Realization for Moving Object Tracking System in Two Dimensional Plane using Stereo Line CCD

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ABSTRACT

A realization for moving object detecting and tracking system in two dimensional plane using stereo line CCDs and lighting source is presented in this paper. Instead of processing camera images directly, two line CCD sensor and input line image is used to measure two dimensional distance by comparing the brightness on line CCDs. The algorithms are used the moving object tracking and coordinate converting method. To ensure the effective detection of moving path, a detection algorithm to evaluate the reliability of each measured distance is developed. The realized system results are that the performance of moving object recognizing shows 5mm resolution and mean error is 1.89%, and enables to track a moving path of object per 100ms period.

KEYWORDS

Moving object tracking, coordinate conversion, target moving path, stereo line CCDs

Ⅰ. INSTRUCTION

There are several tools to input data into a computer. Those are a keyboard, mouse, electric pen, touch pad and etc. All needs positioning corresponding to display. The mouse of them is used with computer in general. This input device is extracted the coordinate system by detecting displacement and its integration. The feature is low cost but not good to detect the absolute position. Nowadays the absolute coordination extraction is essential to input a complicated data, image and select a menu using graphics in multimedia multiple function software.[1-2]

The methods inputting the absolute coordination enables to be classified by using the charged capacity like touch screen, ultrasonic sensor and infrared sensor. The touch screen is required a monitor or tablet covered with a touching film. This has a good feature to recognize an accurate coordinate and to enable to input data by pen, finger or another tools, whereas the covering film on the whole monitor plane or tablet plane causes to be increased the manufacturing cost, and the touch film enables to be damage to the thing by being shocked at an external impact. The ultrasonic sensor has merit to enable to be manufactured a system for low cost, but the coordinate recognition is required to be installed a delicate pen with ultrasonic sensor. The infrared sensing method are composed of an infrared radiator and sensor. The one side is installed a transmitting radiator and the other side is arrayed a receiving sensor. The composition results in low resolution decreased an touch accuracy in depending on the interval of sensors.[3-5]

Thus this paper is proposed the solving system, and the coordinate converting and moving object tracking algorithm to be eliminated the conventional demerits using a stereo line CCDs, lighting source and USB interface in two dimensional plane. The USB interface leads to be convenient and practical for experimentation and utilization. The realizing system enables to be an high accuracy with high resolution CCDs, and the merit results from the multiple input media like finger, pen or etc. The experimentation is proved the effective detection of moving path and accuracy.

Ⅱ. SYSTEM REALIZATION

2.1. System configuration

The moving object tracking system is

composed of analog front, control and algorithm blocks. The analog front has stereo line CCDs to discriminate an object existence in the two dimensional plane and the lighting source supply illumination for CCDs to operate in detail. The control system is divided into sensor control to control the CCDs and USB interface to transmit data into computer to process the algorithm, and algorithm block is processed the moving object tracking and coordinate converting routines from physical image data of CCDs as shown in Fig. 1, the realizing system configuration.

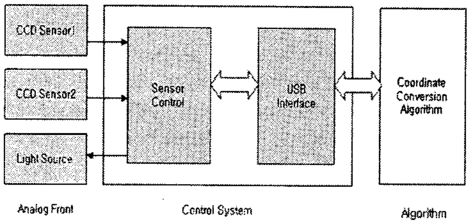

Fig. 1. Realizing system configuration

2.2. Analog front

An one line CCD sensor has 90 degree over in visual angle. Two CCDs enable to keep watch on the rectangular shaped 2 dimensional plane. CCD1 sensor and CCD2 sensor are installed at rectangular up edged corner respectively. A lighting source is required to keep watch clearly. Three sources are arrayed at right and left vertical plane, and bottom plane. The Fig. 2 is shown the scheme arranged 2 CCDs and lighting sources in 2 dimensional plane. Where CCD1 observes a moving object to be based on the right and bottom lighting source in 2 dimensional plane, and CCD2 tracks a moving object on the left and bottom lighting source.

The lighting source is used a infrared LED. This source is good to be directional, and enables to reduce error recognition due to preventing the system from an external noise lighting source because the infrared wave length is higher than the visible light waves. The different wave length between them prohibits an interference from inserting. These feature results in an clear accuracy for the tracking position.

2.3 Object recognition

The lighting source is required beyond the constant lighting level to recognize an object from sensor. If there is a moving object in 2D plane then the bottom, right and left lighting source are inputted into CCDs sensor directly. Thus CCDs sensor are inputted the constant light signal level. This is used as the reference level. Next, if an object appears on the T spot in 2D plane as shown in Fig. 3 then the object intercepts the light between the CCDs and lighting source. This results in the recognition of an object existence.

The generated signal level corresponding to the appearing position of object converts into pixel number of the CCD sensor. The mutual relation between the detected position of the object and the pixel number of CCD sensor get settled by the initial setting time of the system after the calibration is processed.

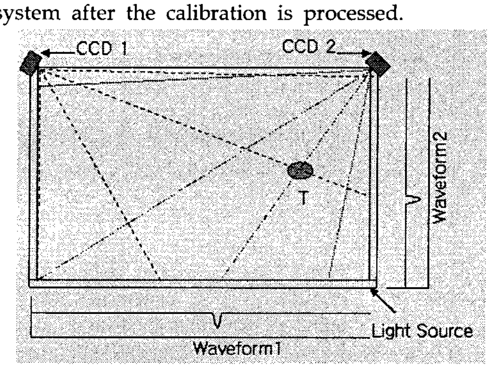

Fig. 2. Signal transformation processing

The Fig. 2 shows signal level representation of sensor at beginning of the generation T in 2D plane. The waveform1 is denoted the signal level inputted at CCD2 sensor and waveform2 is signal level inputted at CCD1. The both data are transmitted from USB port interface block to computer.

2.4. Coordinate transformation

The transmitted data from USB interface port corresponds to the pixel of CCD sensor for an object in 2D plane. This value enables to transform to coordinate of 2D plane using the degree of 2 sensors and the target, and the length in 2D plane. The horizontal length and vertical length in 2D plane are denoted by $l1$ and $l2$, respectively. A width between CCD1 and CCD2 $l1$ is constant given by the system. The angles between the target detection point and sensor 1, 2 are denoted by θ_1 and θ_2 as shown in Fig. 3, respectively. The coordinate $f(x,y)$ is given by equation (1) and (2).

$$x = l1 \frac{\tan\theta_2}{\tan\theta_1 + \tan\theta_2} \quad \cdots\cdots (1)$$

$$y = l1 \frac{\tan\theta_1 \tan\theta_2}{\tan\theta_1 + \tan\theta_2} \quad \cdots\cdots (2)$$

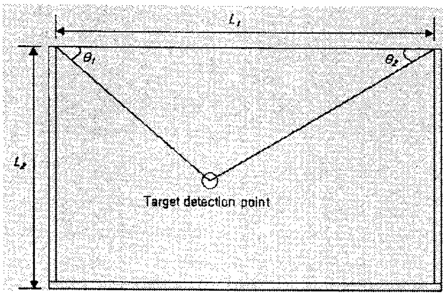

Fig. 3. Detected target and sensor angles

The angle related to sensors and the detected target is used the pixel position of sensors. The sensors are arranged at 45 degrees from right and left corner on the $l1$. This site enables to observe the whole plane of 90 degrees by one sensor. If the number of total pixel N, the pixel of the detected target position n and its angle θ, then the angle is defined by equation (3).

$$\theta = 45^{\circ} + \tan^{1-}\left(\frac{N-2n}{N}\right) \quad \cdots\cdots (3)$$

Substituting equation (3) into equation (1) and (2), replaced by equation (4) and (5). Where n_1, n_2 corresponds to pixel number detected at sensor 1 and sensor 2, respectively. Equation (4) and (5) is used the coordinate transformation algorithm in the computer. The coordinate plane function $f(x,y)$ enables to track a moving path of object cause by continuous data storage with time.

$$\frac{x}{l1} = \frac{n_2(N-n_1)}{n_1(N-n_2)+n_2(N-n_1)} \quad \cdots\cdots (4)$$

$$\frac{y}{l1} = \frac{n_1 n_2}{n_1(N-n_2)+n_2(N-n_1)} \quad \cdots\cdots (5)$$

III. EXPERIMENTATION

The realized system is composed of control embedded system and CCDs sensor module. Fig. 4 shows the upper is USB interface block, right side is CCDs sensor control ASIC (Application-Specific Integrated Circuit) block, lower right is power and left is MPU block. Fig. 5 shows the realized CCDs sensor module. The analog front is realized by the input imaging sensor are used 300DPI 2 CCDs and infrared LED as a lighting source. The scanned image data is transmitted from USB interface to computer, Coordinate transformation algorithm is applied, and converted to the target position for a moving object tracking in 2D plane.

The system is examined by an iterative coordinate detecting. 2D plane is subdivided into detail grid area for being easy to check an coordinate position as shown in Fig. 6. The system evaluation is checked an error that the difference is between the detected coordinate from system and position arranged an object in the grid plane. The object recognition is tested at 50 times, and the error puts on that position and frequencies are accumulated. The more sensor1 is close to sensor2, the more the error is reduced, conversely the more far, the error of the coordinate recognition is increased as shown in Fig. 6. Most of error is distributed at right and left bottom corner on the error table. The test results in mean error 1.89%.

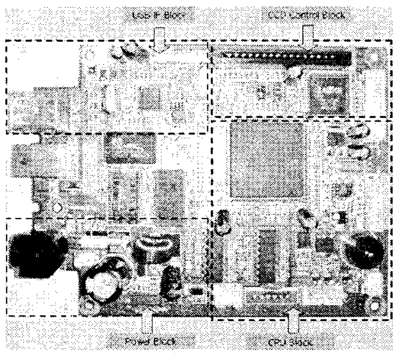

Fig. 4. Embedded control system

Fig. 7 shows an inputted signal status of sensor before sensing a target in the coordinate plane, and a part out of the whole pixel. The signal level is varying caused by an influence of lighting source brightness and external environment.

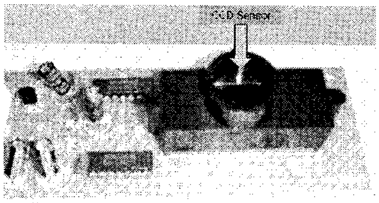

Fig. 5. CCDs sensor module

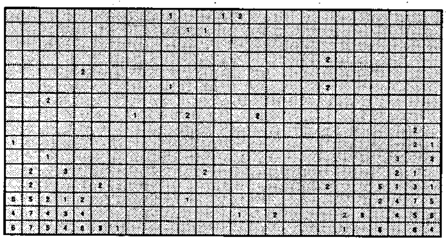

Fig. 6. Error table of recognized Coordinate

Whereas if a light for transmitting to CCD sensor is intercepted by being target in arbitrary position, then a target is detected and signal level get started high status, and sensing level raises up 255 approximately as shown in Fig. 8. The signal status of the whole pixel data is shown in Fig. 9. Where x axis and y axis are represented the pixel and signal level, respectively. The directional feature of infrared LED makes signal-level different depending on angle of CCD sensor.

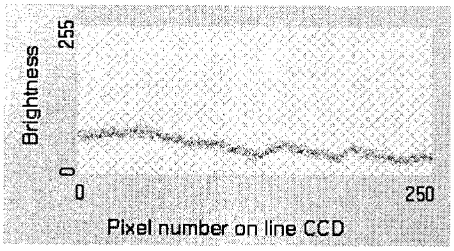

Fig. 7. Sensed signal of ready status

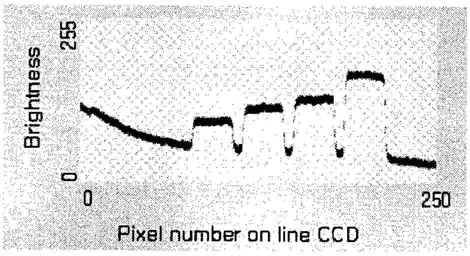

Fig. 8. Sensed signal of detected target position.

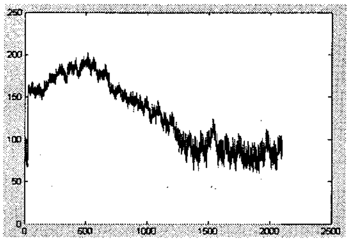

Fig. 9. Pixel signal of CCD sensing

IV. CONCLUSIONS

The realization for moving object tracking system in 2D plane using stereo line CCDs were presented in this paper. The system were composed of CCDs sensor, infrared LED and moving target tracking algorithm. The experimental system results are that the performance of moving object recognizing showed 5mm resolution and mean error is 1.89%, and enabled to track a moving path of object cause by continuous data storage with 100ms period. The system is applied to electric board, restricted area security, disability aid, touching input and etc. In the future, recognition of a touching object size, minute moving detection, and multi object moving detection are required.

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