Research on Video Tracking System Method Based on Classroom Teaching

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Abstract: In response to the problem of video tracking in classroom teaching, a video tracking system using optical flow method improvement method is proposed. Using the processing functions provided by OpenCV, analyze the states of teachers and students in the classroom, obtain their motion states, and then instruct the camera to track close-up or switch panoramic views. Using LK optical flow method to analyze students' motion state; Using clustering algorithms to calculate the number of students standing up; Using spatial analogy method, calculate the position of the close-up student and indicate the rotation of the camera. This system has high practical value and special significance for online teaching, online classrooms, etc.

Keywords: OpenCV; LK optical flow method; Clustering algorithm; Analogy method

Introduction

The intelligent classroom video recording and broadcasting system is an educational technology system that utilizes multimedia technology and computer network technology to record classroom teaching in real-time. This system has moved traditional studios into ordinary classroom settings, not only allowing real-time recording of classroom teaching situations, but also enabling online live streaming and on-demand playback. The intelligent classroom video recording and broadcasting system does not require manual operation during the entire classroom teaching recording process. It only needs to place the camera in a fixed position in the classroom, use image processing methods to enable the camera to automatically record the classroom situation, and can be live streamed in real-time online. During the recording process, it is mainly divided into video recording and audio recording, and video recording can be further divided into recording for teachers, students, and courseware. The recorded classroom videos are stored in the host computer, and the remote learners can directly order the relevant videos they need through the Internet.

In video recording and broadcasting systems, video tracking is an important function, and tracking algorithms are the core of the video tracking system. This article mainly studies a video tracking system based on improved optical flow methods.

1. Application scenarios of traditional optical flow method

Optical flow method is an algorithm for determining the direction of motion of a moving object, which cannot determine the number of objects or determine their position. In other words, the optical flow method can only provide one movement trend. Relying solely on frame difference and background subtraction methods is not ideal.

In classroom teaching, student behavior judgment is relatively complex, such as standing up, sitting down, walking, and the number of behavioral states that students have. Optical flow method can only be used to judge whether students are standing up or sitting down, and cannot complete the function of judging the number and position of students. Therefore, it is necessary to improve the optical flow method and add a method for determining the number of student behaviors and a calculation method for mapping image position to spatial position. The camera tracks based on coordinate indications when receiving spatial positions.

2. Video tracking algorithm based on classroom teaching

2.1 Motion state analysis algorithm - LK optical flow method

In this scheme, the Lucas Kanade algorithm is used to calculate the optical flow vector of the moving target. The specific calculation method is as follows:

In computer vision, Lucas Kanade optical flow algorithm is a two frame differential optical flow estimation algorithm. This algorithm is currently a commonly used and popular algorithm for processing moving targets. This algorithm was developed by Bruce D Proposed by Lucas and Takeo Kanade. It assumes that the optical flow is essentially constant within the local neighborhood of the considered pixel, and thus uses the principle of least squares to solve the basic optical flow equation for the pixels within the neighborhood.

Its specific implementation is as follows:

The acquisition of the first frame image and the second frame image at time is accomplished by calling the function cvQueryFrame(); By calling the function cvGoodfeaturesToTrack(), output the first frame image feature corner position frame1_features; By calling the function cvCalcOpticalFlowPyrLK() and inputting the corner position information of the first frame image, output the position information of the feature corner points of the first frame image in the second frame image frame_2 features; The motion vector of the variable frame_2

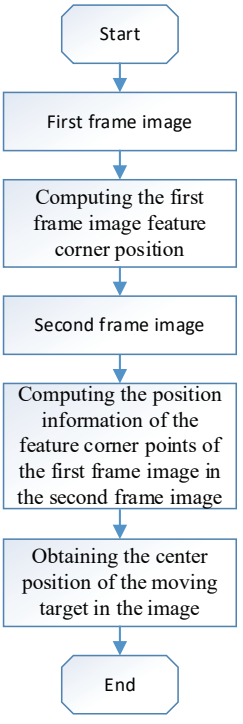


Figure 1 Optical flow processing flow

features represents the direction and magnitude of the target's motion. Decompose the motion vectors obtained from frames 1 and 2 in both horizontal and vertical directions and compare them with amplitude thresholds to determine whether they are moving upwards, downwards, or left or right. By processing the position of feature points in the optical flow field, the center position of the moving target in the image can be obtained.

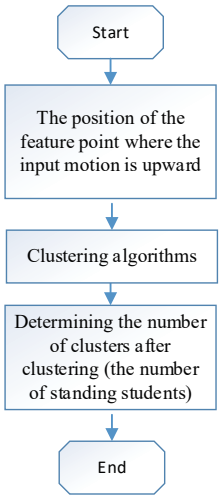
2.2 Number judgment method - clustering algorithm

Using density based clustering algorithms, various parts that belong to the same region but are relatively scattered are clustered together to extract the complete motion target area. The number of motion students is determined based on the number of extracted target areas.

After the clustering algorithm determines the number of standing students, if the determined number of standing students is 1, then cut the close-up shot of this student; If the number of standing students determined at this time is 2 or more, then cut the panoramic shot of the students in the classroom; If the number of standing students determined at this time is 0, cut the lens of the panoramic image.

2.3 Position determination method - analogy algorithm

In the absence of a reference object, although we cannot directly measure the length of an object from an image, we can measure the length ratio of two parallel objects. If the actual size of an object is known (such as placing a coin at the shooting location), the length of the object can be determined by the length ratio and the size of the reference object. Its specific implementation is as follows:



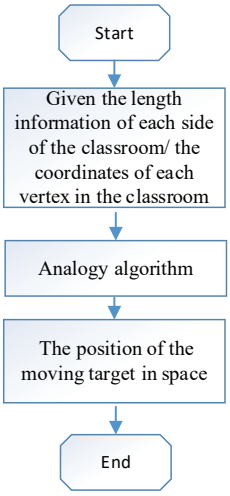


Figure 2 Clustering Algorithm Processing Flow **Figure 3 Analog Algorithm Processing Flow**

Given the length information of each side of the classroom, the coordinates of each vertex in the classroom can be obtained. The optical flow algorithm can calculate the center position of the moving target pixels in the image, as well as the length information of each side of the classroom. Combined with the analogy algorithm, the position of the moving target in space can be accurately calculated.

3. Simulation results

3.1 Optical flow method

From Figure 4, it can be seen that the feature-based optical flow method can quickly separate moving targets from the background by matching the shape information of optical flow classes in the optical flow field with the feature corners of the target, and accurately grasp the motion state of the target. Moreover, the algorithm's judgment is relatively intuitive. The direction of the motion vector of the optical flow class in the optical flow field can determine that the direction of the target's motion is upward.

The advantage of optical flow calculation method is its smaller calculation, more intuitive judgment, and smaller error in judgment results.

3.2 Clustering Algorithm

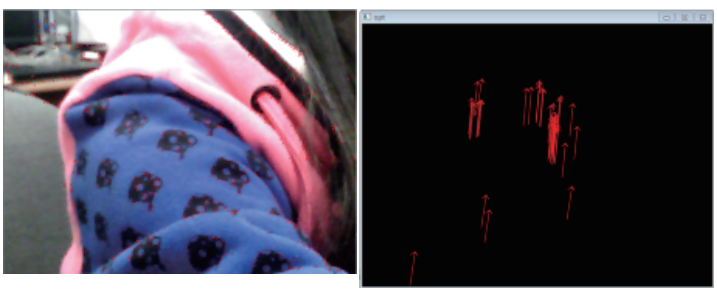


Figure 4: Searching for Feature Points and Determining Motion Direction

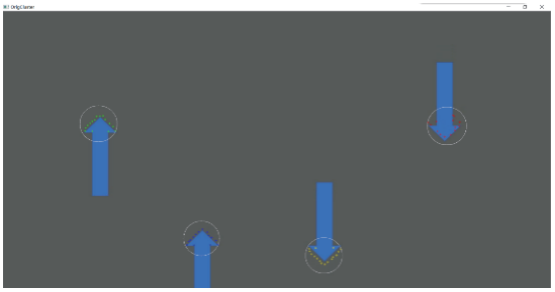


Figure 5 Clustering results

It can be seen that four different moving objects are clustered into four categories, represented by different colors.

3.3 Analogical Algorithm

This scheme design adopts an analogy algorithm to map the position of image motion target pixels to spatial positions, determine the position of students in the classroom, and facilitate sending serial commands to the student tracking camera. When only one student stands up, the close-up shot of that student is cut; When there are two or more students standing, cut the panoramic view of the students in the classroom.

The input parameters are as follows:

```
int width=600;//classroom width
int length=800;//classroom length
int height=200;// camera heigth
int teacher_zone=100;
int cam_pos=250;// camera x position
int student_height=160;
```

Figure 6 Analogical processing result

Where x and y are the spatial coordinates of the target, measured in millimeters, and theta and beta are the angles between the target camera gimbal.

From the simulation results, it can be seen that using the analogy algorithm can accurately determine the position of students in the classroom from the input parameters, and has the advantages of simple operation, fast processing speed, and good real-time performance.

4. Conclusion

The classroom teaching video tracking system uses an improved method of optical flow to automatically track the behavior of students and teachers in the classroom. It can accurately calculate the number of moving students and their movement status (standing up, sitting down), and accurately calculate the coordinates of the moving students. The coordinate information is sent to the pan tilt camera, which rotates the corresponding angle according to the student's coordinate value to make the standing student at the center of the entire camera frame. When the student sits down, it recognizes this status and switches the pan tilt camera to the panoramic state of the classroom. The improved method of optical flow can calculate the real-time motion information of students in the classroom, thereby controlling the tracking of the gimbal.

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