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DYNAMIC EVALUATION OF PEDESTRIANS FLOW BY TIME TRANSITION OF TRAFFIC LINE DISTRIBUTION

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Abstract – This paper describes the measurement to take traffic lines of pedestrian flows outdoors and the investigation of dynamic characteristics by using the density, direction, velocity distribution and etcetera of them. These characteristics express Time Transition and the congestion. These can judge evaluation of the dynamic field. The arrangement of structures and public facilities around the field will be evaluated by them.

Keywords: traffic line, pedestrian flow, congestion evaluation

1. INTORODUCTION

In recent years, importance came to be attached to the design of the environment which surrounds man called an environmental design. It is the necessity of enabling a pedestrian's smooth passing in the large space which was very crowded. Design and the traffic control method of the passage that an accident does not happen easily are desired.

In order to aim at the dynamic existence of a pedestrian, it has to see dynamically. The field is filmed using the camera installed in a height. From the filmed video, a pedestrian's motion is analysed and the characteristic of the field is evaluated.

2. MEASUREMENT OF TRAFFIC LINES OF PEDESTRIAN FLOW

The filmed video data is downloaded to a computer. This video image resizes to 640(wide) * 480(height) pixels. Sampling images frame by 7 fps from the video image (Fig.1 (a)). Making differential image frame was generated by the absolute difference between neighbouring two image frames. A part for color difference is taken out. Noise filtering take away partial fluctuations except pedestrians flow on the differential image frame. Recognition of pedestrian movements is clarified white (Fig.2 (b)). White regions enclose them with green boxes (Fig2 (c)). When the size of a movable object is smaller than a threshold value, it is judged as a noise and removes. In order to look for the same pedestrian movement between neighbouring two differential image frames, the green box like the near and about same size is looked for. The vector between the centres of their green boxes draw. Traffic line segments draw. When drawing a traffic line, the green box of the size similar from the picture of the neighbouring image frame is looked for. The vector angle shows flow direction. Construction of traffic line compound these segments. The line attaches a color by a direction.

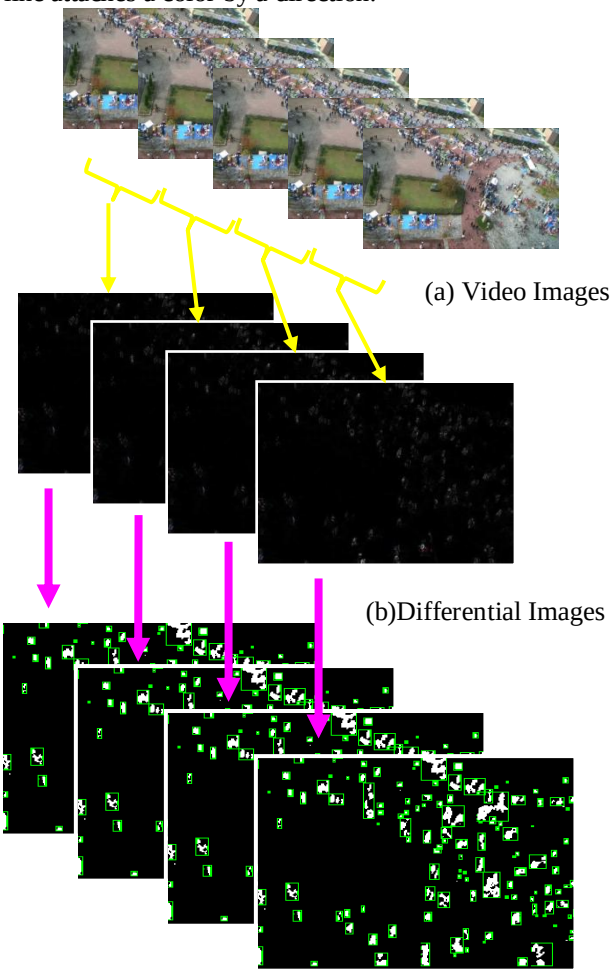


Fig. 1 Detection of pedestrian in walking

(a) Sampling images frame by 7 fps from the video image.
(b) White is clarified
(c) Recognition of pedestrian movements (white regions) encloses them with green boxes.

Fig. 2 Traffic lines of pedestrians

Fig. 3 Color circle showing directions

In this paper, to recognize the pedestrian flow, the measurement to detect the moving track of pedestrian flow as a traffic line is shown (Fig2). The color of the flow line of Fig. 2 is decided with the color circle of Fig. 3.

Fig4 express a letter from the video image to the moving track of pedestrian flow.

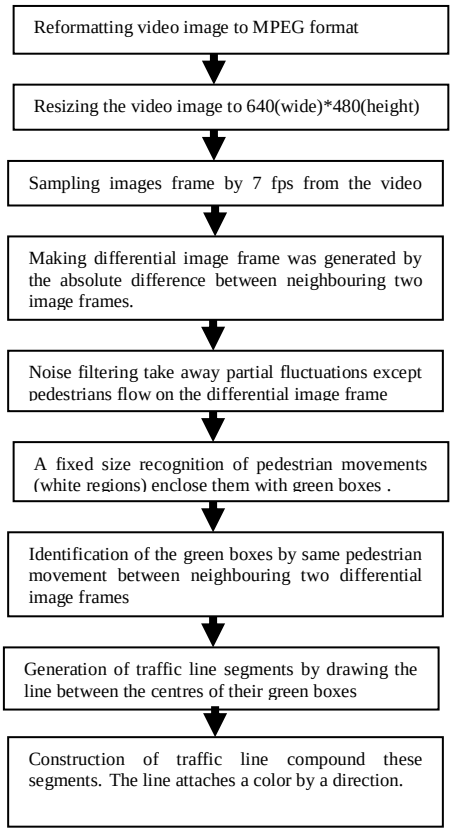


Fig.4 Flow chart of the line of flow

3. SEVEN PARAMETERS BY TRAFFIC LINES

The characteristic parameter was created in order that the field might evaluate. The display method of the direction of the foundations at the time of expressing a parameter and ROI are explained. The situation of the field which is not visible was expressed with eyes by dividing into seven.

3.1. Foundations of the direction

Fig.7 shows a color circle is divided in the eight directions of every 45 degrees.

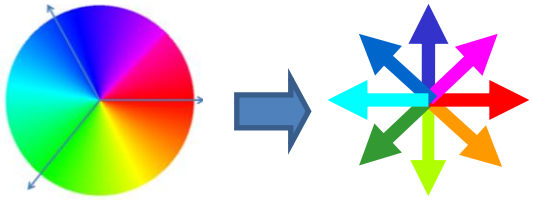


Fig. 5 A direction is divided into eight

Table. 1 direction to color conversion table

■Direction:	337.5	～	22.5	[degree]
■Direction:	22.5	～	67.5	[degree]
■Direction:	67.5	～	112.5	[degree]
■Direction:	112.5	～	157.5	[degree]
■Direction:	157.5	～	202.5	[degree]
■Direction:	202.5	～	247.5	[degree]
■Direction:	247.5	～	292.5	[degree]
■Direction:	292.5	～	337.5	[degree]

3.2. ROI (Region of Interest)

The target place is divided into a fine domain. A traffic line is treated as a set of a fine line segment. An image segment is ROI. Each parameter is analyzed from the set data of the line segment which exists in ROI (Fig. 6).

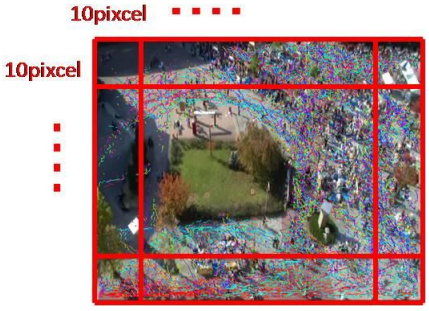


Fig. 6 Definition of ROI

3.3. Density

Relative density with other places is taken. The number of the line segments in ROI is counted, and it divides real area of ROI (Fig.7). According to the value, it draws on a screen in a translucent color. It expresses by a red tone (Fig.8). Deep color areas are a high-density place on this screen. Light color areas are low density .

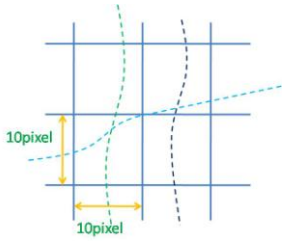


Fig.7 In segment

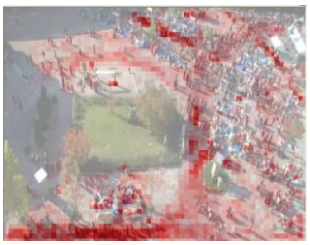


Fig.8 Density distribution

3.4. Average speed

Average speed expresses the speed along which the pedestrian for every place walks. The starting point and the terminal point of a line segment are changed into real coordinates. The length of a traffic segment is calculated. Velocity is computed by multiplying the value and frame rate. The average velocity in ROI is computed. It expresses by a blue tone (Fig.9). Deep color areas are high average velocity. Light color areas are low average velocity.

The place where average speed is high has a low congestion. The place where average speed is low has a high congestion.

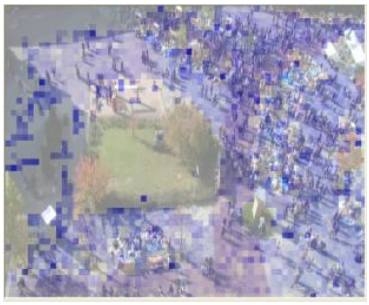


Fig.9 Average speed distribution

3.5. Main direction

The angle of each traffic line segment in ROI is computed. It divides into eight according to the angle of a traffic line segment. The number of traffic line segments is counted for every divided direction. The most number of directions is the main direction (Fig.10). Main direction is denoted by the corresponding arrow of a color (Fig.5).

Fig. 10 Main direction distribution

3.6. Scatter of directions

The number of the directions which exceeded the threshold value for all directions is counted (Fig11). This number is the number of distributions of a direction. It expresses by a green tone (Fig.12). Deep color areas are high distributions of a direction. Light color areas are low distributions of a direction.

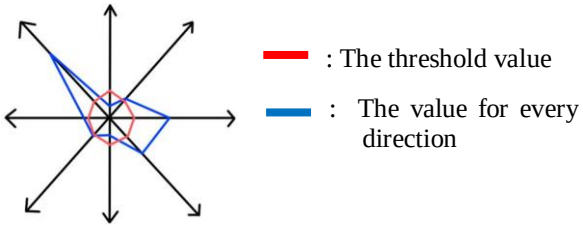


Fig11. An all directions-oriented value

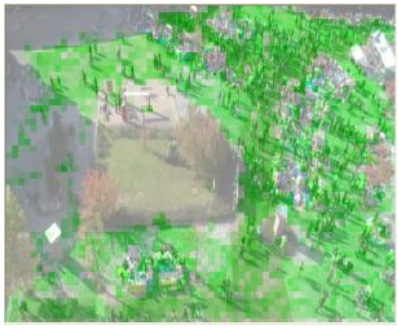


Fig.12 Scatter of directions distribution

3.7. Degree of inflow

Degree of inflow expresses the tendency for a movable object to flow in. The number of the line segments which go in the direction of object block from adjoining Block is counted (Fig.13). It expresses by a red tone (Fig14). Deep color areas are high degree of inflow. Light color areas are low degree of inflow.

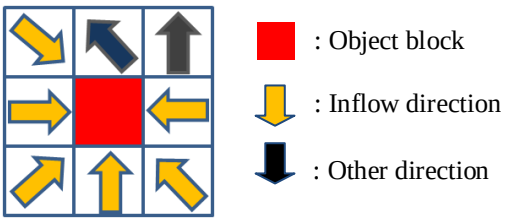


Fig13. Degree of inflow

Fig.14 Inflow distribution

3.8. Velocity differential

Velocity differential expresses the size of the velocity change during a block (Fig.15). The absolute value of the average speed difference of an object block and an adjoining block is computed. The sum of an absolute value expresses a velocity differential. It expresses by a blue tone (Fig.16). Deep color areas are high velocity differential. Light color areas are low velocity differential.

V0	V1	V2
V3	Vr	V4
V5	V6	V7

$$V_{def} = \sum_{n} abs(Vr - Vn)$$

Fig.15 Calculation method of a velocity differential

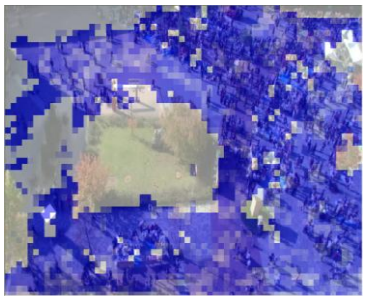


Fig. 16 Velocity differential distribution

3.9. Rate of a direction

Rate of a direction understands people's stream. Calculation method is shown below. A direction decides most sum of the number of three adjoining directions (Fig. 17). The sum total of the direction is divided by the number of all the flow lines and let the middle of the direction be the main directions (Fig.18). It classifies by color for every direction. A shade is attached at a rate of the value. Fig. 19 shows all the direction. Correspondence of a color Refer to Fig. 5. Fig. 20 shows Right direction. Deep color areas are high degree of Rate of a direction. Light color areas are low degree of Rate of a direction. The flow of a direction can be seen on the whole including rate. The view which is different by combining two and three directions is made.

Fig. 17 three adjoining directions

Fig. 18 Middle of the direction

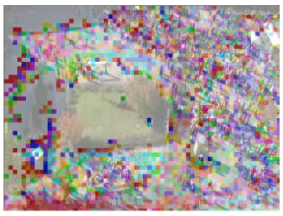


Fig.19 All direction

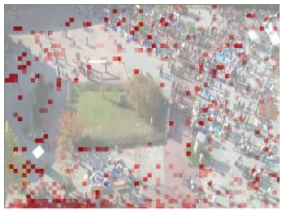


Fig.20 Right direction

4. TIME TRANSITION OF PARAMETERS

The front chapter explained the character of the parameter. Here, change of the parameter by time is explained. People's flow and congestion degree change by time in the same field.

4.1. Observe of normal image

Traffic lines are generated by image processing of the pedestrian flows recorded by digital video camera. From fig4 to Fig6 shows the sample of frame image taken the situation of pedestrians walking at Student University Festival in autumn 2010. In Fig21 (a), On the whole, there are few people. In Fig21 (b), there is the entrance of restaurant building at the right-top side area (circle_1). In this area, it was found that there were many students standing and walking in/out the building. And there were street food stalls in the areas shown with circle_2. In these areas, the students standing in the food stall and walking slowly to look foods and goods for sale were confusing. Around these areas (circle_1, circle_2), the density of students is higher and the walking velocity of them is lower. There was a little student walking in the areas shown with circle_3. The density of students is lower and the walking velocity of them is higher. Fig.21 (b) and Fig.21 (c) are alike.

Evaluation of the field is [the place in a picture, or whole time] different so that three circles may express. It divides and explains at a time to one parameter from the following chapter.

(a) From 10:00 to 10:05

(b) From 13:00 to 13:05

(c) From 16:00 to 16:05

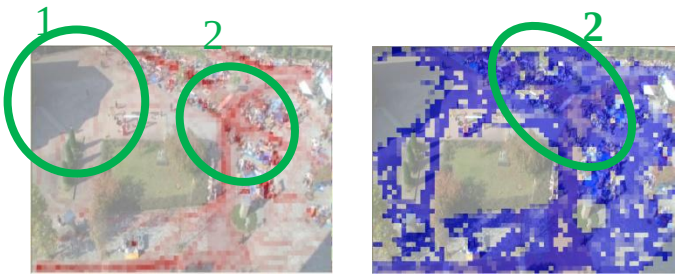
Fig. 21 Observation of normal image

4.2. Observation of time transition of characteristic three parameters

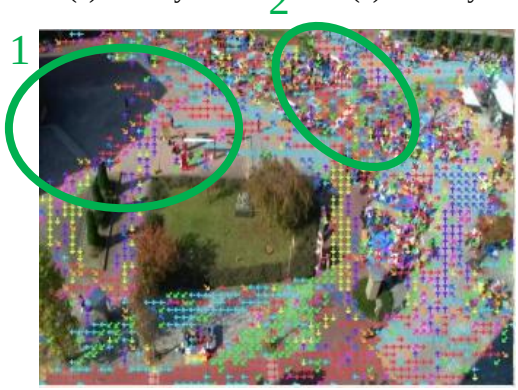
The dynamic information of 5 minutes and the parameter which specialized in one are visualized in a picture. Using three parameters can estimate the field.

It is guessed that the morning had few people than the circle 1. The circle 3 has the deepest red in Fig22 (a).Fig.23 (a) is more low-density than Fig.22 (a). In Fig.22 (c), it turns out that the range of a pedestrian place is narrow. The circle 2 is a place where many people go back and forth. It understands that Fig.23 (c) is more scattering than Fig.22 (c) as for a direction. In Fig.22 (b), since there are many people who avoid each other, there is little speed change. In Fig.22-24 (a), it is the most high-density place. In Fig.23 (c), Main directions have come apart. The direction has come apart from the daytime to the evening. The circles 3 are those who go to a parking lot for bicycles. In fig22-24(c), it turns out that there is more one in the evening than a morning or daytime.

A pedestrian's change can be understood by seeing for every time.

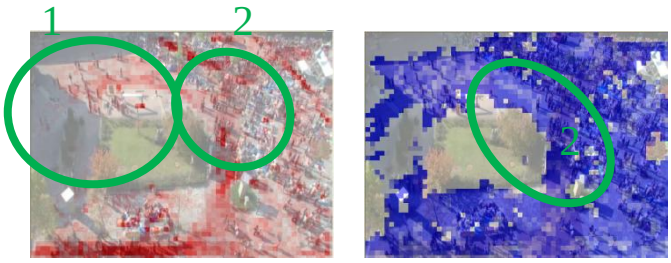


(a) Density (b) Velocity differential



(c) Main direction

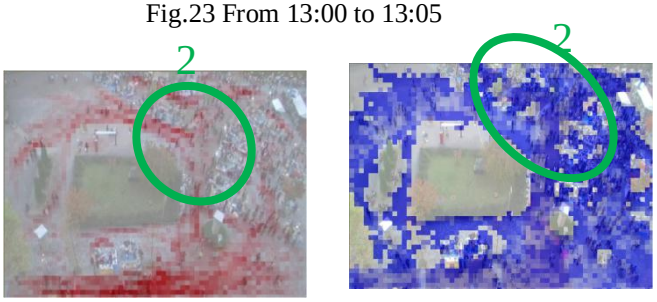
Fig. 22 From 10:00 to 10:05



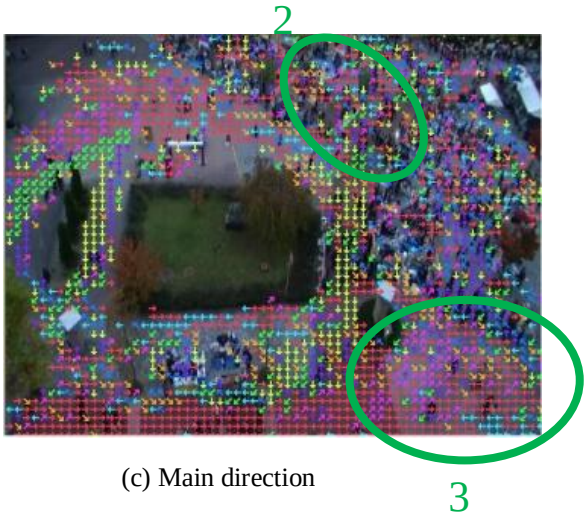
(a) Density (b) Velocity differential

(c) Main direction

Fig.23 From 13:00 to 13:05



(a) Density (b) Velocity differential



(c) Main direction

Fig.24 From 16:30 to 16:35

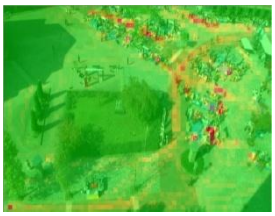
4.2. Congestion degree

It is defined as Congestion degree being related to density, average speed, and the number of direction distributions. If there is high density, it can be judged that it is crowded. If the speed which walks is slow, a flow will worsen. The relation between Congestion degree and speed is an inverse proportion. A flow will be checked if there are many direction distributions. The relation between a congestion degree and the number of direction distributions is proportionally. A congestion degree is denoted by combination of three compensation parameters. Congestion level high area is red. Congestion level middle area is yellow. Congestion level low area is green (Table2).

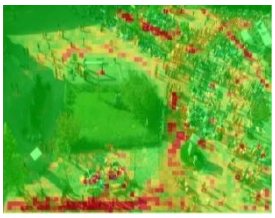
Table2: Congestion level conversion table

	low	high
(high, many)		
(high, little)		
(low, many)		
(low, little)		

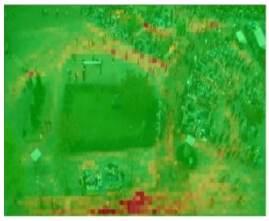
Low Middle High



(a) From 10:00 to 10:05



(b) From 13:00 to 13:05



(c) From 16:30 to 16:05

Fig. 25 the congestion degree

Since there are few people on the whole, it is not crowded from 10:00 to 10:05 (Fig.25). Since there is preparation of selling, the surroundings of a store have a little confusion. There are many persons at 13:00. There are very many congestion degrees in the surroundings, near the entrance of restaurant building, and the main street of the street food stalls. In 16:30, confusion has decreased around the street food stalls. Since people are walking along many main streets, it is crowded.

5. CONCLUSIONS

This paper describes the measurement to detect traffic lines of pedestrian flows and evaluates the latent characteristics (dynamic states of density, direction and velocity) of field where pedestrians are walking. A dynamic image is required for a congestion degree or danger. These characteristics are not able to recognize with video and static images. These characteristics relate to the congestion and latent dangerousness in field/area for pedestrian flows. They are not defined by only arrangement of buildings and facilities. They should be estimated dynamically. Then they must be recognized as the dynamism of density, direction and velocity distribution of pedestrian flows.

By experiments and estimations to analyse pedestrian flows in university campus, some invisible congestions and dangerous areas were confirmed. These areas were changing corresponding with the time transition. In future, authors will reconstruct the measurement system as an on-line system. Investigate the definition of the dangerousness.

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