Collaborative System of Aerial Robots to Handle Loads with Optimal Consumption of Resources
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INTRODUCTION

In recent years, significant progress has been made in the research and development of unmanned aerial vehicles (UAVs) for tasks that involve physical contact and action on objects in the environment, such as transporting and deploying loads, taking samples, grasping in flight and even aerial manipulation, mainly using rotary wing aerial platforms. Aerial manipulators are characterized by having a high degree of redundancy, which combines the manipulation capacity of a fixed base manipulator with the navigation of an unmanned aerial vehicle with a fixed or rotating wing. In this context, the present research project aims to propose a robotic collaboration scheme that allows optimal control of several aerial manipulator robots, in order to carry out tasks autonomously that require both navigation and manipulation capacity.ii) Propose a collaborative tele-operation scheme, based on the kinematics and dynamics of the robot. iii) Develop a multi-user virtual simulator that allows simulating and implementing different advanced control algorithms, iv) Evaluate experimentally the performance of the proposed control algorithms and control schemes, using CEDIA's Computational Cloud for processing the control algorithm to be implemented in each robot.

STRUCTURE OF THE SYSTEM

The proposal of the tele-operation scheme for collaborative tasks between n aerial manipulator robots, this project proposes the building of aerial manipulator robots and the development of a multi-user virtual simulate

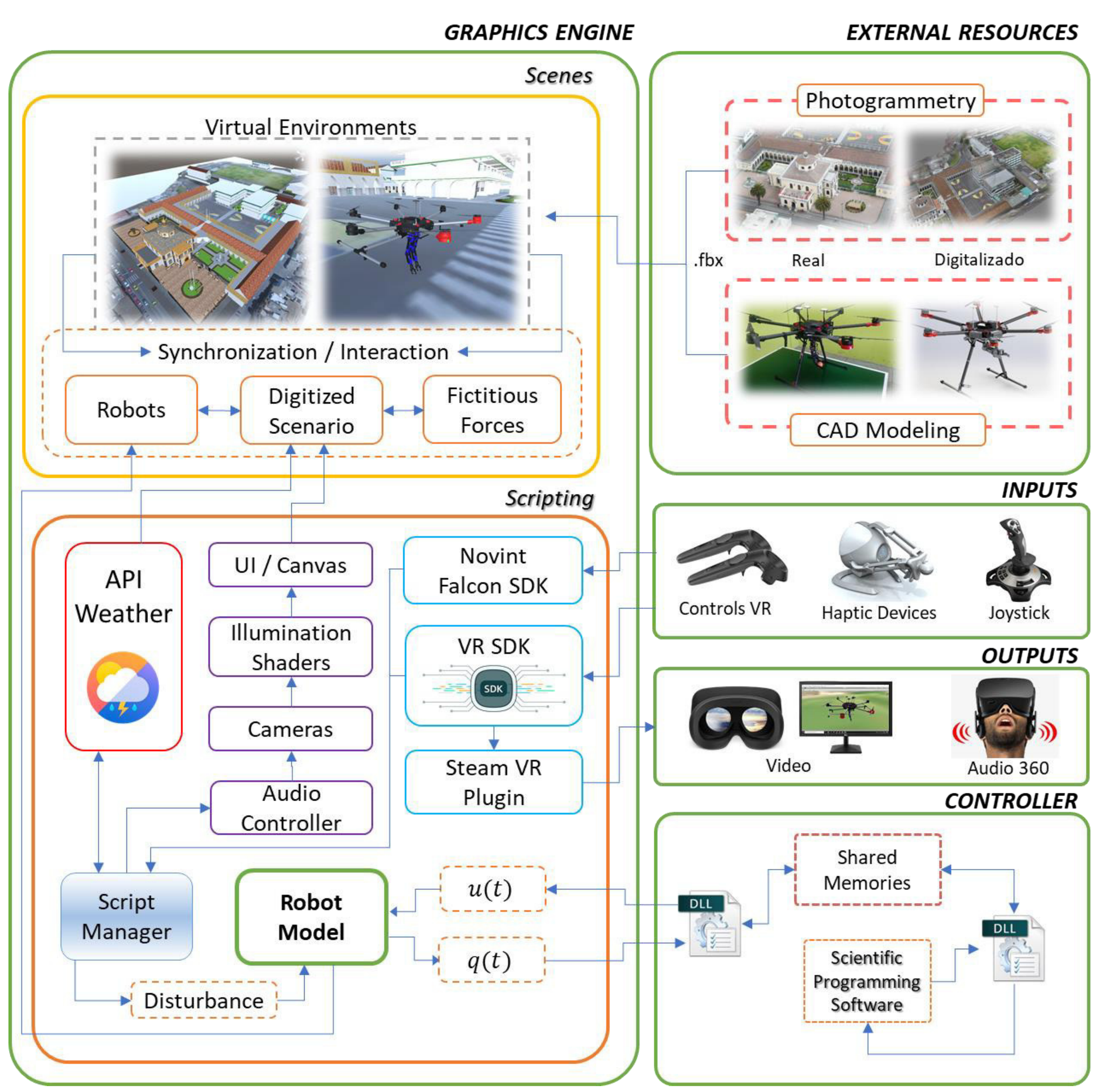

Fig. 1. Structure of the system of control collaborative of manipulators toandinmates .

In addition, this study presents the implementation and evaluation of control algorithms through control schemes based on the Full technique. Simulation and Hardware in the Loop(HIL). The emulation of the robotic system in a 3D virtual reality environment is considered, thus allowing to guarantee a successful experimental implementation.

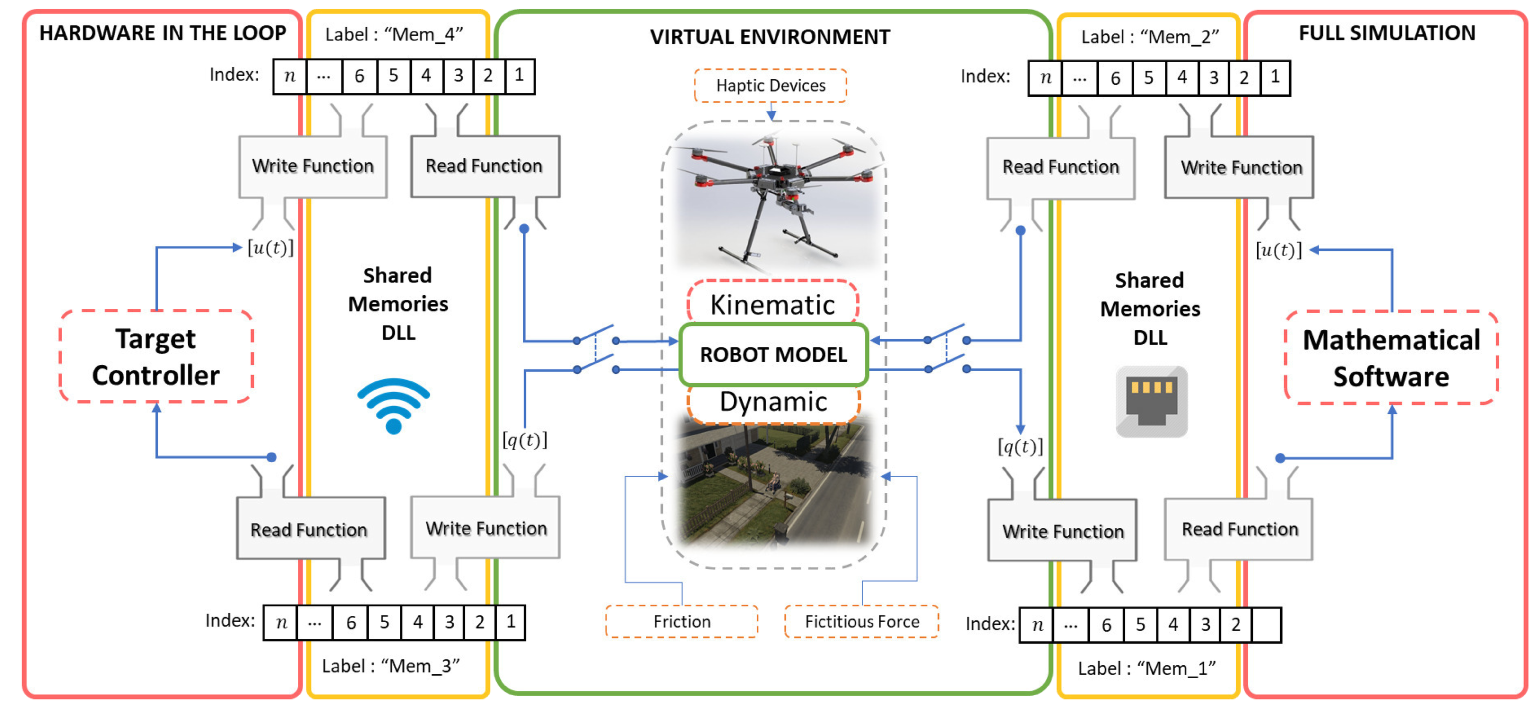

Fig. 2. Control scheme Full Simulation (FS) and Hardware in the Loop (HIL). .

AERIAL MANIPULATOR

An advanced control algorithm was implemented in which the kinematics and dynamics of the aerial manipulator robot are considered, in order to solve the path following problem for navigation and manipulation of objects in unstructured environments. The control algorithm considers energy saving through redundancy control of the robotic system, for which priority is given to the movement of the robotic arm over the movement of the UAV.

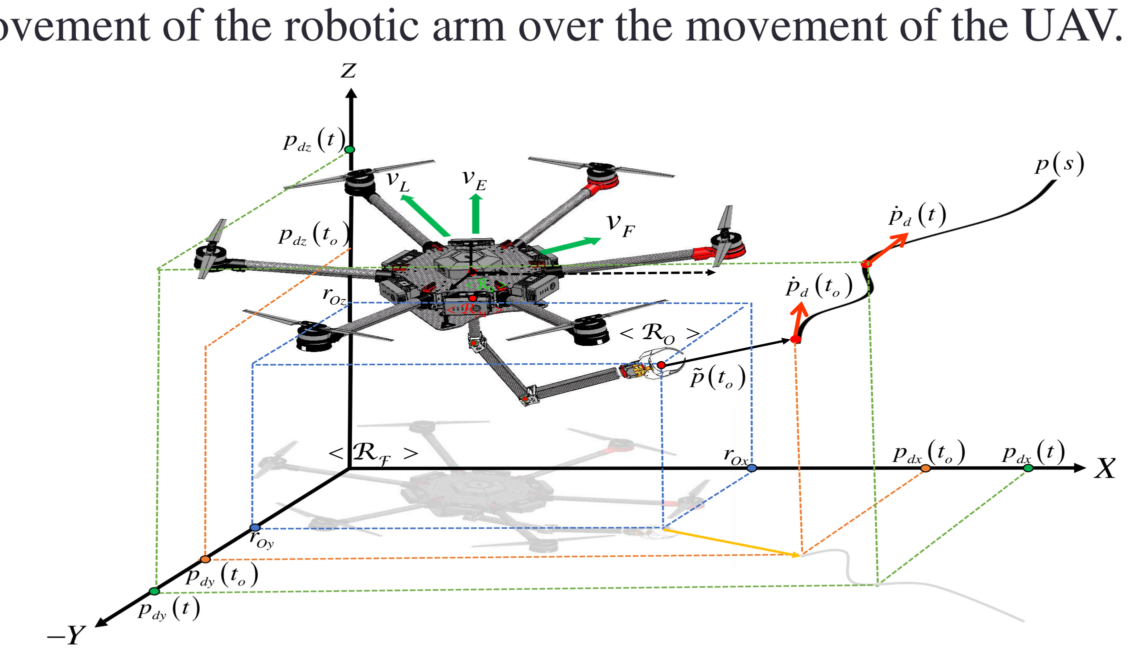

Fig. 3. Road-following problem scheme.

CONTROL SCHEME

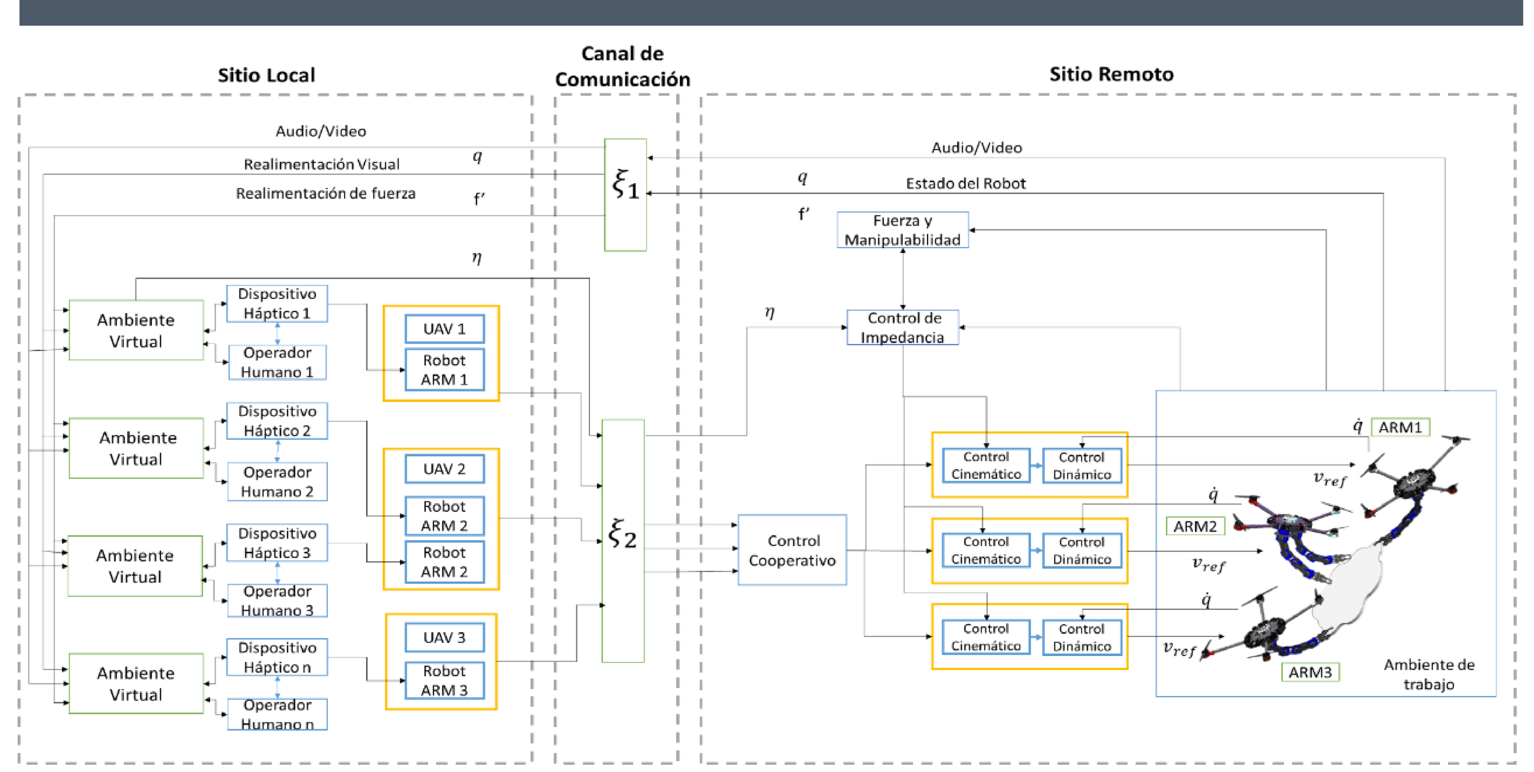

Fig. 4. Proposed bilateral tele-operation scheme.

East project proposes the development of advanced control algorithms to execute collaborative tasks between several robots to be incorporated into a new bilateral tele-operation scheme that allows autonomous and tele-operated control where one or more human operators maneuver in a coordinated way n aerial manipulator robots.

EXPERIMENTAL RESULTS

The operation of aerial manipulators converge in the synergy of mechanical design, electronics, sensors, telecommunications and the computational management of information to implement control algorithms in such a way that control errors $\tilde{\boldsymbol{\eta}}\left(\tilde{\eta}_x,\tilde{\eta}_y,\tilde{\eta}_z\right)\in R^3$ converge to zero.

Fig. 5. Assembly of the aerial manipulator.

Fig. 6. Experimental tests of the proposed controller.

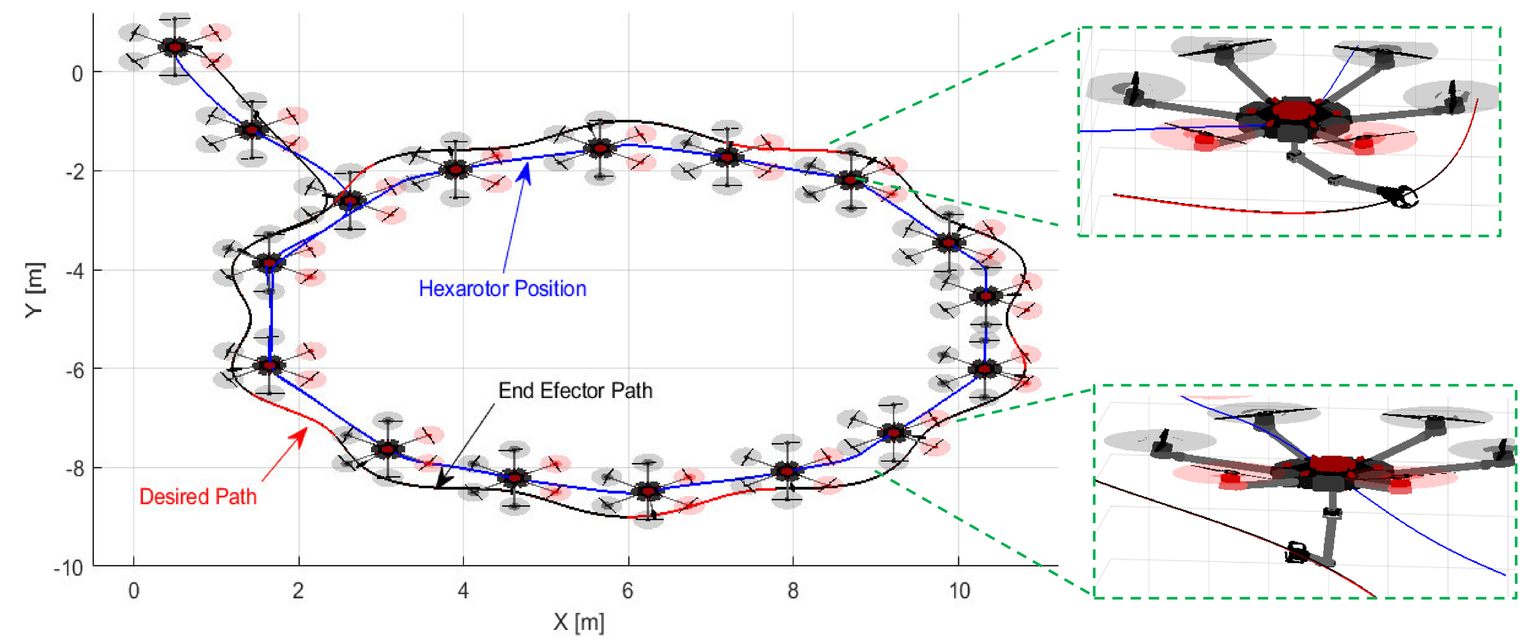

Fig. 7. Strobe movement based on experimental data.

CONCLUSIONS

The unification of aerial manipulator robots of different dimensions or characteristics (simple or dual) allows solving specific problems, where the scaling in the number of robots can be given by the type of application or by the number of degrees of freedom required to achieve the end goal. In this way, this type of solution allows cost optimization and risk reduction in autonomous or teleoperated navigation. On the other hand, getting a group of aerial manipulator robots to execute a desired task autonomously or teleoperated converges in other research areas related to advanced control algorithms that optimize different criteria such as energy saving, movement control, optimal training configurations. when moving an object in common between several robots, among others.

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