

# Proposed and Implementation Video Activity Detection and Warning System for Attention Deficit Hyperactivity Disorder Patients in a Classroom

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## Abstract

An ADHD patient joining into a class is a big challenge for teachers. For taking care of all students, it is difficult for teachers to pay more attention to the ADHD patient. Thus, an activity detection and warning system for ADHD patient is proposed in this paper to help teachers controlling whole class. We extract discrete cosine transform coefficients in pre-coded video bitstream to measure the activity. If the activity of the ADHD patient is higher than the average activity of whole class, the proposed system will remind the teacher to take care the ADHD patient. Experimental results show that the proposed system can detect the activity of ADHD patient efficiently.

## Keywords

*Special Education; ADHD; Activity Detection; Video Technology*

## Introduction

Attention Deficit Hyperactivity Disorder (ADHD) has a triad of symptoms which are inattention, hyperactivity and impulsivity. Most ADHD patients have comorbid disorders, such as learning disabilities, oppositional defiant disorders, depressive disorders, anxiety disorders and so on. The diagnostic criteria for ADHD patients are based on American Psychiatric Association's Diagnostic and Statistical Manual-IV, Text Revision (DSM-IV-TR), which has a set of diagnostic criteria. Besides above mentioned which can affect the patients' schoolwork or social contact and present in two or more settings (e.g., school and home), the criteria have other requirements.

Loe *et al.* mentioned that a small class with 8 to 15 students can satisfy students' special needs. However, there are more than 20 students in a classroom. Since students in kindergarten and elementary school are vivacious and energetic, it is difficult for teachers to

pay full attention to each other, especially for class with the ADHD patient.

Content analysis for video technology is a popular research topic in recent years. The video content provides not only entertainment, but also much useful information. Video surveillance, one of the applications of the video content analysis, has been widely used in banks, stores, parking lots, roads, schools and so on. Most cameras in school are set up at the stairs and galleries for security, but less in the classroom. Collins *et al.* and Zhu *et al.* mentioned that currently video technology nowadays can be used to instant monitoring, tracking objects, analysis human motion, etc. Lukowicz *et al.* utilized a wearable medical computer device with automatic or manual alert. It can monitor and record pulse, blood oxygen saturation, and body temperature of high-risk patients. So far, there are many approaches to measure the physical activity, such as self-report, proxy report, activity monitor, direct observation with accelerometers, pedometers and heart rate monitoring. However, the above mentions which need to wear sensing devices on the body for several days may lead to subjects uncomfortable and indirectly influence their physical activity.

Hence, in this paper, an activity detection and warning system is proposed as considering non-contactable video technology. Our proposed method extracts and analyses video bitstream captured from the camcorder in the classroom. If the activity of an ADHD patient detected by the system is higher than the average activity of whole class, the system will send out a warning for reminding teachers to pay attention to the ADHD patient.

The rest of this paper is organized as follows. In

methods session, we introduce instruments, subjects and proposed activity measure scheme. The experimental results and discussions sessions will then be provided. Finally, the conclusion is made in this paper.

## Methods

### Instruments

Because videos record the activity of students in the classroom, the view of the video is the most important issue in this paper. The videos in this paper are captured by a consumer camera with a tripod installed in top of the platform. The view of videos should contain all students in the classroom. The captured videos will be analysed by the proposed system which measures the activity of the ADHD patient in the classroom. If the activity of an ADHD patient is higher than the average activity of whole class, the proposed system will remind teachers to pay attention to the ADHD patient. It can help teacher to take care of each student's class condition.

### Subjects

This paper is based on convenience sampling methods to look for subjects. Through consulting the teachers in elementary/primary schools in New Taipei City, Taiwan and agreement is reached from class tutors. Since the subject is under legal age, the subjects' parents have been given completely informed consent. Subjects are second year of primary school with 28 students in the class, of which a student identified as suspected ADHD by Special Education Students Diagnosis and Placement Counseling Committee in Taiwan in the class.

### Proposed Activity Measurement Scheme

Chen *et al.* and Hsu *et al.* proposed activity measurement scheme for frames in the video bitstream, and mentioned that the number of discrete cosine transform (DCT) coefficient in a frame of the video bitstream can be utilized to measure the complexity of the frame, meaning that, in a frame, macro block with more non-zero DCT coefficients is more important than others. Hence, the number of the DCT non-zero coefficients is gathered from the pre-coded video bitstream.

For widely applications in this paper, we consider the most popular video coding standard H. 264 which has been built in most of the video capture devices such like ip-cam, digital video camcorder or handset

devices, then extract DCT coefficients from the pre-coded video bitstream captured by camera. Fig. 1 shows the flow chart of the proposed method. After the video bitstream input, we set the target area manually which is the ADHD patient's position. Then, the system accumulates both of whole class without ADHD patient and ADHD patients' activity during  $t$  seconds. If the accumulation activity of the ADHD patient is greater or equal to the  $TH$ , the proposed system will warn the teacher. Finally the accumulation activity in  $t$  seconds will be dropped and the new activity will then be gathered.

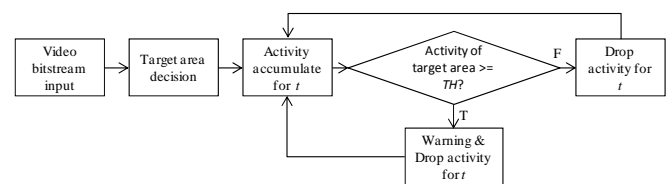


FIG. 1 FLOWCHART OF THE PROPOSED PHYSICAL DETECTION SYSTEM

Equations (1) and (2) calculate the activities. In eq. (1), the proposed system gathers number of the non-zero DCT coefficients in each frame of the target area, where  $T$  denotes the durations. Eq. (2) calculates number of the non-zero coefficient for whole class without target area. In these equations,  $T$  denotes the duration. After observing more than 33 video sequences, it is determined that the  $T$  value is 60, meaning that we consider the activity for 60 seconds. After the gathering of activity energy, eq.(3) determines the threshold value  $TH$ . In this equation,  $\delta$  is the parameter to adjust the activity since the characteristics for different classes are taken into consideration. Also in our observation, the  $\delta$  value is 1.5 in this paper.

$$Activity_{ADHD} = \sum_{t=0}^T ADHD_{ADHD\_t} \quad (1)$$

$$Activity_{Class} = \sum_{t=0}^T ADHD_{Class\_t} \quad (2)$$

$$TH = Activity_{Class} \times \delta \quad (3)$$

## Results

The experimental results are provided as follows. In this paper, we gather 33 video sequences and analyse these video sequence by the proposed activity measurement scheme. The video codec of the digital video camcorder is H. 264 with spatial resolution 1920×1080 and 30 fps.

FIG. 2 and FIG. 3 show the contour map of normal

condition and ADHD patient in high activity, respectively. The central position of the ADHD student is (4, 16). It can be observed that the proposed method can be utilized to gather the high activity area.

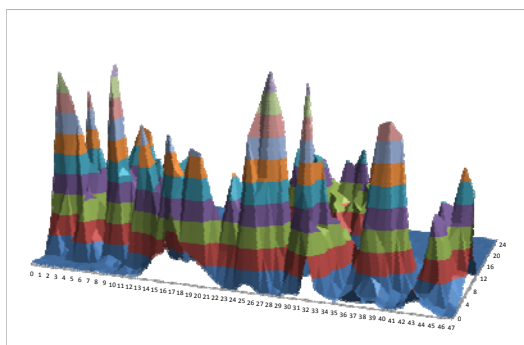


FIG. 2 CONTOUR MAP OF ACTIVITY FOR NORMAL CONDITION

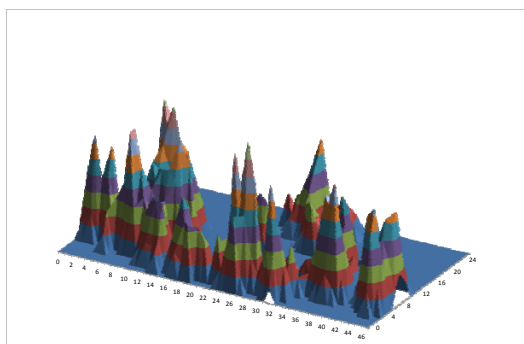


FIG. 3 CONTOUR MAP OF ACTIVITY FOR ADHD PATIENT IN HIGH ACTIVITY

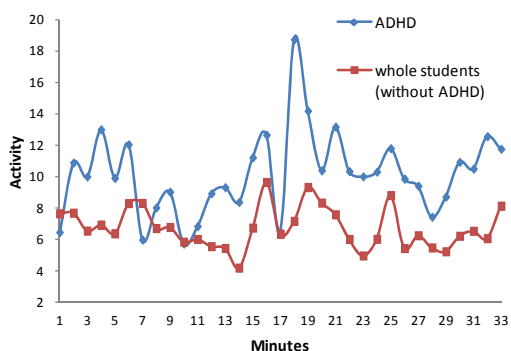


FIG. 4 ACTIVITY FOR EACH FRAME IN 60 SECONDS

FIG. 4 shows the activity curve for every 60 seconds during a class (33 mins). In this figure, it can be observed that using our proposed method activity in high accuracy can be obtained.

### Discussion

From FIG. 4, it can be observed that most of the activities of ADHD patient are higher than the average activities of whole students in a classroom, fitting that the ADHD patient is hyperactivity. This observation represents that an ADHD patient in a class is a

challenge to teachers. From FIG. 4, few points are lower than the average activity of whole students. For example, in the first minute, when teacher begins the class, the ADHD patient doesn't sit back to his seat. The proposed method detects less activity in the target area. Also in 7<sup>th</sup> minute, the activity of ADHD patient is down as the ADHD patient quietly plays with the eraser by himself.

After the ADHD patient has sat back to his own seat until the middle of second minute, the activity of ADHD patient is clearly higher than the other students. In 4<sup>th</sup> and 6<sup>th</sup> minutes, the ADHD patient pays attention to his belongings but not attends to the course, and the activity of the ADHD patient is greater than the average of the other students. The ADHD patient leaves the seat to talk to the classmate in 6<sup>th</sup> minute, thus, the activity is higher than *TH*. However, since the teacher is too busy on other students to take care the ADHD patient, she can't prevent the ADHD patient playing and talking. The proposed system in this time can help her to shift the attention to avoid ADHD patient's active.

After 16 minute, the teacher makes up a class activity, which makes ADHD patient exciting. Nevertheless, in 17<sup>th</sup> minutes, the ADHD patient left to the target area, and the activity of ADHD patient was down.

There is an acute change in 18<sup>th</sup> minutes to 18.7 by observing FIG. 4. It is because someone infuriating the ADHD patient to slap the desk. In the 32<sup>th</sup> minute, the ADHD patient plays with the classmate's bag of kettle and sometimes lies on the desk with squat posture. Later, the classmate's bag of kettle is broken by the ADHD patient. These situations make the activity of the ADHD become higher. It can be obtained that the proposed method can gather the activity effectively.

On the other hand, we further observe from 15<sup>th</sup> to 19<sup>th</sup> and 30<sup>th</sup> to 32<sup>th</sup> minute from FIG. 4. The activity of ADHD is rising up. Reference to the action happening in 18<sup>th</sup> and 32<sup>th</sup> minute mentioned above, it can be seen as a scenario. It can be determined that if the activity of ADHD patient is higher than average of whole student during 2 or 3 minutes, the teacher should be warned to pay more attention to the ADHD patient. Therefore, teachers can efficiently control all students' learning by the proposed system.

### Conclusions

The activity detection and warning system is proposed in this paper that can analyse the activity of all students in the classroom including ADHD patients,

by means of the DCT coefficient in pre-coded H. 264 video bitstream to measure the activity. If the activity of an ADHD patient is higher than the average activity of the whole class, the proposed system will warn the teacher to pay attention to the ADHD patient. Experimental results show that the proposed activity detection and warning system can measure the activity of ADHD patient by non-contactable video technology.

#### ACKNOWLEDGMENT

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