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KARATE WITH CONSTRUCTIVE LEARNING

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Abstract

Any conventional learning process involves the traditional hierarchy of garnering of information and then recall gathered information. Constructive learning is an important research area having wide impact on teaching methods in education, learning theories, and plays a major role in many education reform movements. It is observed that constructive learning advocates the interconnection between emotions and learning. Human teachers identify the emotions of students with varying degrees of accuracy and can improve the learning rate of the students by motivating them. In learning with computers, computers also should be given the capability to recognize emotions so as to optimize the learning process. Image Processing is a very popular tool used in the process of establishing the theory of Constructive Learning. In this paper we use the Optical Flow computation in image sequences to analyze the accuracy of the moves of a karate player. We have used the Lucas-Kanade method for computing the optical flow in image sequences. A database consisting of optical flow images by a group of persons learning karate is formed and the learning rates are analyzed in order to main constructive learning. The contours of flow images are compared with the standard images and the error graphs are plotted. Analysis of the emotion of the amateur karate player is made by observing the error plots.

Keywords:
Constructive Learning, Karate, Optical Flow, Open CV

1. INTRODUCTION

In today's advanced society, robots have become an integral part of life of a person's life. They are being used in many areas such as household, markets, schools etc. With the help of robots, a person's work has become extremely reliable and fast with minimum labor requirements. In spite of advantages that come with using robots, it is extremely important to observe and understand the effect of human-robot interaction on the brain. Robots which can interact efficiently with humans will be a big boost in the day to day activities of the mankind. In particular, in the case of teaching the ability of a machine to interact with humans becomes very important. The robot in this case has to maintain a healthy learning rate which is possible only if the robot can interact and can understand the affective emotional states of the students.

The learning rate of a person is dependent on the interplay between Emotions and learning which are interdependent of each other [1]. Learning is acquiring knowledge and skills which requires thinking while emotions impact on how we process information, finally influencing the learning process.

Fear, anger, sadness and joy are some of the commonly observed emotions. Fig.1 shows the transitions between different emotions representing the emotion transition of a person from positive emotion to negative emotion. Human body is the primary channel for interpersonal communication which conveys information related to interpersonal attitudes and emotions. Generally, teachers give more importance to conveying information and facts rather than to the learning process and its modeling. Due to this, when students don't get the desired results, they take it for granted that they are not good at that task/subject. It is the responsibility of the teachers to make the students realize that failure is also a part of the learning process and to recognize their emotional states and take action which impacts their learning positively [2]. For all this to happen accurately, it is quite essential that we use computers to do the recognizing and processing of emotions.

In intelligent and affective computing, computers are required to recognize and also express emotions to humans. In this process of computer based learning, the learner's emotions are to be identified and accordingly necessary action is to be taken by the computer to optimize the learning process of the learner. In the past, many image processing techniques were used to analyze the interplay between emotions and learning. Generally, face of a person plays a very important role in perception of his emotions. Facial expressions are the source for conveying emotions in face to face interactions. Many methods like facial feature points tracking [3], observing the subjects upper body and eyes [2] were used for the measurement and perception of emotions. By analyzing the emotions, conclusions about the state of mind of the learner can be drawn which can be used to optimize the learning process.

	Negative ←		0	→ Positive
Anxiety-Confidence	Anxiety	Worry	Hopeful	Confident
Boredom-Fascination	Boredom	indifference	Interest	Curiosity
Frustration-Euphoria	Frustration	Confusion	Insight	Enlightement
Dispirited to Encouraged	Dispirited	Dissatisfied	Satisfied	Thrilled

Fig.1. Indicating the transitions between emotions

Since emotions play a very important role in the learning process, it is very important to recognize these emotions with high a very high degree of accuracy which can be done with the help of computers. In the process of learning, the computer recognizes the emotions of the learner and accordingly the learning rate can be optimized. Image processing is widely used to analyze constructive learning [1] and also in interconnecting the emotions of a person and the process of learning.

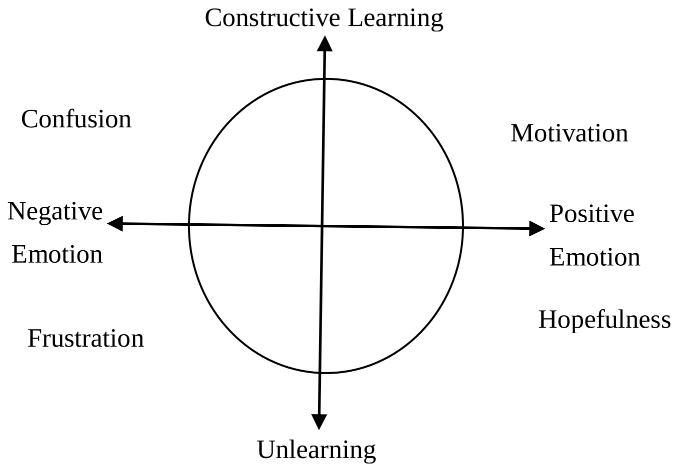

Fig.2. Indicating the relationship between emotions and learning

In this paper, we analyze the accuracy of the moves of a karate player and also the emotional changes he undergoes during the learning process using Lucas-Kanade based optical flow computation. The paper uses the optical flow computation method in imaging to establish the theory of constructive learning. Optical Flow is defined as the way in which one part of an image in a video sequence moves with respect to the other parts during the course of that video sequence. Optical flow is very much useful in tracking and detection of objects, robot navigation etc. In this paper, we use existing OpenCV codes to determine the optical flow images of a group of persons learning karate. The process of estimation of motion in image data sequences is a very important tool in computer vision and hence optical flow has a very important role to play in the area of computer vision. In this paper we have used the Lucas-Kanade method to compute the optical flow in image data sequences.

This paper is divided into the following sections: the next section describes about Constructive Learning whereas Section 3 describes the algorithm used to compute optical flow. Section 4 explains the results and Section 5 concludes the paper. The last section mentions some potential applications of the field.

2. CONSTRUCTIVE LEARNING

The emotions involved in any learning process needs to be studied very thoroughly. Many basic emotions have been proposed in previous theories. Of them fear, anger, sadness and joy are the most common emotions studied previously. Eight basic emotions: fear, anger, sorrow, joy, disgust, acceptance, anticipation, and surprise were described by Plutchik [6]. Ekman [7] has studied a few forms of emotions related to facial expressions. However, none of the proposed theories have managed to address emotions commonly seen in learning experiences, some of which have been noted in Fig.1.

Fig.2 indicates the relation of cognitive dynamics of learning process and emotion axes of Fig.1 [2]. To the right side of the horizontal axis are the positive emotions, whereas the negative emotions are to the left side. The vertical axis above the horizontal axis represents the constructive learning axis while the one below the horizontal axis represents unconstructive learning. To represent the learning process pictorially it is represented as an addition or removal of knowledge. In the beginning, the person under consideration, in this case, the karate player, will be very inspired and motivated to learn his moves with accuracy and hence his state of mind will be in the first quadrant. Obviously the person will find it tough to learn the moves with accuracy in the initial attempts. As he keeps trying, after some time, he will start finding it easier. Now, if the attempts of the player are not sufficient enough to improve the error occurring in his moves, the player becomes frustrated, but still he/she attempts to play well and learn. In this case the learning is constructive but the emotion is negative because of which the player enters into the second quadrant of learning cycle. Depending upon the future attempts of the player, the learning rate of the player may fall into the third quadrant or may shift back into the first quadrant motivated from the fourth quadrant. If the player is still not able to improve his error, he/she moves into the third quadrant due to depression (negative emotion) and unconstructive learning as in this state the person doesn't add anything to his knowledge. On the other hand, if the player is able to improve the error, the quadrant is shifted back to the first quadrant. Further decrement in the learning rate will lead the person to the fourth quadrant which motivates the person to start again.

Optical Flow Contours	**Average Value of Error**	**Average Values of Cross Correlations**
Contour-1	1.5671e+004	7.5088e+005
Contour-2	4.6653e+003	8.0459e+005
Contour-3	2.0592e+003	8.6318e+005
Contour-4	1.9155e+003	1.0675e+006

Fig.3. Average Error and Cross Correlation values for Optical Flow contour

3. ALGORITHM

The Lucas-Kanade method [5] is a very common and widely used technique for computing the optical flow in images sequences. It works under the assumption of the variation of the flow being very less in a local neighborhood [4] of a particular pixel of an image under consideration and solves the basic optical flow eqs. for all the pixels falling under that assumed neighborhood. That is, in all optical flow computations, it is assumed that in a particular neighborhood, the flow vector does not vary much and can be assumed constant.sss

Let us consider a point '*k*' in the image. Within the neighborhood (here, neighborhood means local neighborhood) of the point '*k*' it is assumed that the displacement of the image contents between two frames close to each other is small and doesn't vary much within that particular neighborhood of point '*k*' under consideration. With this statement holding it can be assumed that basic optical flow equation [5] holds for all pixels within a window centered around the point '*k*' we assumed.

Hence with all these assumptions holding the local image flow vector, that is, the velocity vector (V_x, V_y) will have to satisfy [4] the following set of equations,

$$\begin{aligned} I_x(u_1)V_x + I_y(u_1)V_y &= -I_t(u_1) \\ I_x(u_2)V_x + I_y(u_2)V_y &= -I_t(u_2) \\ I_x(u_3)V_x + I_y(u_3)V_y &= -I_t(u_3) \\ &. \\ &. \\ &. \\ I_x(u_n)V_x + I_y(u_n)V_y &= -I_t(u_n) \end{aligned} \tag{1}$$

Here, u_1, u_2, u_3,…… u_n represent the pixels situated within the window centered around the assumed point 'k'. The terms $I_x(u_i)$, $I_y(u_i)$, $I_t(u_i)$ represent the partial derivatives of the image I with respect to position x, y and time t .These partial derivatives are evaluated at each pixel u_i present in the assumed window. These equations can now be written in the matrix form, $Sv = p$ where,

$$S = \begin{bmatrix} I_x(u_1)\ I_y(u_1) \\ I_x(u_2)\ I_y(u_2) \\ . \quad . \\ . \quad . \\ . \quad . \\ . \quad . \end{bmatrix} \quad v = \begin{bmatrix} V_x \\ V_y \end{bmatrix} \quad p = \begin{bmatrix} -I_t(u_1) \\ -I_t(u_2) \\ . \\ . \\ . \\ -I_t(u_n) \end{bmatrix}$$

The system of equations that we have arrived upon has more equations than unknowns and hence this system is over-determined. The Lucas-Kanade method solves this deficiency by using the method of least squares.

By this method: From the matrix equation,

$$Sv = p \tag{2}$$

Now, pre-multiplying on both sides by S^T, we get,

$$S^TSv = S^Tb \tag{3}$$

From this, we get,

$$v = (S^TS)^{-1}S^Tb \tag{4}$$

Converting Eq.(4) into the matrix form, we get,

$$\begin{bmatrix} V_x \\ V_y \end{bmatrix} = \begin{pmatrix} \sum_{i=1}^{n} I_x(u_i)^2 & \sum_{i=1}^{n} I_x(u_i)I_y(u_i) \\ \sum_{i=1}^{n} I_x(u_i)I_y(u_i) & \sum_{i=1}^{n} I_y(u_i)^2 \end{pmatrix}^{-1} \begin{bmatrix} -\sum_{i=1}^{n} I_x(u_i)I_t(u_i) \\ -\sum_{i=1}^{n} I_y(u_i)I_t(u_i) \end{bmatrix}$$

The matrix S^TS is commonly called the structure tensor of image under consideration at the point 'k' we assumed in the beginning. The problem with the least squares method is that it pays same attention to all the n pixels; u_i, i = 1 to n .This results in the optical flow information gradually diminishing as we move away from the edges. This method is quite strong and robust to noise.

4. RESULTS

The aim is of the study is to analyze the state of mind of a group of players for a continuously improving learning rate. An amateur player tries to his perform karate moves, his attempts are recorded. The database of the moves of the player is formed and the optical flow is computed using the algorithm mentioned above. All simulations were carried out on an Intel dual core 1.6 GHz machine. The results obtained from the simulations enable us to investigate the learning rates and the emotions associated with them.

Optical flow computation was computed for the amateur karate move of player and the results were recorded. Optical flow contour error and cross correlation values are recorded in the table shown in Fig.3 for the learning rate contours using the algorithm explained above. The resultant optical flow contours are used to analyze the learning rates. By comparing the flow contours, learning rates can be understood. The player in the starting is highly motivated to learn the karate moves. The state of mind of the amateur player is in the first quadrant of the learning cycle as show in Fig.2, as he is motivated to learn hence is learning will be constructive. The initial attempts of the amateur player will have large error and will be far away from perfection. We measure the error with respect to a threshold value known as the ground truth. We have taken a threshold error 'ŋ'(1.5671e+004) and flow images whose contours with errors equal to and less than this threshold have been displayed in the table. Thus, for each move/action, we measure the error with respect to the ground truth or reference value.

As the amateur karate person tries to perfectly (expected) learn the karate move and is unable to do so, he moves into the 2nd quadrant due to frustration. If his contours are persistently not good then the player feels depressed and thinks that he can't do karate moves at all because of which he will be pushed into the third quadrant. The player analyzes the ideas which do not work and starts afresh from first quadrant after moving to fourth quadrant. It is observed that during this process the error values will not decrease. With the increase in attempts of the player, the error will decrease as the accuracy of the player towards performing karate moves increases. The learning rate of the player improves which leads to the decrease in error incurred by the player with the increase in his attempts. As the attempts of the player increase, the error decreases and it finally becomes minimum when the player achieves perfection. The number of times a person will traverse the cycle varies from person to person and it depends on the person's motivation levels. We further analyze the contours obtained after the performing error of the person moves below the specified threshold ŋ. The experiment is performed on three players and the average error plots obtained are shown in Fig.5.

Fig.4. Figure showing the flow vectors for a moving hand for three experiments

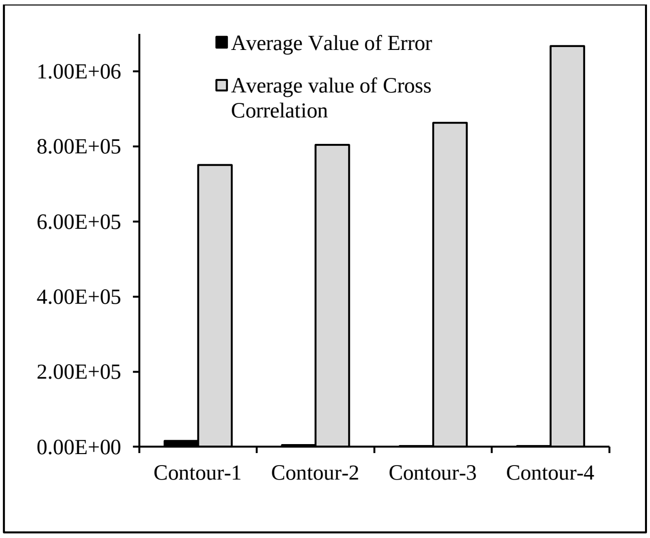

Fig.5. Table showing average error plots

5. CONCLUSION

This section presents a concise summary of the paper. This paper presents a novel approach to analyze the learning rate from the optical flow calculated in images. The paper analyses the learning rate of the karate players performing the moves. The error graphs of the players with relation to the emotion are studied which can be used to improve the learning rate of the players. Depending upon the improvement or decrement in the learning of the person the future quadrant is decided. If after the first attempt, the error of the player increases, the person gets frustrated but simultaneously attempts to learn because of which the person moves into the 2nd quadrant. Now in order to improve the learning rate of the person or to stop him from moving into the third quadrant, the person needs motivation or his mood has to be changed (lightened) which is highly influenced by the instructor. The instructor should analyse the emotional state of the person carefully and should try to move the person back to first quadrant because if he/she moves to the third quadrant (state of 'depression') it is highly likely that the person will move to the fourth quadrant which will lead to a fresh start of the whole process. This can position the person in a state of depression and the person may start doubting his capabilities.

This paper can be used to study and improve the learning rate of students. It is an effective methodology by which students can be helped to learn effectively in a better way which will improve their leaning rate. Excellent human teachers identify the student's emotion and take actions to impact the learning rate positively. In situations like learning with computers, computers need to have emotion identification abilities so as to assist the learner in a better way. By observing the error trends, necessary actions can be taken by the instructor so as to optimize the learning. The decrease in error indicates that the person is in 1st quadrant of learning cycle. So his emotions are positive. If the error is not decreasing with the number of attempts, it indicates the person might move into the quadrants of negative emotion. So based on the patterns of error, the quadrant the person is in can be assessed. Based on this, emotions can be recognized and the computer's can give the necessary interventions to improve the learning rate.

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