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ARVI

The Arvi project, a collaboration between HMDrive a high-tech startup, aims to enhance driver experiences in industrial vehicles and sports cars using augmented reality (AR). The project focuses on interface design, business development, and algorithm improvement.

Key objectives include creating a user-friendly AR interface for tractors, allowing farmers to access real-time data without distraction, thereby improving safety and efficiency. The team also seeks to secure a seed founding round to support product development and market entry, having already secure a pre-seed investment by the Motor Valley Accelerator. Engagement with venture capital firms and attendance at industry events aim to establish connections and bolster HMDrive's reputation.

Innovation drivers include algorithm enhancements for stable hologram display relative to the driver's position, using computer vision techniques to reduce motion sickness. While initial results are promising, further testing is necessary.

Overall, the project has made significant strides, but ongoing refinement of the interface, algorithms, and business model is crucial for success in a competitive market landscape.

Key Words

Real-time Stabilization Algorithms Driving Innovation

View from inside a sports car in motion


FULL GAS
HMDrive
ch for sports driving - driver's visual experience through the AR glasses
powered by HMDrive S.r.l.


BRAKE
HMDrive
AR virtual coach for sports driving - driver's visual experience through the AR glas
powered by HMDrive S.r.l.

Project description written by the Principal Academic Tutor

HMDrive is an innovative startup, born in 2019 as a R&D project @ Politecnico di Milano (Italy), now spinoff, incorporated in May 2022, then accelerated by Motor Valley Accelerator. HMDrive develops advanced SW solutions and smart HW integrations for improving driving safety, performance and experience. They have created a new vehicle-driver interface based on Augmented Reality glasses. They currently work with important European sports cars, tractors and trucks OEM. Their mission is finally to improve drivers' capabilities.

The Augmented Reality Vehicle Interface (ARVI) project main goals are: enjoy a unique experience in a rapidly growing startup, learn by doing & get a working methodology, work on cool stuff, having the freedom to build new things from scratch. The project is designed for students that are willing to be out of their comfort zone, ready for complex tasks and to be hands-on. The group will start by defining a working methodology with the HMDrive team, then, after understanding HMDrive's technology & roadmap, they will start the idea generation process, designing and thinking of an application running on the HMDrive platform.

This project prioritizes entrepreneurship, innovation, and a multidisciplinary approach. With a strong focus on user-centered design, it aims to foster a flexible, creative, and proactive team capable of delivering innovative solutions.

Team description by skill

Three members of our team, with advanced computer science knowledge, were responsible for developing a robust head tracking algorithm for the HMDrive project. After a thorough investigation of existing algorithms, we selected ORB as the best fit due to its speed, accuracy, and resilience. ORB was integrated into the system and rigorously tested under various driving conditions to ensure accurate and stable AR projections, even with head movements. These tests helped us identify and address any issues, refining the algorithm for a seamless user experience.
Even if our team had no members with a business oriented background, two members were instrumental in driving HMDrive's business development, traying to apply the concepts learned in the ASP schools. They conducted extensive research to identify potential investors, including venture capital firms, and established connections within the automotive and augmented reality industries. By participating in industry events like SMAU Milan and SMAU London, they expanded HMDrive's network and positioned the company favorably for fundraising. These efforts laid a strong foundation for HMDrive's growth within the competitive automotive technology sector.

The design process for HMDrive's AR interface was spearheaded by the sole member of our team with specialized design expertise. The process commenced with a comprehensive research phase, involving collaboration with HMDrive's engineering team to identify critical data points for display. He then led the design phase, exploring various approaches to present the data in a clear and intuitive manner. Through multiple iterations and rigorous testing, the interface was refined based on HMDrive's team feedback, ensuring it met and exceeded user expectations. This iterative process resulted in a visually appealing and user-friendly AR interface that seamlessly integrated with HMDrive's functionality.

Goal

The primary objective of this project is to revolutionize the driving experience by creating a deeply integrated and immersive environment that fosters seamless interaction between the driver and the vehicle. Our focus lies in developing a portable and adaptable AR-based technology that not only enhances safety but also elevates the overall user experience on the track. By providing drivers with access to a wide range of performance data, telemetry information, and critical safety metrics, our customizable interface aims to empower them with the knowledge and tools necessary to optimize their driving performance. Through an intuitive and intelligent design, we seek to create an AR experience that is both informative and engaging, ultimately enhancing the driver's connection to their vehicle and elevating the thrill of the driving experience.

The global automotive HMI (Human-Machine Interface) market, valued at approximately $17 billion in 2022, is projected to grow at a compound annual growth rate (CAGR) of 11.56% from 2021 to 2028. This presents a significant market opportunity for AR-driven interfaces such as ours, as consumers increasingly demand smarter, safer, and more immersive driving experiences. AR glasses technology, specifically, is projected to reach a market size of $30 billion by 2026, driven by applications in both enterprise and consumer segments, which positions our product within a fast-growing technological space.

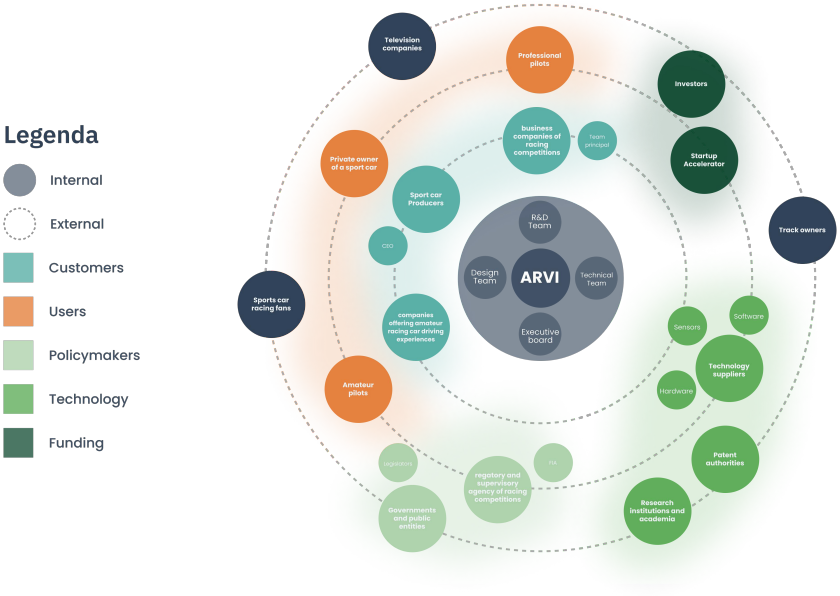
Understanding the problem

The rise of Augmented Reality (AR) technology has been exponential in recent years, with its applications spanning from entertainment to critical safety functions across numerous industries. In the automotive sector, much of the current research and investment are directed toward enhancing vehicle performance and automation. However, relatively little attention has been given to transforming the driver’s or user’s actual experience, especially in high-performance contexts such as sport driving. This project aims to shift the focus by centering the user within the driving system itself, enhancing the interaction between the driver and the vehicle, particularly within the sport and high-performance driving segments.

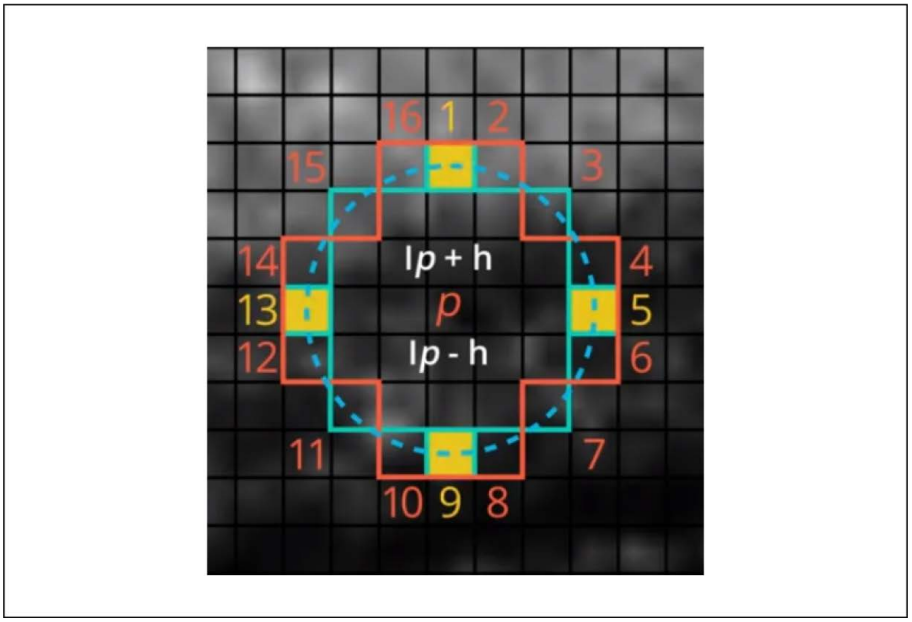
HMDrive is a highly complex augmented reality (AR) system designed to improve driving experiences, especially in high-speed, high-performance environments like racing. The system involves a combination of hardware (cameras, sensors, AR glasses), advanced software architecture, and sophisticated algorithms that manage real-time data to ensure accurate and responsive AR displays for drivers.

The hardware setup of HMDrive serves as the foundation for collecting and processing real-time data, which ultimately drives the immersive augmented reality (AR) displays. This intricate architecture is built around several interconnected core components, each playing a vital role in ensuring the system's functionality and performance.

The software architecture of HMDrive is designed for modularity, flexibility, and stability, allowing the system to operate efficiently even in challenging environments. It is built to handle multiple data streams from various sensors and ensure real-time AR display without compromising performance or stability.



Stakeholder Map



Keypoint detection in orb algorithm

Exploring the opportunities

Choosing the best optical tracking algorithm for HMDrive was crucial. This technology is essential for accurately tracking head position and orientation, ensuring AR content aligns with the real world. A strong tracking algorithm is necessary for an immersive AR experience.

HMDrive evaluated several optical tracking algorithms, including ORB, optical flow, neural networks, and geometric minimization. ORB was chosen for its robustness to changes in lighting and viewpoint, while optical flow offered high accuracy in motion tracking but was computationally expensive. Geometric minimization was explored for 3D object pose reconstruction but abandoned due to difficulties in defining a 3D model. Ultimately, HMDrive adopted a hybrid approach, combining ORB for robustness and optical flow for refinement.

Generating a solution

After selecting the ORB algorithm, HMDrive's team implemented a version for driver head pose estimation using 2D images from a head-mounted camera. The advantage of this 2D approach is lower computational demand compared to 3D algorithms. It can swiftly recover tracking when vehicle tracking is lost, potentially replacing more complex methods. Two pose estimation methods were tested: comparing the current image with the previous one (Scenario A) or the most similar video frame (Scenario B), with Scenario B yielding more accurate results but facing instability over time.

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