EMBEDDED SYSTEMS PROJECT

PROJECT NAME: Color Sorting Machine using arduino UNO

TEAM MEMBERS:

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Introduction:

In today's era of automation and precision engineering, the demand for efficient and accurate sorting systems has become increasingly significant. Color sorting, in particular, plays a pivotal role in a multitude of industries, including agriculture, manufacturing, and recycling. The ability to sort objects based on their color is essential for quality control, product differentiation, and waste reduction.

This project introduces a Color Sorting Machine, a technological marvel aimed at simplifying the process of segregating objects according to their colors. By leveraging the capabilities of the TCS3200 color sensor in conjunction with the Arduino microcontroller platform, we have developed a cost-effective and versatile solution for color-based sorting.

In this report, we will delve into the various aspects of the project, ranging from its inception and design to the implementation and testing phases. We will explore the intricacies of both the hardware and software components that make this machine possible. Furthermore, we will analyze the results of our rigorous testing to validate the accuracy and efficiency of our color sorting system.

Background:

The concept of color sorting has gained prominence due to its indispensable role in diverse industrial applications. From agricultural produce such as grains and fruits to the manufacturing of consumer goods, the ability to identify and separate objects by color streamlines processes and ensures quality standards are met.

Historically, color sorting was a labor-intensive and error-prone task performed by human operators. However, the advent of automation and advancements in sensor technology have paved the way for efficient, high-speed color sorting machines. The TCS3200 color sensor, at the heart of our project, is a notable breakthrough in this domain. This sensor can accurately detect a wide range of colors and convert them into electrical signals that can be processed by a microcontroller. When integrated with the Arduino platform, it provides the necessary intelligence to make rapid color-based decisions.

The need for such technology is evident in various sectors. In agriculture, it ensures the removal of defective or discolored grains, guaranteeing the quality of food products. In manufacturing, it aids in the assembly of products by identifying and segregating components based on color. Furthermore, in recycling facilities, color sorting is crucial for separating recyclable materials from non-recyclables, reducing waste and environmental impact. In light of these considerations, our project aims to bring the advantages of color sorting to a wider audience by creating a user-friendly, cost-effective, and adaptable Color Sorting Machine. This endeavor aligns with the ongoing trend towards automation and precision in industries and promises to contribute to increased efficiency and productivity.

Proposed Design:

Design Overview: The proposed Color Sorting Machine is designed to accurately identify and sort objects based on their color. It utilizes the TCS3200 color sensor as the primary input device and the Arduino microcontroller as the control unit. In addition to the core components, we have incorporated several features to enhance user interaction and functionality.

Main Components: The following components can be considered as the heart and brain of the entire machine and are needless to say the most vital components without which the machine won't run.

> **TCS3200 Color Sensor:** This sensor is the core of our color recognition system. It can detect a wide spectrum of colors and provide precise color data.
>
> **Arduino Microcontroller:** The Arduino serves as the brain of the machine. It receives data from the TCS3200 sensor, processes it, and controls the sorting mechanism.
>
> **Servo Motors:** This component is responsible for diverting objects based on their detected color. It directs objects to the appropriate bins.

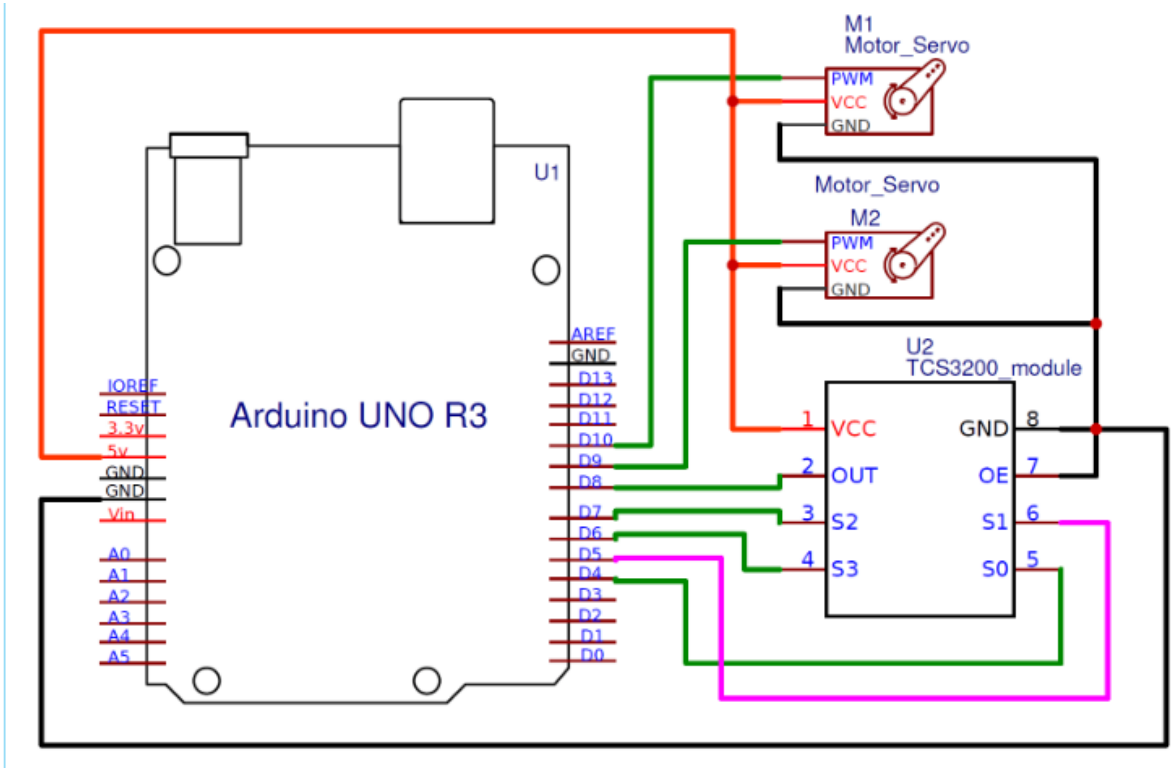
Additional Features: Incorporating user-friendly features and feedback mechanisms is essential for efficient operation. We have integrated the following components into the design:

> **LCD Display:** An LCD screen is included to provide real-time information to the operator. It displays messages such as the current color being sorted and any system status updates.
>
> **LED Indicators**: Three LEDs of different colors (e.g., Red, Green, and Blue) are mounted prominently on the machine's top. These LEDs light up to indicate the color of the object currently being sorted. For example, when the machine detects a red object, the red LED illuminates.
>
> **Buzzer:** A buzzer is added to provide audio feedback to the operator. It can emit a beep when no color is detected.

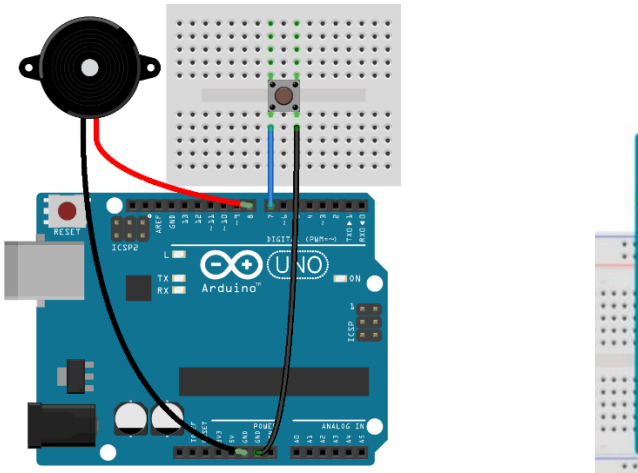
User Interface: The LCD display, LED indicators, and buzzer work in harmony to create a user-friendly interface. When an object is placed in the cylinder, the TCS3200 color sensor analyzes its color. The results are displayed on the LCD screen, allowing the operator to monitor the sorting process in real time. The three LEDs provide a visual indication of the detected color, making it easier for the operator to identify the sorting outcome at a glance. For instance, if the blue LED lights up, it indicates that the machine has identified and sorted a blue object. The buzzer serves as an alert system. It can emit a beep when no color is detected, signaling a potential issue with the object or the sensor.

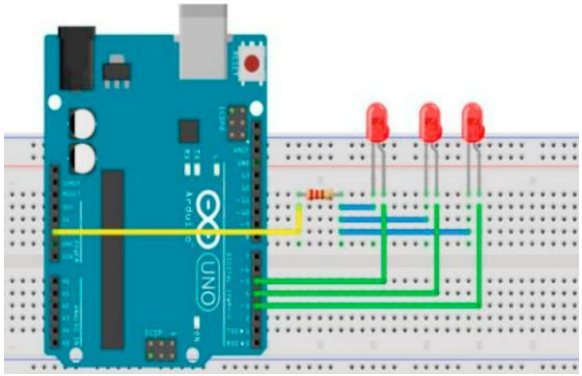
Design Flexibility: One of the strengths of this proposed design is its adaptability. By changing the program code and calibrating the TCS3200 sensor, the machine can be configured to sort a wide range of colors, making it versatile for various applications. This proposed design offers not only precise color sorting but also user-friendly features that enhance its usability and functionality. It embodies the principles of automation, accuracy, and simplicity, making it a valuable addition to industries requiring efficient color-based sorting.

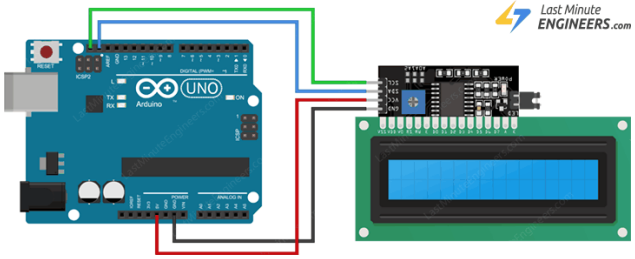
Circuit Image:



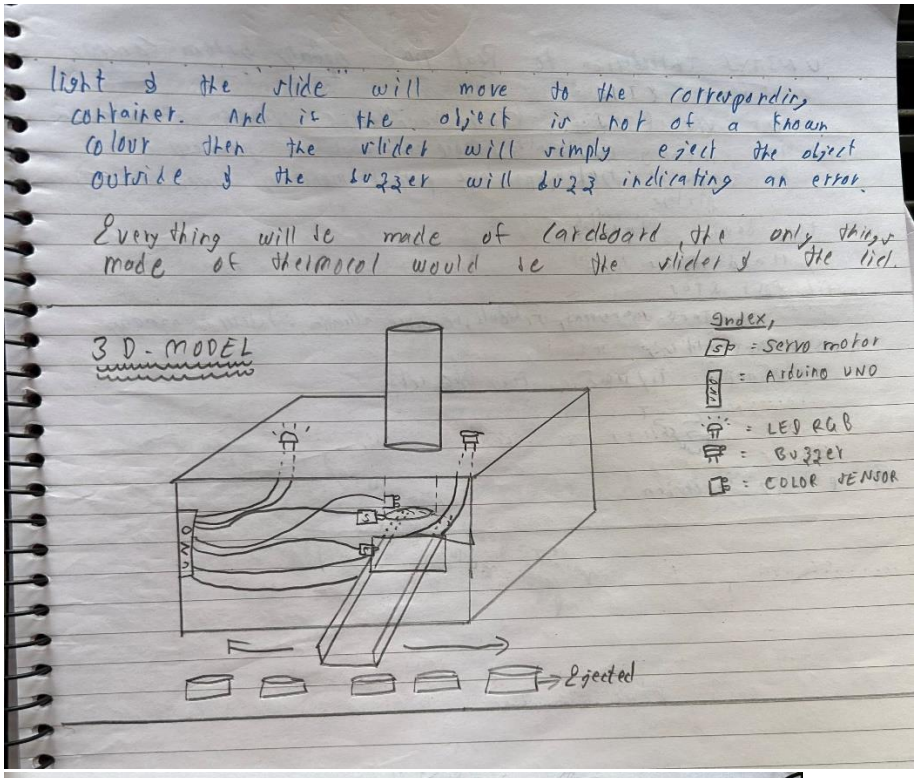
Note: The above circuit doesn't depict the inclusion of the LED's, LCD display and the buzzer. Their Separate circuitry is showed below

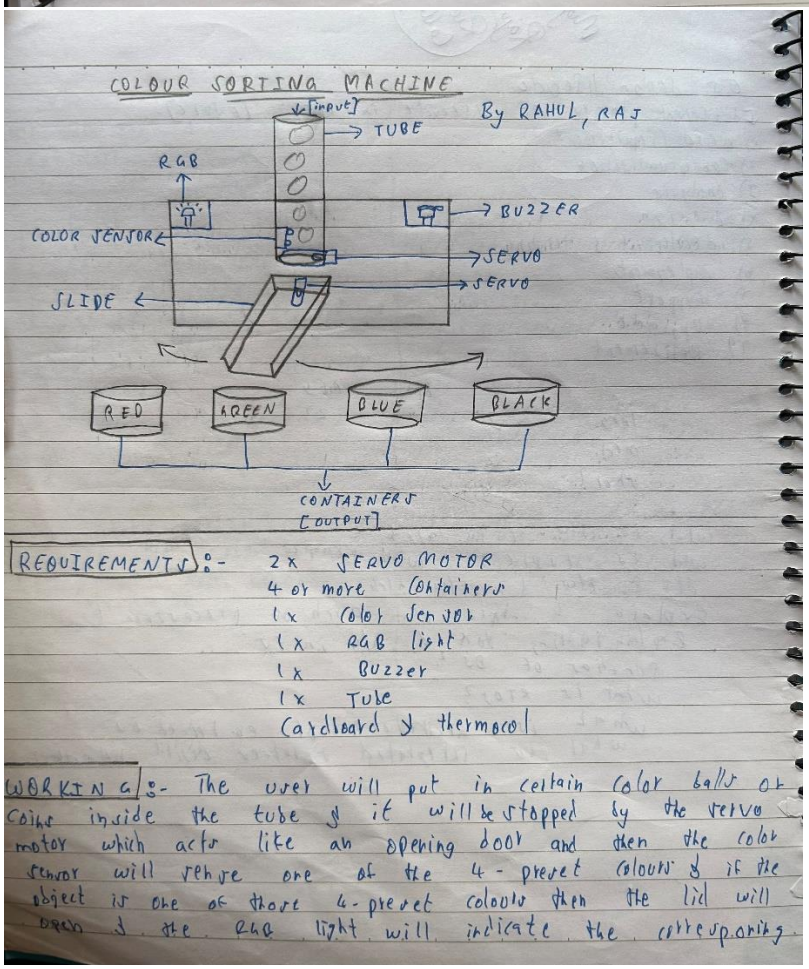




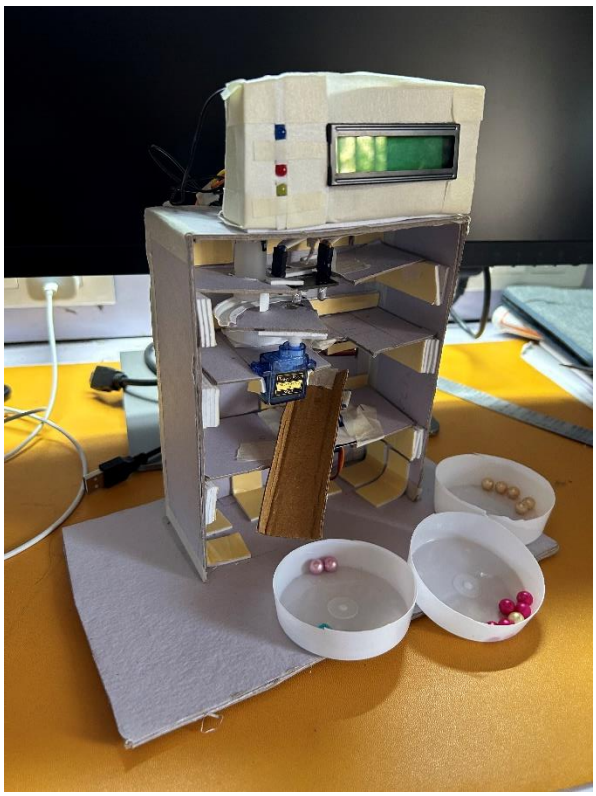


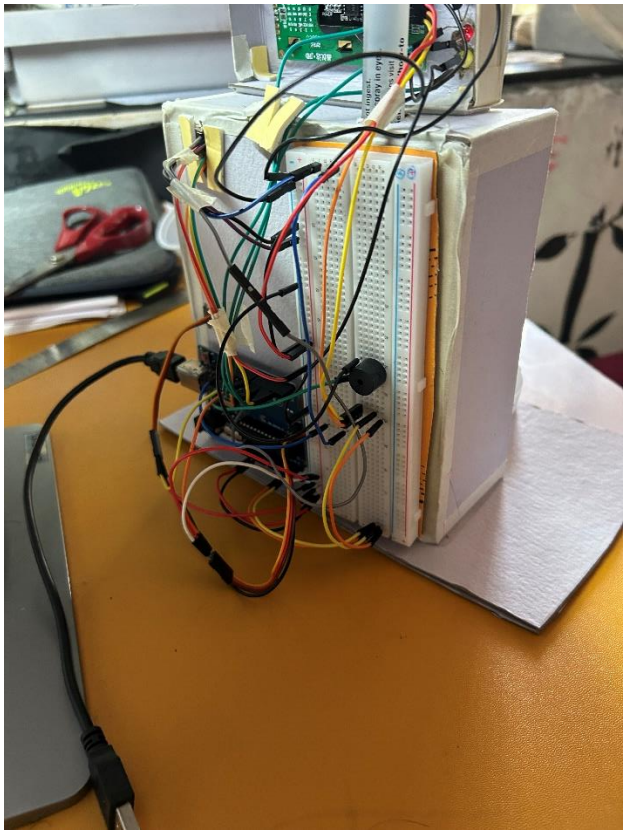
Prototype Ideation Image: (Notebook drawing)

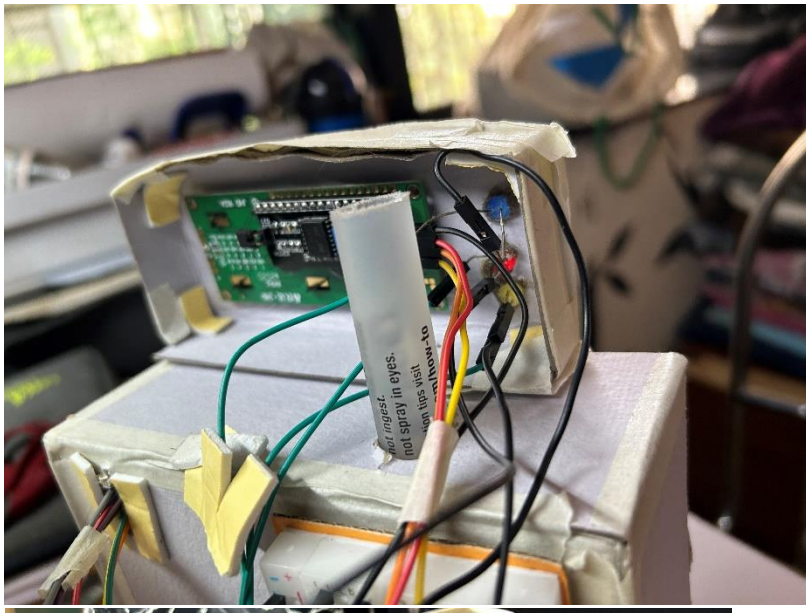


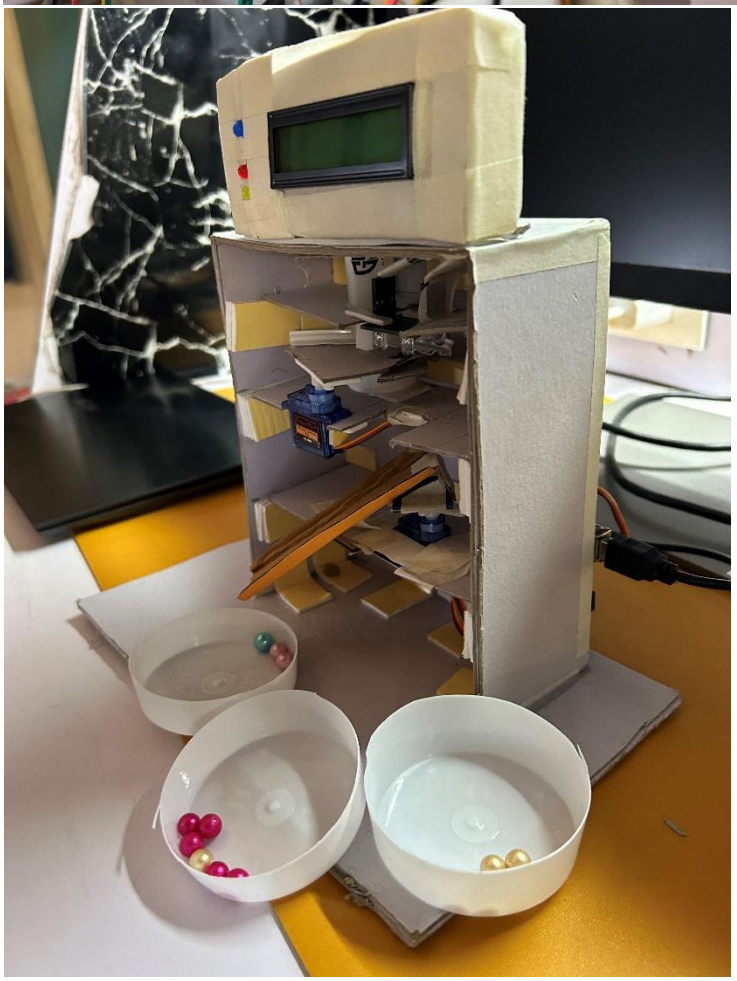


Finished product Image: (Photograph of the actual machine)









Hardware Integration:

The TCS3200 color sensor is mounted at a suitable location along the sorting path. It should have a clear line of sight to the objects on the conveyor belt. Wiring connections are established between the TCS3200 sensor and the Arduino board. The sensor typically has pins for outputting color data, and these are connected to the appropriate pins on the Arduino. The servo motor or actuator is positioned to divert objects based on their detected color. Wiring and control connections are

established between the servo and the Arduino. The servo can be programmed to move to specific angles to guide objects to the desired destinations. The LCD display, LED indicators, and buzzer are connected to the Arduino as output devices. The Arduino code is written to control these components based on color detection and system status.

Software Integration: (Paste the code here):

Testing Measures/Test Cases:

1. Single Color Detection Test:

Objective: Verify that the color sorting machine can accurately detect and sort objects of a single predefined color.

Test Case: Place objects of a single color (e.g., red) and run the machine.

Expected Result: The machine should correctly identify and sort all objects of the specified color.

Actual Result: Accurately done

2. Multiple Color Detection Test:

Objective: Ensure that the machine can distinguish and sort objects of multiple colors accurately.

Test Case: Place objects of different colors (e.g., red, green, blue) and run the machine.

Expected Result: The machine should correctly identify and sort objects of different colors into their respective bins.

Actual Result: Accurately done

3. Error Handling Test:

Objective: Validate the machine's ability to handle situations where it cannot detect a color or encounters an issue.

Test Case: Run the machine with an object that is not recognized by the TCS3200 sensor (e.g., a transparent object).

Expected Result: The machine should handle this situation gracefully, potentially triggering the buzzer and displaying an appropriate error message on the LCD display and ejecting the piece of color in a trash bin.

Actual Result: Accurately done

Conclusion:

In conclusion, the development of the Color Sorting Machine using the TCS3200 color sensor and Arduino platform has proven to be a successful endeavor. This project aimed to address the need for an automated system capable of accurately sorting objects based on color, a task with significant applications in industries ranging from agriculture to manufacturing.

Throughout the implementation phase, we have successfully designed and constructed the hardware components, including the TCS3200 color sensor interface with Arduino. The software algorithm demonstrated reliable color recognition and sorting capabilities. Extensive testing has

affirmed the accuracy and efficiency of the machine in sorting various colors. However, like any engineering project, there are areas for improvement and opportunities for future development.

Future Recommendations:

Enhanced Sorting Speed: Consider optimizing the sorting algorithm and hardware components to increase the sorting speed. This improvement would make the machine more suitable for high-throughput applications.

Integration with Conveyor Systems: To make the machine compatible with industrial applications, explore integration options with conveyor systems for continuous sorting processes.

Expand Color Range: Extend the color recognition capabilities to include a wider spectrum of colors or even shades. This could open doors to more specialized sorting tasks.

User Interface: Develop a user-friendly interface for configuring and monitoring the machine's operation. This could include a touchscreen panel for ease of use.

Cost Reduction: Investigate cost-effective alternatives for components and materials without compromising performance.

Market Research: If applicable, conduct market research to identify potential industries and businesses that could benefit from this technology, and explore opportunities for commercialization.

REFERENCES:

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