SUDOKU SOLVER

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Abstract-

It is a Sudoku game with a user-friendly GUI. Players can choose to play the Sudoku game or explore an augmented reality feature. The game and augmented reality experiences are interactive, and players can return to the main menu at any time.

Index Terms-

Introduction:-

This is a small fun game that uses ML to extract sudoku from a live camera feed and then solve it and show the solution on the camera feed as augmented reality setup, with that it has other features also like manually solving the sudoku that we can either enter from a pre taken image file or taking an image from a camera and extract the sudoku. From there on you can solve the sudoku on your own or allow the computer to solve it.

Study of Similar Projects:-

There have been a lot of python based sudoku solver available on the internet, but most of them work with a matrix entered by user and then returns the answer in the same format, its a very simple and fail proof design taking inspiration form that I have decided to extract the matrix from the image and then solve it using algorithm and then over lay the solved solutions on the original image and doing all this in real time.

Online we can find a lot of different sudoku solvers that work on various different algorithms like Backtracking, BitMask and Cross-Hatching but they all have their slight benefits but here I went for Exact cover method.

Basic Concepts/Technology Used

The Exact Cover method is a combinatorial problem-solving technique used to solve problems that involve selecting a combination of items from a set to satisfy certain constraints or conditions. It was popularized by computer scientist and mathematician Donald Knuth and is closely associated with the concept of Algorithm X. One of the most well-known problems that can be solved using the Exact Cover method is the N-Queens problem and, as mentioned earlier, Sudoku puzzles.

Using the Exact Cover method, particularly in the context of solving Sudoku puzzles, offers several advantages over other methods. Here are some of the key advantages of using the Exact Cover method:

1. Efficiency: The Exact Cover method is highly efficient and can solve Sudoku puzzles quickly, even for the most challenging ones. It's based

on efficient data structures and algorithms, making it a favorable choice for solving complex problems.

2. Deterministic: The Exact Cover method is deterministic, meaning it will always find a solution if one exists. It follows a systematic approach to explore all possible combinations without randomness or guesswork, ensuring that it finds a valid solution if it exists.

3. Guaranteed Correctness: Because the Exact Cover method is based on a well-defined mathematical problem (Exact Cover), it guarantees that the solution it finds is correct and satisfies all Sudoku rules. There's no need to validate the solution separately.

4. No Backtracking: Unlike many other Sudoku solving methods that rely on backtracking and trial-and-error, the Exact Cover method doesn't require backtracking. It efficiently explores possible solutions without the need to backtrack when encountering conflicts.

5. Generalization: The Exact Cover method is a general algorithm that can be applied to other types of problems beyond Sudoku. It's a versatile technique used in various fields, such as computer science, artificial intelligence, and operations research.

6. Optimizability: The Exact Cover problem can be formulated as an optimization problem. This means that, in addition to finding any solution, you can also find the best solution based on specific criteria (e.g., minimizing the number of filled cells in a Sudoku puzzle).

7. Parallelization: The Exact Cover problem can be parallelized, allowing it to take advantage of multi-core processors and distributed computing. This makes it suitable for high-performance computing environments.

8. Structured Approach: The Exact Cover method provides a structured and algorithmic approach to solving Sudoku puzzles. It's a well-defined

procedure that can be understood, implemented, and analyzed systematically.

9. Educational Value: Implementing the Exact Cover method for solving Sudoku puzzles can be a valuable educational exercise. It helps individuals understand combinatorial problem-solving, algorithm design, and data structures.

10. Algorithmic Challenge: Solving Sudoku using the Exact Cover method presents an interesting algorithmic challenge and is a great exercise for those interested in algorithm design and problem-solving.

Implementation And Result:

The implementation part is done and no its not completely flawless and yes it does need some ironing of errors but for now the main aim is done

My project combines the exciting worlds of augmented reality and Sudoku solving, making it an engaging and educational experience. The real-time Sudoku recognition and overlay feature adds a dynamic element, letting users witness the puzzle-solving process as it unfolds. This feature is perfect for both newcomers looking to learn Sudoku and seasoned Sudoku enthusiasts.

I've also included the option to import Sudoku puzzles from images or use a camera to capture them. This functionality is a convenient way to bring traditional puzzles into the digital world. It opens up possibilities for digitizing puzzles from newspapers, books, or handwritten notes, making it a versatile tool for puzzle lovers. You can also solve the puzzles yourself and then have the code verify your solutions, encouraging active participation and learning.

I'm aware that there's room for improvement in certain areas of the code. Software development is an iterative process, and these initial steps form a solid foundation. I'm committed to refining the code to make it more efficient, user-friendly, and reliable. This may involve optimizing algorithms, enhancing the user experience, and implementing effective error handling. I also plan to expand compatibility to various platforms

and ensure data security, making the application even more appealing and trustworthy.

I believe in creating a vibrant and supportive community around this project, and I'm dedicated to adhering to legal and ethical standards. I welcome feedback and contributions from fellow developers to help propel the project's growth. My passion for refining this project will lead to a valuable and enjoyable application for Sudoku enthusiasts and a broader audience, making Sudoku more accessible and enjoyable for all.

Future Scope

In the future, I envision expanding this project to include a broader range of puzzle-solving solutions. Sudoku is just the beginning; there's a world of puzzles out there waiting to be explored. One exciting addition I'm planning is support for solving Rubik's Cube puzzles. By incorporating computer vision and artificial intelligence techniques, I aim to create a Rubik's Cube solver that can decipher complex configurations and provide step-by-step solutions.

But it doesn't stop there. I'm also considering other puzzles like crosswords, jigsaw puzzles, and brain teasers. The goal is to provide a one-stop platform for puzzle enthusiasts, whether they enjoy logic-based challenges, spatial reasoning tasks, or word games. These additions will make the application a versatile companion for anyone looking to enhance their problem-solving skills and have fun while doing it.

As I continue to develop and refine this project, I'm excited to welcome new ideas and collaborations. Puzzle-solving is a vast field, and there are countless opportunities to explore. Together with the community, we can create a puzzle-solving hub that offers diverse experiences and encourages intellectual growth.

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Conclusion

In summary, this project combines augmented reality with Sudoku solving, making it an engaging experience for users. It offers real-time Sudoku recognition, puzzle imports, and manual solving options. While there's room for improvement in the code, it provides a strong foundation for future development.

The use of the Exact Cover method for Sudoku solving brings efficiency, determinism, and guaranteed correctness. It's an educational and efficient approach that avoids backtracking and offers optimization possibilities.

Looking ahead, I plan to expand this project to include a variety of puzzle-solving solutions, such as Rubik's Cube and more. The goal is to create a versatile platform for puzzle enthusiasts and foster a supportive community of developers and users. The future is full of exciting possibilities for intellectual exploration and fun in the world of puzzles.