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Technical faculty "Mihajlo Pupin"
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AIIT

International Conference

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Serbia, Zrenjanin, October 25, 2013

**UNIVERSITY OF NOVI SAD**
**TECHNICAL FACULTY "MIHAJLO PUPIN"**
**ZRENJANIN, REPUBLIC OF SERBIA**

# International Conference

# International Conference on Applied Internet and Information Technologies ICAIIT 2013

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# INTRODUCTION

Information Technologies and Internet as a part of Computer science creates new approaches and perspectives, new models and numerous services, which opens up and makes use of the world of information and symbolized knowledge. Advances in Information technology, including the Internet, have dramatically changed the way we collect and use public, business and personal information.

The 2nd **International Conference on Applied Internet and Information Technologies** is an international refereed conference dedicated to the advancement of the theory and practical implementation of both knowledge of Information Technologies and Internet and knowledge of the special area of their application.

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The key Conference topic covers a broad range of different related issues from a technical and methodological point of view, and deals with the analysis, the design and realization of information systems as well as their adjustment to the respective operating conditions. This includes software, its creation and applications, organizational structures and hardware, different system security aspects to protocol and application specific problems. The Conference Topics are:

1. Information systems
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9. ICT Support for decision-making
10. Management in IT
11. E-commerce
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**President of the Organizing Committee**
**Ph.D Borislav Odadžić**

Zrenjanin, October 2013

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# CONTENT:

# Controlling Computer Games through Web Camera with Motion Detection

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**Abstract - The paper describes an implementation of interface for playing chess game realized through motion detection and object tracking. User hand movements are recorded with a web camera and used to move chess pieces in a given board position. We are primarily concerned with the perception and identification of user movements compared to the chess playing strategies and the game logic. The interpretation of the chessboard position and the computer next moves are performed using standard chess engine. This work contributes to the development of more natural interfaces that enable communication via user motions and gestures instead of standard computer devices.**

## I. INTRODUCTION

Over the last decade games controlled by user motions instead of standard input computer devices like keyboard or mouse became more popular. Most of the techniques for motion detection, speech and gesture recognition become affordable to general market and enabled introduction of new modern techniques of human-computer interaction. These natural interfaces that enable communication via speech and gestures additionally require fast video-processing algorithms and affordable PC cameras [1].

Since 1999, when the first motion controlled game Play Me2Cam has been developed by Intel and Mattel [2], several new devices have been released, such as EyeToy camera for PlayStation [3], and game controllers Microsoft Xbox 360 Kinect, Sony PlayStation Move and Nintendo Wii Remote Plus.

Many studies describe methodologies for novel user interfaces, such as perceptual user interfaces [4], camera-based computer games [5], face tracking [6], camera tracking and hand held controller [7] or camera tracking and voice commands [8] and technologies for human motion detection [9].

Hämäläinen [8] describes a system "video mirror" for getting feedback during training martial arts where user can see his movements from different sides. Moeslund, and Granum in [9] present a survey of computer vision techniques for capturing human motion. Freeman et al. [10] propose several algorithms and create applications based on the proposed motion detection and control. Their methods use orientation histograms and optical flow analysis.

This paper describes an interface for playing chess that uses web camera to detect user movements. Interest in chess playing machines started to grow when Deep Blue computer beat Gary Casparov in 1997 [11]. Majority of the existing chess playing machines use modified chessboard to simplify the recognition of the chess pieces and use fixed boards. For example, Revelation II chess computer system developed by Digital Game Technology and Phoenix Chess Systems uses sensory chessboard that recognizes pieces and movements [12]. Chess playing robot arms shown at the Maker Faire also use instrumented chess sets [13]. Novag 2 Robot Chess Computer uses special instrumented board and special chess pieces [14]. On the other side, there are systems, like robotic arm Gambit which can play with arbitrary chess sets and boards [15]. Gambit is an integrated system able to handle different kinds of chess pieces, to detect user actions, to perceive the chessboard and to play the game.

Two aspects have to be considered for a successful design of chess game controlled by detected user movements:

- Perceiving the environment with chessboard and chess pieces and recognizing user moves,
- Interpreting the state of the game and computing the next step.

This work is not concerned with chess playing strategies and game logic. We use standard chess algorithm to generate moves based on a given state positions. The next move is obtained by querying a standard chess engine. In motion controlled interface the system moves the piece based on user actions in front of the camera. The game has a predetermined set of actions that are appropriate in a particular position. So motion detector is used to classify the user's actions.

The aim of this work is to solve the problem of perception and identification of user movements. Location of the chessboard and position of the changes in successive images are determined using processing techniques, such as line detection and edge detection [16]. Standard libraries from Adobe Flash Platform are used for implementation of the image processing techniques [17][18].

Next section describes the methodology used for perception and recognition of user hand movements. Then we present the steps for implementation of the chess video game following the chess rules and minimax algorithm. Paper ends with a brief discussion and conclusions.

## I. MOTION DETECTION

The trivial way to detect motion is to compare two consecutive images representing the same situation taken in short time interval. The motion detector compares the two consecutive images and if differences are noticed, it gets to a pixel-to-pixel comparison of the images. Consecutively, images are classified in two categories: changed and unchanged. This comparison method is vulnerable to noise since even small changes or differences in illumination are considered as motion. To ignore the insignificant changes we used threshold value [18]. The detection of movement is based on the assumption that the moving objects have different color from their surroundings.

The threshold function in pseudocode is as follows:

```
if ((pixelValue & mask) operation (threshold & mask))
then set pixel to color
else  if (copySource) then set pixel to corresponding pixel
value from sourceBitmap
```

As previously mentioned our application uses several classes from Adobe Flash Professional CS6, such as ColorMatrix, MotionDetection and MotionTracker. The system allows motion tracking of moving elements and extracting information about their position, rotation and scaling. The tracking point is represented with a little circle as Fig. 1 shows.

Function track from MotionTracker class is used to compare the old and new image. Function getColorBoundsRect determines whether a rectangular region fully encloses all pixels of a specified color within the bitmap image. It is used to set the coordinates of the tracking circle.

In order to develop a motion controlled interface the system has to recognize the user movement in front of the camera and to move the appropriate piece based on that movement. The program has a predetermined set of actions that the player can perform and hence the motion detector is used to classify these actions. The system follows the user's movements: if the user raises his hand the piece is moved up, if the user hand is moved to the left the piece is moved to the left, etc.

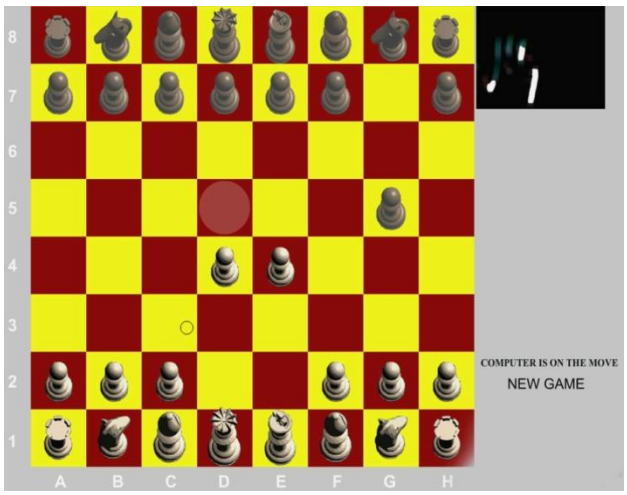


Figure 1. Moving pawn from field D2 to D4

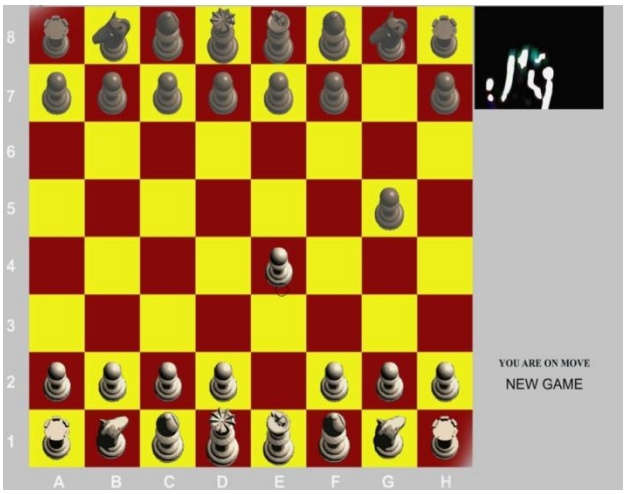


Figure 2. Computer response to user move

This video game is available at the following link http://www.robotsonline.info/chess.html.

Fig.2 shows a computer response to user's action that moves a pawn from E2 to E4. The upper right corner represents the user's hand movements that are used to control the game. The threshold function tests the pixel values against a specified threshold value and sets pixels that pass the test to new color values. This function is used to isolate color ranges in the image.

### *A. Connection between chess video game and motion detection module*

The chess playing game with motion detection is realized with two separate ShockWave Flash files which communicate using the LocalConnection class of the Adobe Flash Platform. The object of LocalConnection class invokes methods in another object of the same class.

The communication can be performed within a single SWF file, between multiple SWF files, between content (SWF-based or HTML-based) in AIR applications and between content (SWF-based or HTML-based) in an AIR application and SWF content running in a browser.

ShockWave Flash file intended for motion detection can send commands to ShockWave Flash file that implements chess video game. For example, some of the commands send coordinates of the tracking circle.

## II. IMPLEMENTATION OF THE CHESS GAME

Chess video game is implemented using existing chess engine. Chessboard is represented as an array with 64 elements. The movements of the pieces have to follow chess rules, such as "king can move one field in each direction" or "knight can move like L".

The evaluation of the position is done based on the structure of the pawns, the occupation of the center and other factors. Usually the computer generates a move tree to a certain depth and searches for the best move. A common algorithm that is used for calculation of the best move is minimax. In this algorithm each player tries to maximize his advantage and to minimize the advantage of the opponent.

Important part of chess video game is an user interface that enables communication with the user. This work uses user's hand movements instead of interactions with the mouse or the keyboard. The next step is coding a list of valid moves that serves to control the input from the user and to calculate the best move of the computer. Also the method for checking whether the king is in a check has to be implemented as part of the chess rules.

To reduce the calculations during the search of the move tree alpha-beta algorithm is used (Fig. 3). Search depth is set to a level 2, to speed up the calculation of the next move as an important characteristic of the interactive video games. At each step of the searching the function retains the best score it has found so far. When the maximizing player is searching a node and finds a path from that node having a higher score than the minimizing player's best score, then he knows that the node from which he is currently searching is too good to be true since the minimizing player will never give him the opportunity to play the move to that node.

```
function alpha_beta_search(real_side, search_depth, alpha, beta)
{
    var max_score = - 10000000; // initialization of best score
    var __reg3 = new Array();
    var catch_piece = null;
    var score_to_move;
    var moves_to_pc;
    var i = 0;
    while (i < 8)
       {
        var __reg1 = 0;
        while (__reg1 < 8)
           {
                if ((chessBoard[i][__reg1] & 1) ==
                    side && chessBoard[i][__reg1] != VOID)
                  {
                   __reg3 = __reg3.concat(moves_to_calculate
                     (i, __reg1, side)); //concatenation of all moves
                  }
                ++__reg1;
           }
         ++i;
       }
       var i = 0;
       while (i < __reg3.length)
          {
            catch_piece = moving_this(__reg3[i], side);
            if (depth == 0)
               {
                 score_to_move = side == SIDE_COMPUTER ?
                       pc_score : player_score;          }
              else{
                   score_to_move = 0 - alpha_beta_search
                   (getOpponent(side), depth - 1, -1 * beta, -1 * alpha);
                   // recursion of  alpha_beta_search function
                   }
            unmoving_this(__reg3[i],side,catch_piece);

            if (score_to_move > max_score){
                 max_score = score_to_move; }
            if (max_score > alpha) {
                 alpha = max_score; }
            if (alpha >= beta) {
                 return alpha; }
            ++i;
          }
          return max_score;
     }
```

Figure 3. Alpha-beta searching algorithm

## III. CONCLUSIONS

This paper describes a novel approach to building interfaces for board games. In this sense the motion detection is used as a control mechanism in chess video game. The implementation of this interface does not impose any additional expenses because almost every computer has installed Flash Player and web camera. Using JavaScript the coordinates of the moving object can be transferred to any program that implements motion detection.

The implemented motion controlled interface is able to recognize user's hand movements in front of the web camera and to move the selected piece according to that movement. The predetermined set of actions that the player can perform following the chess rules enables simple classification of the performed actions and interpretations of the movements.

Standard chess engine is used to implement chess rules, to evaluate the board position during the game and to compute the next move of the computer.

This work contributes to the recent trend for creating games controlled by motion detection instead of standard computer input devices.

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