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Entropy Measurement to Extract the Signification of Abnormal Activity from Camera's Frames and its Application for Fall Detection

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ABSTRACT

Most of the indoor accidents are related with fall down. Many medical studies are point out that key factor for keeping patient's life is fast response of monitoring system. In modern life, peoples are isolated with neighbor, especially in living quarters. Therefore many solutions are developed for falling down monitoring that base on wearable sensors. These methods require of an expensive sensors system with electric power supplier and telecommunication devices. In context of patients with disease and weak status, patients are trend to remove sensor system. This issue requires to find out another approach so that sensors system will not be needed. We study the fall detection by monitoring camera. For increase the accuracy, we proposed a simple and effective method to extract features of abnormal activities. By tracking the magnitude of entropy and its distribution, our fall detection model has a capability of differentiating falls from other activities

Keywords*: feature extraction, fall monitoring, chaos of information, entropy*

1. Introduction

A development of smart cities has motivated for many higher request in living. The life quality of elder is most expected factor. Therefore, a fall monitoring by camera is one of important problems. Aggarwal (2011) shows that an abnormal activity is strongly

related to fall in elder [1]. This was motivation for studying the abnormal activity detection. In the literature, researchers proposed different methods [1-8, 11-19] to detect abnormal activity, researches focus on bellowing approaches. The abnormal activities detection techniques is briefly summarized in below table

TABLE 1. Summarization of methods for activities recognition

No	Main author	Description	Reference
1	Khalid. S	The template matching method based on the similarity between activities that pre-determine. In fact, this method highly probability generate a fail negative result when fall be happened in new way, Khalid. S generalized this problem by statistic aspect, in [2] he shown that a fall activity uncorrelated to normal activity.	[2]
2	Yin, J.; Meng, Y	In method of state space, a normal activity is formulated in a statistical model by training. An abnormal activity is detected by deviation from statistical parameter of normal activity.	[3]
3	Loy, C.C. Xiang, T. Gong, S		[4]
4	Hu, D.H.; Yang, Q		[5]
5	Lui, Y. Beveridge, J.R. Kirby, M	Manifolds Geometry method is based on the relation between human activities and particular matrix manifold	[6]
6	Lui, Y		[7]
7	Anice Jahanjoo, Marjan Naderan and Mohammad Javad Rashti	Classify abnormal activities by deep belief network algorithms	[8]
8	O. Popoola and K. Wang	The abnormal activities is defined by training data	[11]
9	G. J. Burghouts, V. P. Slingerland, H. ten R.J.M, H. den R.J.M, and K. Schutte	the irregularities is descripted by expert in action monitoring	[12]
10	H.Nallaivarothayan, C. Fookes, S. Denman, and S. Sridharan	Action monitor using un-supervisor learning	[13]
11	Y. Benabbas, N. Ihaddadene, and C. Djeraba	The abnormal activities detected by clustering	[14]
	C. Piciarelli and G. L. Foresti		[15]
12	B. Antic and B. Ommer		[16]
13	A. Adam, E. Rivlin, I. Shimshoni and D. Reinitz	The abnormal activities is recognized by the difference in velocity and trend	[17]
14	M. Roshtkhari and M. Levine	Base on pixels	[18]
15	V. Mahadevan, W. Li, V. Bhalodia, and N. Vasconcelos		[19]

2. Proposed method

Teng Li presented in [10] that the features extraction is directly effecting to accuracy of the results.

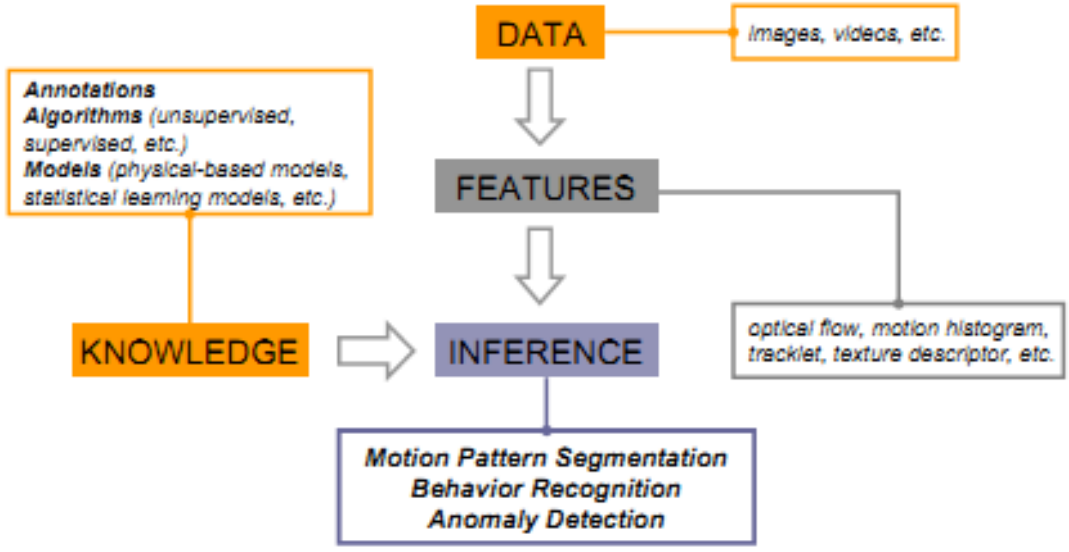

Figure 1. *Scheme of the recognized system [10]*

Therefore he most important work for activities recognizing is features extraction. This paper focus on a proposes that to give a method for extraction signification of abnormal activities that allow to automatically detect fall in elder that would typically require a human supervisor

The key contribution of our study is applying Entropy measurement to highlight the features of abnormal activity.

Entropy measurement

Entropy measurement can be mathematically defined as

$$H = -K \sum_{i=1}^{n} p_i \log p_i ,$$

where

K is a positive constant.

p_i is a probability of event i

Shannon shown that the entropy measurement has a relative to magnitude of a chaos of the information [9]. The chaos of information is highly related to abnormal activity. This idea gave us inspire to solve aboved problem, extract features of the abnormal activity.

The chaos at pixel with row y0 and column x0 is estimated as bellowed description

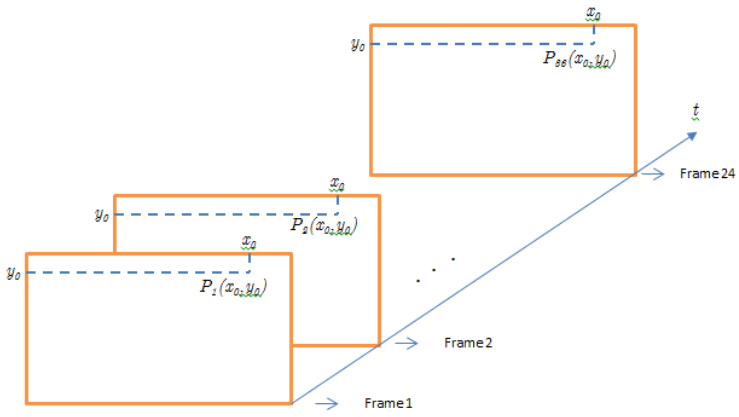

Figure 2. *Description of entropy estimation at pixel with row y_0 and column x_0 over 24 frames*

Proposed a method to estimate the chaos at each pixel through magnitude of entropy

At pixel $P(x_0, y_0)$ we denote that,

$P1(x_0, y_0)$ is value of pixel $P1$ that belong frame no 1. Similar,

$P2(x_0, y_0)$ is value of pixel $P2$ that belong frame no 2.

$P24(x_0, y_0)$ is value of pixel $P24$ that belong frame no 24.

$H(x_0, y_0)$ is magnitude of entropy at pixel $P1(x_0, y_0)$ over 24 frames. $H(x_0, y_0)$ is computed by entropy function of Matlab.

Illustrate the relation between abnormal activity and entropy

Fig 3 illustrate from frame 1 to 24, with fall man at central of room

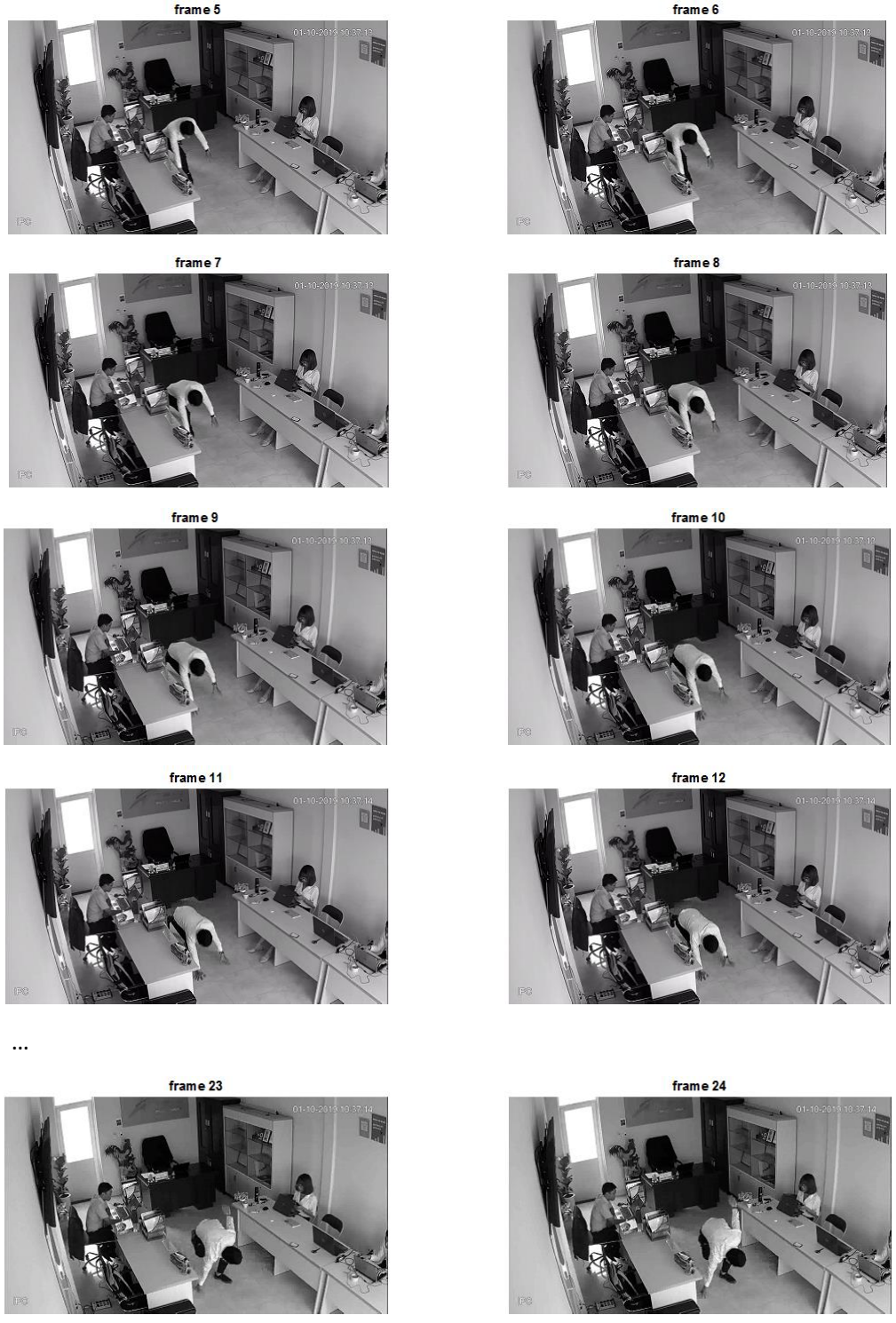

Figure 3. *Frames 18 to 24*

We estimated entropy for all pixels over 24 frames and the result is shown in fig 4. In fig 3, domain with black dots where reflected entropy close to zero. The segments without black dots reflected that entropy larger than zero that mean exist some chaos as fall.

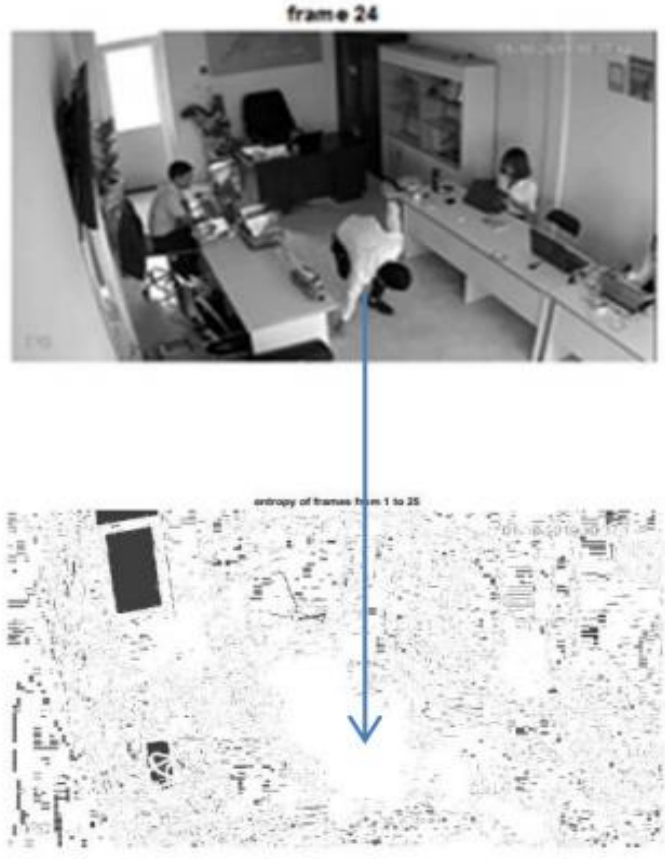

Figure 4. *Entropy of frame 1 to 24.*

Figure 5 illustrated an opposite cases, without fallen man.

Figure 5. *Frames 34 to 57.*

Figure 6. *Entropy of frames 34 to 57.*

By another word, this research visualized by entropy measurement so that almost elements of 2D array are close to zero whenever falling is not happen. This is particularly meaningful for classification purposes

3. Experiment

Our method was implemented using matlab R2016a, on a PC using Intel dual core 2.0 GHz CPU, with 8GB RAM. In this article, we introduce an application of our proposed method that is fall man detection. MATLAB statistic toolbox is used for supporting pratical results in this paper.

Dataset for action recognition contains 2 activities, such as falling action and running (without falling). The collection of data was implemented by us.

The no of forgeries accepted by the system are given as the FAR that is False Acceptance Ratio which is measured as the ratio of no. of forgeries accepted to no. of forgeries considered for evaluation. So, FAR is calculated by the followed formula

$$FAR = \frac{N_{fa}}{N_{ft}} 100$$

where N_{fa} is number of forgeries accepted and N_{ft} is number of forgeries tested.

The no of originals rejected by the system are given as the FRR that is False Rejection Ratio which is measured as the ratio of no. of originals rejected to no. of original signatures considered for evaluation. So, FRR is calculated by the formula given in equation

$$FRR = \frac{N_{or}}{N_{ot}} 100$$

where N_{or} is number of originals rejected and N_{ot} is number of originals tested.

TABLE 2. Experimental results and evaluation of our approach

Number of samples	FAR (%)	FRR (%)
Clip1	2.5	5.0
Clip2	1.5	6.2
Clip3	1.2	4.5
Clip4	1.5	5.5
Clip5	2.2	6.5

TABLE 3. Comparison of detection techniques

Reference	Dataset	Accu (%)
Benabbas [14]	CUHK	77
Mahadevan [19]	UCSD	75
Our method	CUHK	92.3

4. Conclusion

In this research paper, the entropy based for fall Monitoring is presented to save lives and property damages. The objective of this paper is to detect fall man by improvement the quality of features. The performance evaluation need more samples clip for its implement.

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