

Research Article

Ergodesk-desktop Ergonomics Using the New Quadratic Search Algorithm

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Abstract: Ergonomics is nothing but the rules governing the workplace. ErgoDesk is the ultimate drug-free way to look after your spine and health. This research provides an interesting and realistic solution towards achieving the goal maintaining good health. Physical stress at the work environment can reduce efficiency of the individuals at work. Ergonomics is described as the rules to be adapted by one, at work environment. The main focus of ergonomics is to reduce the physical stress caused by factors like improper body mechanics, repetitive motor movements, static positions, vibrations, lighting and impact or contact with objects. Henceforth, through this paper, we present a distinct tool called the “ERGODESK”, which could be useful for monitoring a computer user’s posture and activities. In this study, we present a real time feedback system for detecting people and their postures and generating summaries of postures and activities over a specified period of time. The system runs reliably on different people and under any lighting. The fundamental challenge, to detect the change in user’s posture most accurately in the least time, has been analysed and a solution in form of new Quadratic Search Algorithm has been proposed. The system captures an image of the user at regular intervals of time, carries out certain pre-processing steps and then checks for a change in user’s posture by comparing it with a reference image acquired previously in series of steps as per the New Quadratic Search algorithm. Then the user is notified about the change of his ergonomic posture.

Keywords: Ergodesk, ergonomics, physical stress, postures, quadratic search algorithm, user notification

INTRODUCTION

Ergonomics can be split into two words ‘Ergo’ and ‘nomic’. ‘Ergo’ stands for workplace and ‘Nomic’ stands for the rules governing it. In short, Ergonomics is nothing but the rules governing the workplace. ErgoDesk is the ultimate drug-free way to look after your spine and health. Ergonomics can be applied in two ways, depending on the work place. One way is to use Reactive Ergonomics where something needs to be fixed and corrective action is taken. The other option is making use of Proactive ergonomics, which is the process of seeking areas that could be improved; and fixing the issues before they become a large problem.

Health problems could also arise due to wrong or bad postures. Leaning is common form of poor posture. It causes your back to be unsupported and can encourage you to round your back and shoulders, leading to back, shoulder and neck pain. Slumping or slouching in your chair is common form of poor posture. It also results in lower back pain.

What can ergonomics do about such problems? Well, ergonomic postures not only involve maintaining the right postures, it also includes working in the right

ergonomics work environment as mentioned. Ergonomics posture recommends how to make the user sit in the right posture to restrain from any damage to his health.

The user is requested to sit up straight; his lower back should fit snugly against the backrest of the chair. The monitor should be directly in front of your body and not the keyboard. It should not be too off to the side. Fingers should be in line with the home row, they should be curved and on top of the keys. Palms slightly up off the keyboard and wrists straight. Elbows relaxed and in to side.

ErgoDesk is a real time ergonomic help for those who use computers. ErgoDesk assesses the user’s correct posture, detects the change in user’s posture and alerts the user to take breaks. It also guides the users on certain pain relieving exercises.

The problem at hand is to obtain an image of user at regular intervals and compare it with the reference image in an effective way such that the movement, if any, could be detected accurately in optimized time. The main objective of this paper is to bring ergonomics at your desktop.

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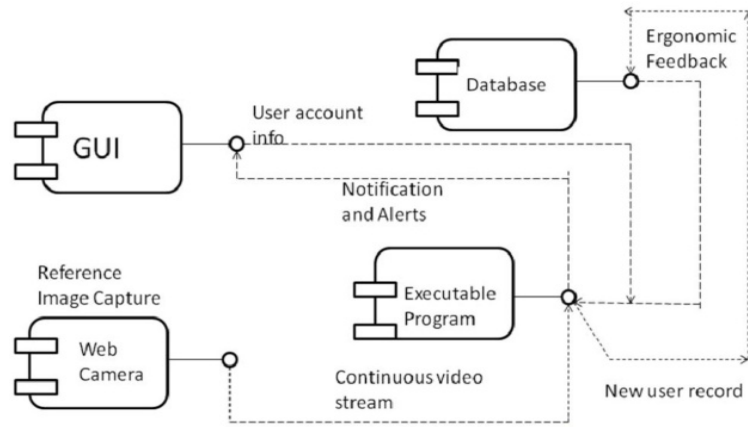


Fig. 1: ErgoDesk system architecture

MATERIALS AND METHODS

Video processing play a significant chore in several applications computer science like robot navigation, multimedia broadcasting, medical treatment, military and remote sensing. Motion estimation (Aroh, 2004; Deepak and Mohamed, 1988) is the method of seminal motion vectors for moving object transformation from one 2D Image to another, in video sequences of frame to be consider. It classified into three categorized, namely Region based, Gradient based and transformed based Approach. Block matching algorithms (CUergo, Cornell University-Ergonomics Web; Chimienti *et al.*, 2002; Zhu *et al.*, 2004) helps to find the motion vector. The dislocation between matching of candidate block within a search region to best matches with the current block in the current frame called motion vector) for each block rather each pixel and to reduce the complexity. Mean Absolute Error (MAE), Mean Squared Error (MSE) and Sum of Absolute Differences (SAD) are common measures used to find the displacement values for the best match.

The general block matching algorithms (Moshi and Hel-Or, 2009; Arora and Rajpal, 2014; Mishra *et al.*, 2014) called The Full Search (FS), New Three Step Search (NTSS), Two Dimensional Logarithmic Search (TDL), Cross Search Algorithm (CS) and Four Step Search (FSS), which is the simplest for estimation of local motion. It is simple and regular. We divided each of the frames into macro blocks. Then we compared each macro block with the other, after that we matched the macro block based on the cost function.

In this study we present a distinct tool called the "ERGODESK", which could be useful for monitoring a computer user's posture and activities and new Quadratic Search Algorithm has been proposed for detecting people and their postures and generating summaries of postures and activities over a specified period of time.

Proposed system: Figure 1 shows the system architecture of ErgoDesk.

ErgoDesk is a tool that helps in assessing the posture of a user. ErgoDesk consists of three modules called Graphical User Interface (GUI), Information Capture and Posture Assessment.

Graphical User Interface (GUI): Graphical User Interface of ErgoDesk tool has been designed with at most importance so that it is user friendly. It guides the user efficiently throughout the tool. The major tasks carried out by the GUI module are:

User account verification: The username provided by a user is made sure to be unique and it can identify the data files associated with that particular user. A new user of ErgoDesk should provide a user name and password. The information provided, is verified with details in database and authentication is provided accordingly.

Risk assessment: Postures depends on the person's current state of health, computer usage and work environment. A suitable questionnaire is provided to get details regarding the former facts. A new user of the ErgoDesk is expected to answer the questionnaire which makes the assessing process easy and comfortable. Based on the answers the user's risk level is determined to low or average or high. This risk level determines the break intervals and the degree of how strictly he/she should follow correct postures.

Ergonomic advice: Maintaining proper posture while using computers can help a user avoid a lot of problems. Thus, a new user of the ErgoDesk is expected to go through the Ergonomic advisory session. Therein, explains the correct posture to be maintained in front of the system, the distance of the head from the monitor, position of the hands on the keyboard and other necessary information.

Information capture: Information capture module provides the system with the information required for the posture assessment. ErgoDesk assumes that the

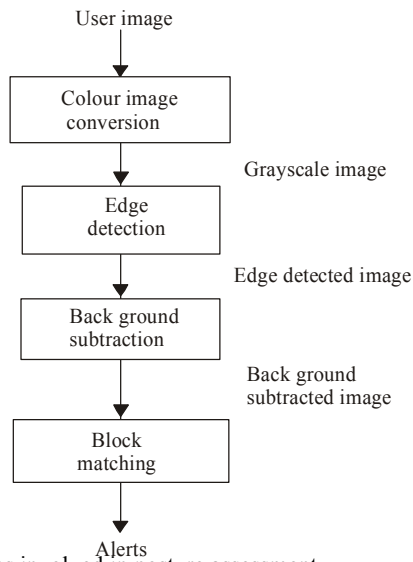


Fig. 2: Steps involved in posture assessment

user's background is stationary. A web camera, continuously will video the user, a frame from this live video stream is obtained and analysed in the posture assessment module.

Posture assessment: Posture assessment module does the actual computation. It receives an image of user's current posture as input. The correctness of the posture is checked by the proposed new quadratic search algorithm is applied certain pre-processing steps are carried out on the input image. Figure 2 shows steps involved in posture assessment module.

New quadratic search algorithm: The New Quadratic Search which performs the matching between the macro block of the reference image and the search image. The algorithm is explained as follows:
Input:

- i) Reference face Image r_i (Image captured with correct postures)
- ii) Search face image s_i , captured continuously through web camera

Algorithm:

- Step 1:** User face is extracted for both in r_i and s_i after pre processing step (edge detection followed by background subtraction)
- Step 2:** Non overlapping Macro Block (MB) is created for both r_i and s_i .
- Step 3:** MB with user area (face) are indexed, respectively I_r and I_s for both r_i and s_i .
- Step 4:** New Quadratic Search, which performs as follows:

If $Match(I_r(r_i), I_s(s_i))$ equals, then User sitting at the correct postures called *Nil Position*.
If $Match(I_r(r_i), I_s(s_i))$ moves towards right side of the system, then User sitting at the right side, called

right movement and ERGODESK is called to correct the posture.

If $Match(I_r(r_i), I_s(s_i))$ moves towards left side of the system, then User sitting at the left side, called left movement and ERGODESK is called to correct the posture.

If $Match(I_r(r_i), I_s(s_i))$ zoom from centre to all the side of the system, then User sitting closer to the monitor, called front movement and ERGODESK is called to correct the posture.

If $Match(I_r(r_i), I_s(s_i))$ shrinks towards centre, then User sitting little away from the monitor, called back movement and ERGODESK is called to correct the posture.

Step 5: If $Match(I_r(r_i), I_s(s_i))$ equals is retained more than 5 min then the ERGODESK is called and informed user to take rest.

RESULTS AND DISCUSSION

We have classified user posture into five different categories, namely Nil Position, Left Position, Right position, Front position and back position. The algorithm has been compared with the classical block matching algorithms called full search and three step search algorithm. Figure 3 to 7 illustrated the results and the Fig. 8 shows that the New Quadratic Search significantly produce better results (The type of movement along the x-axis and the number of users for whom the results were correct along y-axis).

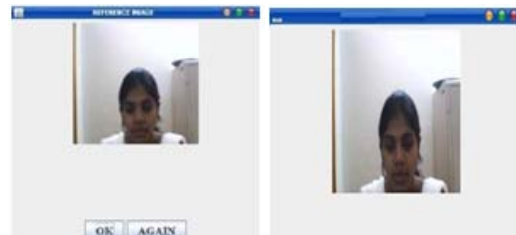


Fig. 3: Nil movement



Fig. 4: Left movement



Fig. 5: Right movement

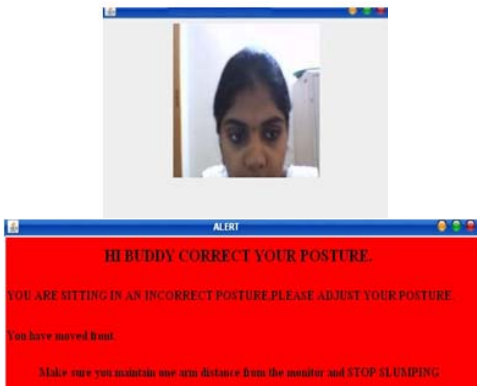


Fig. 6: Front movement



Fig. 7: Back movement

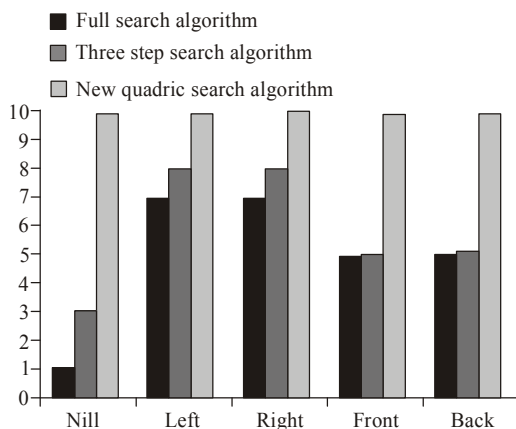


Fig. 8: Comparative analysis of the new quadratic search with classical block matching algorithms

CONCLUSION

In this study The New Quadratic Search Algorithms for Desktop Ergonomics has been successfully implemented and a tool ErgoDesk has been developed to continuously assess the posture of the user. The tool helps to provide a solution to the health problems caused by over usage of computers. This algorithm has seemed to work very efficiently when compared to the other existing Block Matching Algorithms. The efficiency of the tool lies in the hands of the end user. Care has been taken to provide a user friendly tool so that the user gets user friendly feedbacks about his posture. In this study we focused face image based analysis and it can be enhanced head movement, shoulder movement hand movement in the future.

ACKNOWLEDGMENT

We thank Amrita University and department of computer science engineering for providing us continuous support and infrastructure to get this project done.

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