y_N 1 0 0 0 - X_N x_N - Y_N x_N 0 0 0 X_N Y_N 1 - X_N y_N - Y_N y_N C_{11} C_{12} \cdot \cdot C_{31} C_{32} = C_{33} x_1 C_{33} y_1 \cdot \cdot C_{33} x_N C_{33} y_N \quad - - - (3)$$

In formula, $C_{i,j}$ for transition matrix element value; C_{33} be made as constant.

Step (4), according to the transformational relation of step (3), is converted to the target observation position in single camera camera image the areal coordinate partly of target, uses regional geography coordinate and local ground coordinate to represent the true ground location of target; Concrete: the target image coordinate that cameras view is arrived, utilize transition matrix to be projected to earth axes, obtain the areal coordinate partly at current sub network network, the geographic coordinate of zygote network in parallel, the true ground location of target of expression current time.Wherein,

In step (4), the target image position of observation is the observed reading of the central point of target and junction, ground, is subject to surface constraints; By step (3) transition matrix and target image position detection value, calculate target floor coordinate, expression formula is as formula (4).With the geographic coordinate of step (2) sub-network and the target that calculates partly areal coordinate combine the ground location that represents target.

$$C_{31} x - C_{11} C_{32} x - C_{12} C_{31} y - C_{21} C_{32} y - C_{22} X Y C_{13} - C_{33} x C_{23} - C_{33} y \quad - - - (4)$$

In above formula, (x, y) is image coordinate, and (X, Y) is areal coordinate partly, $C_{i,j}$ for transition matrix element value.

The part that the present invention does not elaborate belongs to techniques well known.

Claims (4)

1. be applied to the positioningly appearance calibration method in video monitoring system, the method, by dividing monitor network and realizing terrain object in conjunction with the single camera localization method based on reference point and locate, is characterized in that: the steps include:

Step (1) is divided into monitor network to have the sub-network of plane restriction uniformly;

Step (2) arranges the position reference point of locator network, measures its regional geography coordinate;

Step (3) is set up local earth axes, and one group of ground reference point is set, and measures the transformational relation between single camera coordinate system and local earth axes;

Step (4), according to the transformational relation of step (3), is converted to the target observation position on single camera image the areal coordinate partly of target, uses regional geography coordinate and local ground coordinate to represent the true ground location of target;

Wherein, the described single camera localization method based on reference point, by set reference point on monitoring scene ground, the reference point that utilization measures is the image coordinate in areal coordinate and single camera coordinate system partly, calculates the transformational relation matrix between single camera coordinate system and local earth axes; Afterwards, by the target image coordinate conversion observing, be areal coordinate partly; When single camera is fixedly time, transformational relation matrix is constant, unique, and its parameter can obtain with the one group of ground reference point measurement that is no less than 4.

2. a kind of positioningly appearance calibration method being applied in video monitoring system according to claim 1, it is characterized in that: in described step (1), observation camera node monitor area ground shape distributes, by the node division that is arranged in same ground level to same sub-network.

3. a kind of positioningly appearance calibration method being applied in video monitoring system according to claim 1, it is characterized in that: in described step (2), to each sub-network, on its ground, region, select any as the position reference point of sub-network, utilize satnav instrument to measure its geographic coordinate, and as the ground reference point under local earth axes.

4. a kind of positioningly appearance calibration method being applied in video monitoring system according to claim 1, it is characterized in that: in described step (3), the region ground level of sub-network of take is set up local earth axes O-XY as XY plane, the position reference point of step (2) is local earth axes initial point O, the image coordinate of ground reference point and local ground coordinate are respectively (x, y) and (X, Y); Set world coordinate system O w-X wy wz wx wy wplane is identical with local earth axes, the world coordinates of ground reference point is (X, Y, 0), according to video camera perspective transform principle, can obtain image coordinate (x, y) the transformational relation matrix and between local ground coordinate (X, Y), expression formula is as formula (1), wherein each parameter forms transformational relation matrix, as formula (2); To N ground reference point, obtain one group and measure equation, expression formula, as formula (3), solves this equation and obtains transformational relation matrix, determines transformational relation;

C 11 X + C 12 Y + C 13 - C 13 Xx - C 32 Yx = C 33 x C 21 X + C 22 Y + C 23 - C 31 Xy - C 32 Yy = C 33 y - - - (1)

C = C 11 C 12 C 13 C 21 C 22 C 23 C 31 C 32 C 33 - - - (2)

X 1 Y 1 1 0 0 0 - X 1 x 1 - Y 1 x 1 0 0 0 X 1 Y 1 1 - X 1 y 1 - Y 1 y 1 · · · · · · · · · · · · · · · · X N Y N 1 0 0 0 - X N x N - Y N x N 0 0 0 X N Y N 1 - X N y N - Y N y N C 11 C 12 · · C 31 C 32 = C 33 x 1 C 33 y 1 · · C 33 x N C 33 y N - - - (3)

In formula, C ijfor transformational relation matrix element value, wherein, i=1,2,3, j=1,2,3; C 33be made as constant.

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