Abnormal activity detection by using Transition Matrix Model (TMM)

SAOWANEE RUANGNIAM[†1] NIKOM SUVONVORN[†2]

Abstract: Many studies for development of technologies assists older peoples are focus on finding difference pattern between normal and abnormal activities. In this work, the focus is on creating a model of behavior for use in classifying abnormal activities. The Transition Matrix Model (TTM) was proposed for solving uncertainty activities problem. Our model focus on the related more than a pattern of activities. We applied Root mean square error (RMSE) for compared normal model with same sequence of activities by adding different levels of noise such as 10, 25, 35 and 50%. Less noise dataset showed 100% accuracy under the assumption that when less noise the result in this method will decision is normal activities while adding more noise will result in the decrement of accuracy. For future applications, the proposed method can be applied for immediate help of the elders living alone and their behavior analysis.

Keywords: Abnormal activity, modeling for abnormal activity, activity detection.

1. Introduction

The number of elder people is increasing. The active people working outside could not care their elderly at any time. In most cases the elder people must be alone in the home. The technologies for assisting older people able to live alone at home are become necessary. Several studies [1][2] have focused on the monitoring and notification when events causing injuries, such as falling. Other interesting works [3][4] introduced a technologies for checking the abnormalities under the concept that if the pattern of activities in daily life are changing it might mean unhealthy, such as insufficient sleeping, or repeating harmful actions.

In our work, we introduce the Transition Matrix Model (TMM) to create a model of normal activity that can detect and track abnormal activity. The vision based technique for classifying the 12 basic activities [5] previously proposed as model input data. The frequency transition of activities are observed and modeled into a comprehensive matrix called the TMM. However, in real daily life a pattern of activity is not predictable. We defined daily activities as normal activity. The normal activity was compared with same sequence by change some activity different that we call noise.

In our algorithm, we select the Root Mean Square Error (RMSE) for compared the difference of these 2 data. The RMSE has been used for judging the performance prediction model. We applied this measurement quality by applying the prediction value as in consideration activity and the actual value as based on normal activity. A sliding window was applied for estimate the difference between same and similar times to use the result obtained for analyzed normal or abnormal activity. We testing this method at the size of windows = 5. A window in sliding windows collects 1 matrix every 1 hour. We observe threshold =4 can separate abnormal activity.

†1 saowaneercss@gmail.com, Prince of Songkla University
†2 kom@coe.psu.ac.th, Prince of Songkla University

2. Related Work

The beginning of many research for discovering abnormal of activities in daily life is extracting a pattern of activities of humans. Several work applied the learning method, such as Neural Network, Data mining or Hidden Markov model for recognition normal pattern. Those model based on time point or duration time between activity

P. Rashidi and D. J. Cook [7] proposed mining method for discovering patterns of activities. This method can discover both discontinuous activity and varied-order patterns and they used hierarchal clustering for pattern recognition.

The pattern of activities is one part in the abnormal activities detection in of daily living. H. Jung et al. [3] developed a new abnormal detection method in a life pattern by using an alignment method when changing sequence of activities in daily life.

M. Novak et al. [8] apply Neural network Self-Organizing Maps (SOM) for anomaly detection following in three types of anomalies in human behavior. The daily pattern of user was learned and detected abnormal situations.

I. Kamihira et al. [9] collect frequency of human responding to multisensory in home. The collected data in two weeks was averaged that defined to normal activity. The comparison between sampling of the current data in 10 second and normal activity are detection abnormal activity in daily life.

Z.A. Khan and W. Sohn [10] proposed elderly cares system by recognize six abnormal activity. The method was proposed to fix two problems. First, they proposed the R-transform to solve problem when person movement from two viewpoint. Second, they used the kernel discriminant analysis (KDA) classification similarities in posture of different activities.

3. Proposed Method

3.1 Transition Matrix Model (TMM)

In the lifestyle of the elderly living in the house. Daily activities may not have a definite time. However, we think that in the nearby duration time there should be activities that are

related, such as after waking up having to cook and sitting in the living room regularly during 6-7 am. May not be the same time every day. Therefore, we try to model the data collected in terms of the relationship of each activity at each time interval. The flexibility to find the abnormal routine of the day.

A) Modeling

The sequence of event in a day was created. After that we used this sequence to create a model for processing it as a normal or abnormal activity. An activity occurring before an activity (x before y) in Allen's 13 temporal relations [6] were used in our work .We use the matrix to store these data. The matrix can have the convert relation of x before y (y after x) at the same time. Figure I. shows the Transition Matrix Model. The x-y axis is the activity of all 12 activities derived from our previous work [5]. When the activity occurs for example walking in kitchen after that cooking, we will define walking in kitchen in x and cooking in y. In modeling, we will count the activity at that time added count in position (2,1) because 1 in x dimension is walking in kitchen and 2 in y dimension is cooking show in Figure I

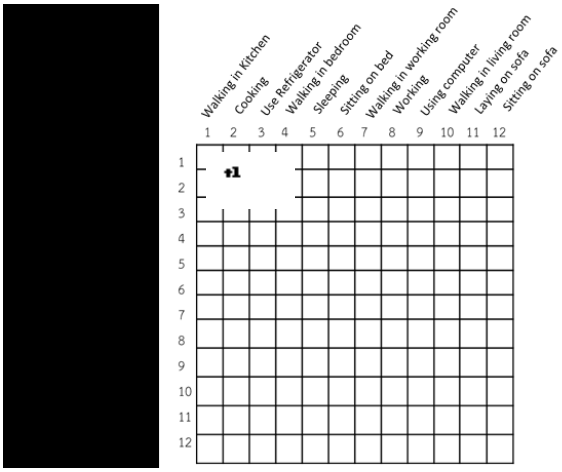


Fig. I. Increasing the number of activities occur in the transition matrix model.

The transition matrix model was consists every 1 hour, a total of 24 hours.

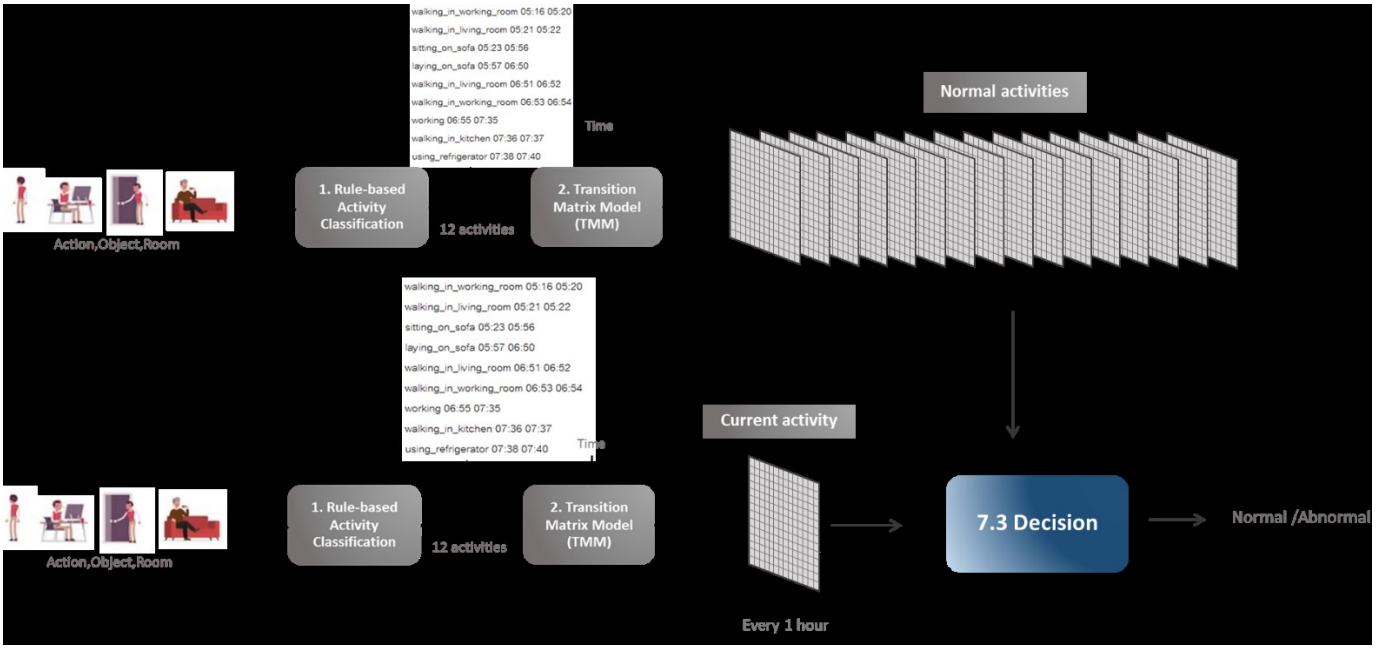


Fig. II. Research diagrams and decisions to abnormal activities.

3.2 Decision

After modeling the activity relationship in 1 day, we determined that the model without additive disturbance was a normal activity shown in Figure II. in up diagram.

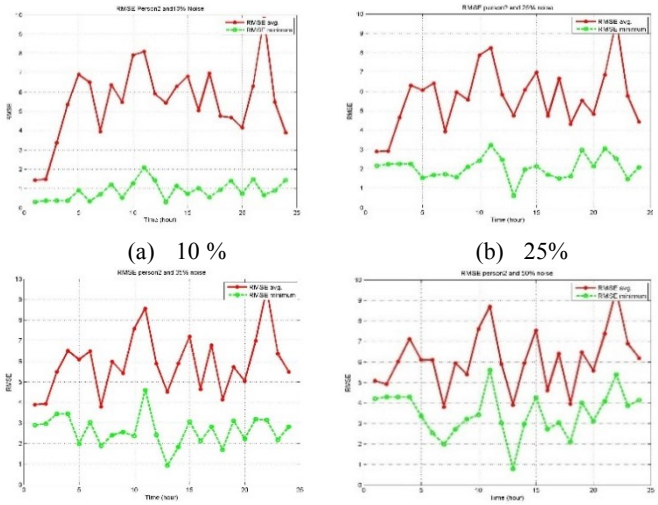
The same sequence was added noise as 10 25 35 50 percent of all activities in 1 day by random position and change that activity to new activity in the same room shown in below diagram. The noise activity was used for input data compared with normal data by using Root Mean Square Error (RMSE) and sliding Windows. We use sliding windows size=5 in this work that mean we compare 1 input matrix with 5 matrix is, 2 hour ago(t-2), 1 hour ago(t-1) this time(t) , 1 hour after(t+1), 2 hour after(t+2). The result after this process.

4. Experiment and result

In the experiment, the first step is the sequence activity was created by manual creating. The series activities consist of activities, beginning time and ending time. In this work we used only 12 activities in 4 rooms following Rule based activity classification in our previous work [5]. The series of activities in 24 hours were generated to 1 activity per 30 second. This sequence was added interrupt activities that we call noise were explained before.

We present the results of a graphical approach to provide a clearer overview of the results. The y-axis is Root Mean Square Error (RMSE) and the x-axis is 24 hour in a day. The red lines show results at minimum in 5 result (t-2, t-1, t, t+1, t+2). The

average in 5 results shows the green line. We can observed when little disturbance (10% noise) red line RMSE not more than 2 and green line unstable as some hours were significantly different, as shown in Figure. III.



(a) 10 % (b) 25%

(c) 35% (d) 50%

Fig. III. Sample of experimental results in from normal data sets and the same data set with difference level of noise.

Table I. Accuracy result (T=4)

Person	Percentage of noise					Avg.(%)
	0	10	25	35	50	
1	100	100	100	91.67	54.17	89.17
2	100	100	100	95.83	58.33	90.83
3	100	100	95.8	100	79.17	95
4	100	100	100	100	62.5	92.5
5	100	100	100	100	79.17	95.8
6	100	100	100	95.83	75	94.17
7	100	100	95.8	100	50	89.17
8	100	100	100	95.83	62.5	91.67
9	100	100	100	95.83	58.33	90.83
10	100	100	100	95.83	50	89.17
Avg.(%)	100	100	99.17	97.08	62.92	91.83

After increased the disturbance activity, the RMSE value was also increased. When more disturbance activity was increased by 50%, it was found that at some intervals the RMSE was higher than 4 but some were still less than 4. This is due to disturbance unevenly at each interval. We use RMSE (min) =4 for threshold to separate normal or abnormal activity and testing in same data with hypothesis that if there is little disturbance (10, 25, 35 and 50 % of noise) the result can conclude is the normal activity. Table I. Show the accuracy result when noise only 10, 25, 35 % our method have accuracy around 100% mean .when person do not the same activities this method and this model can conclude is normal. When noise 50% the accuracy decease mean this method can conclude is abnormal.

5. Conclusions and future work

We have built a model in which we focus on the flexibility of identifying abnormal activity. Our models keep the relationship of activity at that particular time. we used a comparison using the root mean square error (RMSE) in comparing the models were set up to the normal activity and the new activity that added the noise activity percentage. In experiment and result we found the threshold=4 has been used to distinguish normal and abnormal activities and has an average accuracy value of 91.83 and for further experiments we attempted to use that 10 difference series of activity or real dataset and apply this method to technologies for assistance elderly.

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