Dibris Dipartimento di Informatica, Bioingegneria, Robotica e Ingegneria dei Sistemi

Virtual Reality for Robotics

Report

VRxR

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UNIVERSITY OF GENOA, MARCH 2023

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1 Introduction

Virtual Reality consists of a simulation of something that does not exist, in a very real environment. So for example, one can be having a vacation in Vienna without even leaving his sofa. The main purpose of VR is not only to experience something new by vision but the user has the ability to engage based on sensors and motion tracking devices. [2] Imagination and purpose together drive technology, it is due to these that technology today is evolving at an exponential rate. VR tricks one's mind using computers that allow to experience and interact with a 3D world. VRs displays are available in various forms, they produce a set of data that can be used to develop models, communication, training methods, and interaction. VRs can be classified into 3 types: immersive, semi-immersive and non-immersive. In the agriculture industry, virtual reality has the potential to revolutionize the way farmers manage their crops and fields. With the integration of advanced technologies like automated drones and laser systems, farmers can optimize their work processes, saving time and resources while ensuring better crop yield and quality. [1] Therefore, this report presents a VR project that simulates an automated drone equipped with a laser system, operating in an agriculture environment. The simulation was created using Unreal Engine, a powerful game development engine that provides a highly realistic and interactive experience. The goal of this project was to develop a virtual environment that accurately represents a real-world scenario and operate the drone and its laser system to eliminate anomalies in plants.

2 State of Art

Virtual Reality is an experience of a world that does not exist. Thus, in simple words, the possibilities of such technologies are endless. Moreover, the integration of Virtual Reality (VR) technology with agriculture has been an area of growing interest in recent years. Especially, the integration automated drones has added new dimensions to the use of VR in agriculture with even more possibilities and applications, thus, more problems solved. Automated drones have been increasingly used in agriculture for tasks such as crop mapping, precision spraying, and crop monitoring such as in China.[3] Moreover, according to analysts, drones in agriculture will be worth a massive 5 billion of dollars by the end of 2025.[4] The use of drones has proven to be a cost-effective and efficient method for covering large areas of land and providing farmers with valuable information about their crops and fields.[4] The integration of laser systems with drones has added a new level of precision, allowing farmers to target specific areas on plants, such as pests or disease-affected regions, and eliminate them. The use of VR technology in agriculture is still in its early stages, but it has shown great potential for providing a hands-on experience for farmers and people interested in this innovative field. This can help them understand the benefits and challenges of using automated drones and laser systems in agriculture. Additionally, VR simulations can provide valuable insights into the potential risks and limitations associated with the use of these technologies. This project, implemented as a simulation in Unreal Engine, aims to contribute to the state-of-the-art in the use of VR technology in agriculture specifically the use of an automated drone equipped with a laser system and operating in an agriculture environment with the purpose to target anomalies in plants. By creating a virtual reality simulation, the UAV travels along a path and uses its laser to achieve its goal.

3 Tools

This project is based on Unreal Engine V4.27, which is an immersive type of VR system empowering to build assets workflows with tools that can deliver on creative vision and quality bar now and in the future. It merges augmented reality, virtual reality and mixed reality technologies together to evolve rapidly and become more powerful. In the field of VR simulations, Unreal Engine has emerged as a leading game development engine, providing highly realistic and interactive experiences. Unreal Engine has been used in a variety of applications, including training simulations and product demonstrations, and has shown great potential for use in agriculture. The use of Unreal Engine in this project allows for the creation of a virtual environment that accurately represents a real-world scenario and provides a highly realistic and interactive experience for users.The engine features advanced tools for creating dynamic and immersive environments, such as real-time lighting and particle effects. One of the key features of Unreal Engine is its Spotlight and Camera system, which allows developers to create a virtual environment that accurately represents a real-world scenario and provides a highly realistic experience for users. When applied to a drone simulation, the Spotlight and Camera system can be used to create a dynamic and immersive environment that accurately represents the experience of flying a drone in an agriculture environment. The system can be used to create dynamic lighting effects that accurately represent the movement of the drone and its laser system, and to simulate the perspective of the drone as it flies over crops and fields.

Please find below the link to the GitHub project:
https://github.com/AngelicaScamarcia/VRxR

4 Description

The main purpose of this project is to create an environment using drones for environmental monitoring, with a smart mobility and civil protection. Nowadays, the rise of VR has also had an effect on the world of drones. Specifically the art of FPV or "first-person view" flying which has began to share significant aspects of VR technology. For thousands of years, agriculture has played an important role in everyday life, and that's the reason behind the chosen project being related to the agriculture field. It is a natural resource that sustain human life and provide economic gain. It combines creativity, imagination, and skill involved in planting, thus we aim to add innovation to it also. Therefore, this project consists of a specific type of drones simulated in the agriculture environment equipped with a specific laser, flying above the environment and stops under specific conditions to burn and get off of bad herbs fruits and vegetables and leaving the good ones which farmers might manually do but with less accuracy and more time consumption. Drones in agriculture are numerous, it is one of the technologies that is driving precision agriculture which improves efficiency, productivity, crop yield and profitability through the use of technology. It's a powerful tool for farmers and agronomists to assess the health of their crops they can get an overview of their fields and collect data much faster and more efficiently than traditional methods by seeing how healthy their plants are, where they might need water or nutrients, and if there any plants that have to be burnt or not. Noting that all these cases might be missed without the use of a drone and can lead to hundreds or even thousands of dollars worth of lost due to issues that were not caught early enough on the ground. This project is based on two important parts, the drone motion part and the laser part. First, the drone motion is along a specified path, which was implemented by starting with specifying several arrows being the range along which the drone will move. Those arrows are combined into an array, in a way that the drone is able to reach the target and then obtain its world location. The search event for the next position is repeated in a loop in order to have total coverage of the environment concerned (in this case the plantation). Then we set a timer by event, with a custom event for motion which will be triggered to start after the event begin play. Then the drone's world location will be computed based on the original location combined with the Larp vector depending on the float variable connected to the aforementioned motion event. After the motion event is called, it will set the float variable to zero then it will call timer which will trigger every specified number of seconds and add a value to to the variable making it higher. Additionally, Larp Vector is used which basically goes from one location to other location and the variable is used to basically specify how much it should blend from the first location to the other new location. Furthermore, the drone should also rotate, thus, an event tick is added and attached to an 'add local rotation' function, then splitting its structure pin of delta motion and making the z axis as variable which will be randomly set everytime a new location is triggered. Considering the laser part, it is implemented using the Spotlight feature, by attaching a spotlight component to the drone and changing the component's properties such as its color, intensity, brightness, cone angle, outer and inner radius are adjusted to closely match those of a laser. Furthermore, a camera is attached to the drone to monitor its perception. The goal is also to have screenshots documenting the situation in the environment,that is why we have implemented a function that is able to take screenshots, in a loop at a fixed time, at high resolution through the camera attached to the drone.

5 Results

After all these implementation steps and trials along with fine tuning, the obtained result consists of a drone autonomously and dynamically moving in an agricultural environment, with a laser component attached to it and emitting a laser beam simulating how it could target anomalies in plants and agriculture. The results obtained can be clearly seen in the figures below:

Figure 1: Project Image

Some of the advantages of such a system can be:

1. The laser beam allows for precise targeting of individual plants, allowing farmers to identify and treat specific anomalies without having to treat an entire field.
2. The use of a drone equipped with a laser allows for quick and efficient scanning of large fields, reducing the amount of time and resources needed to identify and treat anomalies.
3. Drones can access areas that may be difficult to reach on foot, such as steep or uneven terrain.
4. By reducing the need for manual labor and manual treatment of anomalies, the use of a drone with a laser can lead to significant cost savings for farmers.
5. The increased efficiency provided by a drone equipped with a laser can help increase overall productivity for farmers.

Whereas some of the disadvantages of such a system can be:

1. The use of drones can be limited by adverse weather conditions, such as high winds or heavy rain, which can affect the stability and accuracy of the laser beam.
2. The use of a laser beam poses potential safety hazards, particularly to individuals working in close proximity to the drone.
3. Operating a drone equipped with a laser requires a certain level of technical skill and training, which may not be available to all farmers.

6 Conclusions

To conclude, using such drones equipped with lasers in agriculture has shown great potential for identifying and targeting anomalies in crops. The precision, speed, and accessibility provided by this technology has the potential to greatly increase efficiency and productivity for farmers, while reducing costs and manual labor. However, there are also challenges to the widespread adoption of this technology, including the cost of equipment and maintenance, regulations, weather limitations, and the need for technical skills. Future improvements can be considered for further enhacements of such technologies and limit the challenges as much as possible. For instance, Computer Vision and Machine Learning techniques can be applied to the real-time monitoring of the drone obtained by the camera to increase the detection of anomalies and filtering of targets, which improves its accuracy for laser emission, preventing it from targeting in specific conditions such as when a human is detected in the area. Moreover, traffic analysis and smart maneuvering strategies with route optimisation can also be applied for complex agricultural environment. Furthermore, drone weather resistance and stability with more efficient mechanical structure and operations.

References

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