

Project: Tic Tac Toe

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ABSTRACT

Keywords:

Tic Tac Toe
Suction pump
Minimax Algorithm
OpenCV
Aruco

This project explores the integration of robotics, computer vision, and AI algorithms in the context of a Tic Tac Toe game. Colored cubes representing X and O are manipulated using a suction pump, and the game state is managed through color detection and image processing. The experiment incorporates an algorithm based on the Minimax algorithm for optimal moves. The gameplay involves human and robot interactions, where the robot calculates the best move and executes it by fetching cubes from Bin A. The real position of the cubes is determined using camera coordinates. The project serves as a practical application of diverse technologies, showcasing the potential for human-robot collaboration and innovative solutions in automation.

1. EXPERIMENTAL PROCEDURE

Game Setup:

- Color-Coded Tic Tac Toe Cubes:** In this setup, the Tic Tac Toe game employs color-coded cubes. The 'X' symbol is represented by the Blue color cube, while the Green color cube signifies the 'O'. Manipulation of these cubes is facilitated through a suction pump, and the game's evolving state is meticulously tracked using color detection mechanisms.
- Aruco Marker and Grid Definition:** To establish the playing area, Aruco markers serve as key reference points. Once the playing region is demarcated, a 3x3 grid is visually constructed on the image using the cv2.line function. This grid layout becomes instrumental in pinpointing cube positions and systematically tracking the game state.
- Cube Positioning Logic:** Determining the positions of the cubes is a crucial step. It involves assessing whether the x, y coordinates of each cube fall within the predefined range of the x, y lines drawn on the image. Periodically, these positions are updated within a 2D array sized 3x3. In this array, vacant spaces, 'X', and 'O' are systematically represented as 0, 1, and 2, respectively.

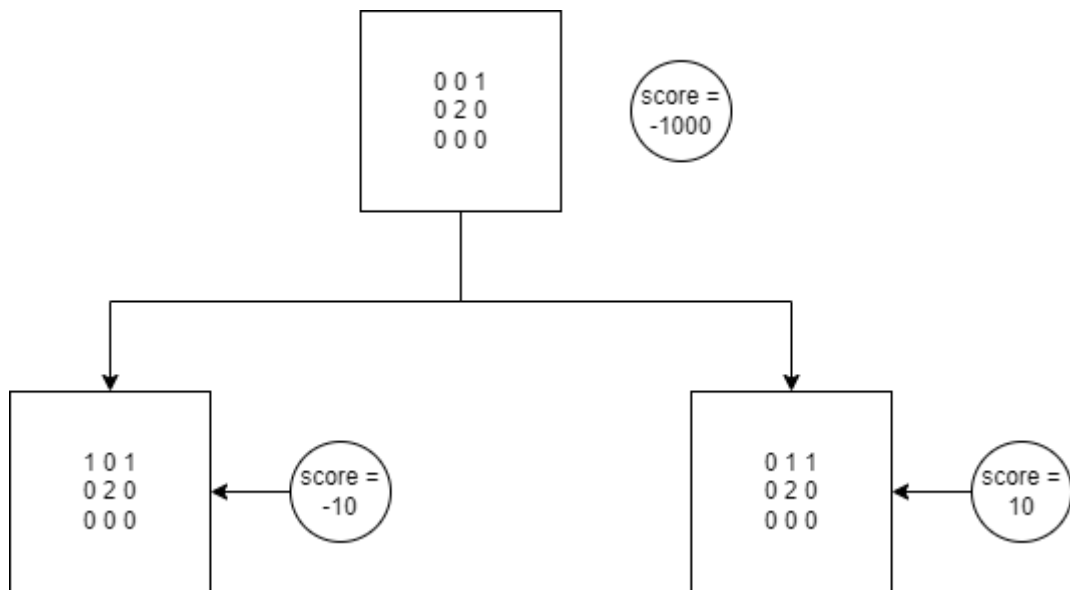
Tic Tac Toe Algorithm:

- Minimax Algorithm Implementation:** The core of the Tic Tac Toe logic lies in the utilization of the Minimax algorithm. Employing a recursive methodology and leveraging a tree structure, this algorithm strategically determines the most optimal moves. It operates by managing a 2D array that symbolizes the current state of the game board. The algorithm initiates with a best score set to -1000. Subsequently, the first encountered empty space is chosen as the player's move and undergoes a thorough evaluation.
 - Move Evaluation Criteria:** The algorithm evaluates moves by scrutinizing if adjacent values align with the player's move. Scores are dynamically updated, assigning values of +10 or -10 based on the evaluation outcome. This comprehensive approach ensures that the entire game is played out through diverse moves, systematically traversing the entire tree structure to pinpoint the most favorable move.
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function findBestMove(board):
    bestMove = NULL
    for each move in board :
        if current move is better than bestMove
            bestMove = current move
    return bestMove

```



Gameplay:

1. **Human Move Execution:** The game commences with the human player executing the initial move. Post-cube placement, a pivotal moment occurs when the "Enter" key is pressed. This action prompts the program to capture the current image, subsequently extracting and updating the ongoing game state.
2. **Algorithmic Move Calculation:** Employing the Minimax algorithm, the robotic player calculates the most strategically sound move. Subsequently, the robot swiftly navigates to Bin A, meticulously retrieving the cube that aligns with the calculated move.
3. **Cube Transfer Mechanism:** The game introduces a compelling dimension as the suction pump is activated, skillfully transferring the cube from Bin A to the designated grid within the playing area.
4. **Real Position Calculation Process:** Ensuring precision in gameplay, the real position of the grid is meticulously calculated. This involves computing the center of the camera coordinates and adjusting these coordinates based on the calculated ratio.
5. **Game Culmination and Result Output:** The program seamlessly progresses towards its conclusion when a definitive winner is declared or, alternatively, when the game culminates in a draw. The final outcome of the game is systematically conveyed and printed in the terminal, providing a conclusive summary of the interactive gaming experience.

This comprehensive experimental procedure meticulously details the intricate setup, algorithmic underpinnings, and dynamic gameplay involved in the Tic Tac Toe project. The fusion of color detection, image processing, and robotic actions enriches the gaming experience, providing a holistic understanding of the integration of diverse technologies for an interactive and engaging outcome.

2. REFLECTIONS AND OBSERVATIONS

The Tic Tac Toe project served as a practical exploration of diverse functionalities within the OpenCV library, providing hands-on experience with image contouring, erosion, masking, and dilation. These techniques proved essential in color detection, showcasing the potential of computer vision in robot applications. The exposure to new smart functionalities demonstrated how robots, when equipped with sensors and AI models, can be transformed into versatile automated bots, revolutionizing tasks in manufacturing and warehouse management.

The project highlighted the potential applications of such technology, ranging from welding work to defect detection and palletizing in warehouses. This insight emphasizes the adaptability of robots in various workspaces, showcasing their capacity to perform complex tasks traditionally handled by humans. The interactive and fun aspects introduced in the project underscore the potential for enhancing human-robot collaboration, ultimately reducing human effort in significant workspaces.

In essence, the Tic Tac Toe project not only imparted technical skills but also instilled a broader perspective on the transformative power of robotics. It opened avenues for creative and practical applications, paving the way for innovative solutions in the evolving landscape of automation and robotics.

3. RESULT

Below is the link for the game play:

1. [Tic Tac Toe](#)