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DIGITAL TWIN AND MIXED REALITY-BASED PROCESS CONTROL FOR BOILER APPLICATION

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ABSTRACT

Mixed reality (MR) integrates virtual reality components seamlessly with human vision. Head-mounted devices feature transparent screens, offering users an unobstructed view, while employing diverse technologies to project images onto these screens. Whether for monitoring industrial operations or power plants, MR offers a more convenient means of visualizing images and data compared to traditional charts or screens. MR introduces innovative ways of engaging users by projecting information in a 3D format. As medical schools and other institutions delve deeper into MR, experts will undoubtedly uncover novel applications for this technology. In a ground breaking move for the technology sector, the MR Vision system emerges as a pivotal tool for real-time machine monitoring and tracking. Leveraging image-based output and tracking capabilities, the MR Vision system sets a new standard for efficiency and precision in machine management.

1. INTRODUCTION

Problem

Despite the potential benefits of Mixed Reality (MR) in various sectors such as industrial monitoring and medical education, there remains a need for advanced systems that effectively integrate virtual reality components with human vision. Current MR technologies offer transparent screens on head-mounted devices, but there is a lack of comprehensive solutions that seamlessly project images and data onto these screens for real-time machine monitoring and tracking. Therefore, the development of the MR Vision system aims to address this gap by leveraging image-based output and tracking capabilities to set a new standard for efficiency and precision in machine management.

Solution

To address the challenges outlined in the problem statement and abstract, the development of the MR Vision system will focus on several key components:

1. Advanced Hardware: Designing and manufacturing head-mounted devices with transparent screens that provide users with an unobstructed view, while integrating diverse technologies for projecting images and data onto these screens. This hardware will be optimized for durability, comfort, and seamless integration with MR software.

2. Cutting-edge Software: Developing MR software that utilizes innovative algorithms and techniques to project information in a 3D format, enhancing user engagement and comprehension. This software will also incorporate real-time machine monitoring and tracking capabilities, allowing users to visualize machine data overlaid onto their physical environment.

3. Machine Learning and Image Processing: Implementing machine learning algorithms for image-based output and tracking, enabling the MR Vision system to recognize and analyze machine components, anomalies, and performance metrics in real-time. This will enhance the system's efficiency and precision in machine management, facilitating proactive maintenance and optimization.

4. Integration and Compatibility: Ensuring seamless integration of the MR Vision system with existing industrial monitoring and management systems, as well as medical education platforms. Compatibility with industry standards and protocols will be prioritized to facilitate widespread adoption and interoperability.

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5. User Interface and Experience: Designing an intuitive user interface that enables users to easily interact with the MR Vision system, access relevant information, and perform necessary tasks without hindering their workflow. User experience testing and feedback will be incorporated into the development process to optimize usability and satisfaction.

6. Security and Privacy: Implementing robust security measures to protect sensitive data transmitted and processed by the MR Vision system. This includes encryption protocols, access controls, and compliance with relevant data protection regulations to ensure the confidentiality and integrity of user and machine data.

By addressing these components comprehensively, the MR Vision system will provide a transformative solution for real-time machine monitoring and tracking, setting a new standard for efficiency and precision in various industries.

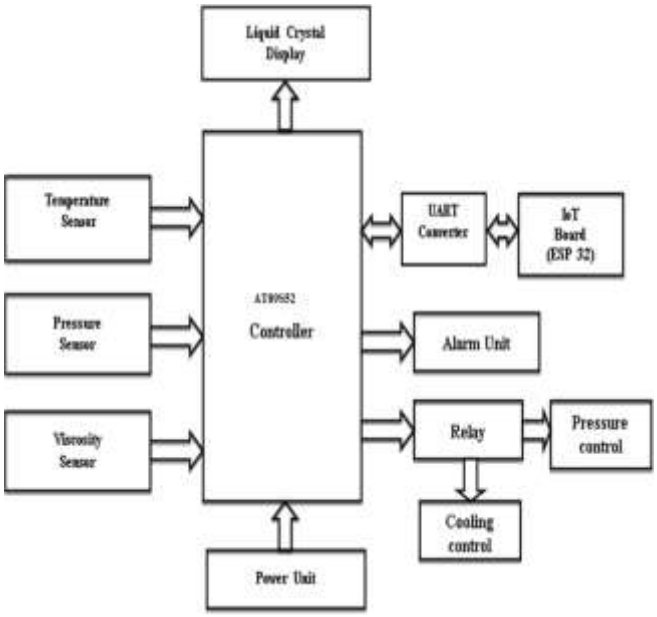
Existing System

No database based system available to compare or to analyse a person's history of tracking and biomedical data. No updated technology for scanning like AR, VR and MR. No image based output in current method.

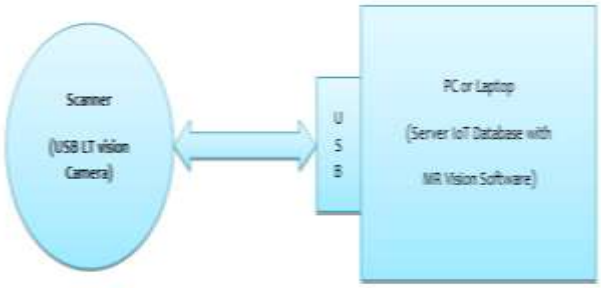
Proposed System

Mixed reality combines virtual reality elements with human vision. Head-mounted devices use clear screens to give users an unobstructed view, but various technologies can be used to project images onto the screen. For monitoring the industry or power plant, MR provides a means of viewing images and data far more convenient than charts or screens. Furthermore, MR can provide new ways of interacting with users by projecting information in 3D view. As medical schools and other organizations continue to explore MR, experts will devise novel uses for MR technology.

- First time in Technology MR Vision system utilizes for the real-time update and track of machines.
- The Images based output and tracking with MR vision system.



A system for monitoring and controlling industrial processes. It uses sensors to track temperature, pressure, and viscosity, with a microcontroller managing the data. An IoT board enables remote access, while a display and alarm unit provide real-time feedback and alerts. Actuators, like relays, adjust pressure and cooling as necessary for optimal operation. Overall, this setup enhances efficiency and safety in industrial settings.



A system where a PC or laptop is connected to a server hosting an IoT database and MR vision software. A barcode scanner is linked to the PC, allowing barcode scanning for data input. Additionally, a USB LT vision camera provides visual input for tasks like image recognition. This setup offers versatile applications such as inventory management and quality control.

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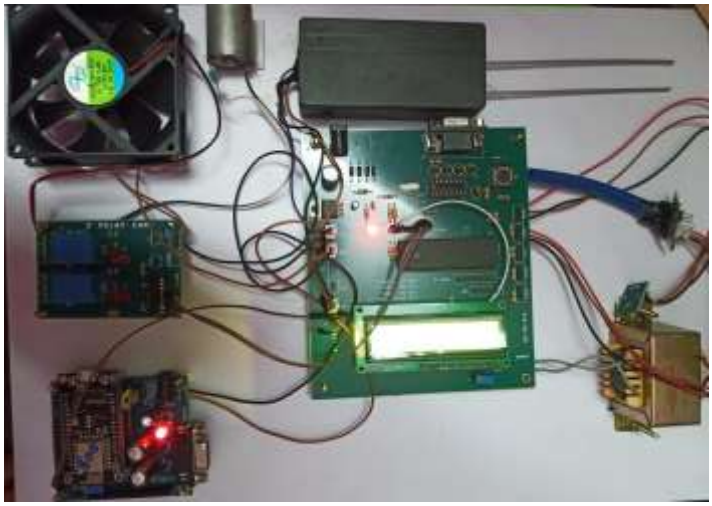
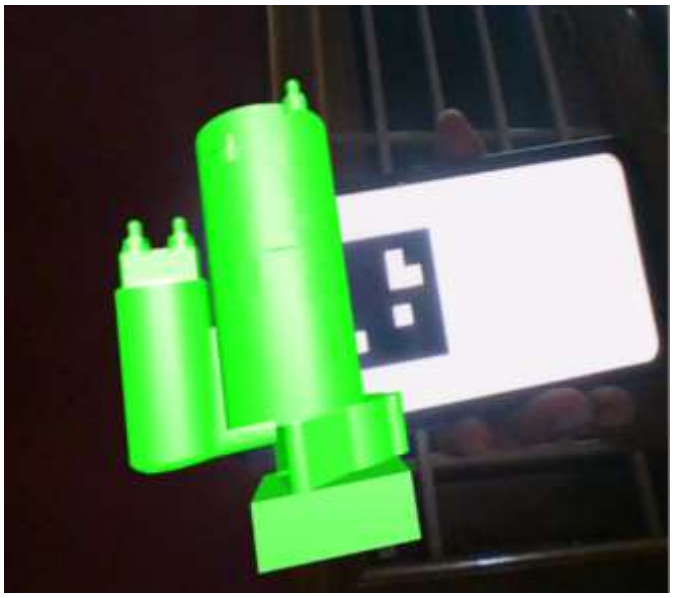
2. RESULT AND DISCUSSION



Type	Input Voltage	Output Voltage
Stepdown Transformer	230V	12V

Power generation using stepdown transformers. It highlights key factors like efficiency, voltage regulation, and suitability. This comparison helps in choosing the right transformer type based on needs and constraints, making it useful for decision-makers in power systems.



A digital copy of a boiler system. It mimics the real boiler's components and how it works. providing a virtual representation of its physical components and operational dynamics.

This digital model serves as a simulation tool for analyzing and optimizing boiler performance without the need for direct access to the physical equipment. By replicating the behavior of the actual boiler, including factors like fuel combustion, heat transfer, and steam generation, the digital replica enables engineers and operators to conduct virtual experiments, test different control strategies, and predict system behavior under various operating conditions.

3. CONCLUSION

In this survey we could able to Identify a promising solution for enhancing operational efficiency and safety. By creating virtual replicas of physical assets through Digital Twins, coupled with real-time data processing and visualization enabled by Mixed Reality, operators gain valuable insights into boiler performance, facilitating predictive maintenance and optimized operations.

This approach not only minimizes downtime and maintenance costs but also improves overall system reliability and safety. As a result, the synergy between Digital Twin and Mixed Reality technologies offers a transformative paradigm for process control in thermal power plants, ensuring sustainable and resilient energy generation for the future.

4. FUTURE SCOPE

The future scope of the digital twin and mixed reality-based process control for boiler applications involves integrating advanced AI algorithms for proactive fault detection and performance optimization. Enhancing mixed reality interfaces with AR and VR technologies could provide operators with more immersive and intuitive experiences. Additionally, incorporating edge computing and IoT devices would improve system responsiveness and reliability. Expanding the project's applicability to various industrial sectors beyond thermal power plants could offer tailored solutions for diverse process control needs. Moreover, adapting the system to manage hybrid energy systems and renewables could support the transition to cleaner energy sources. Continuing innovation and research will ensure the system remains at the forefront of industrial process control advancements.

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