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Assisting humans by transferring skills to the robot in remote-controlled vertical farming

Alexis Boulay, 1st year CIFRE PhD student with Farm3

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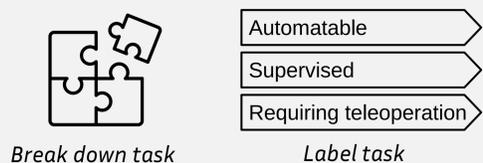
Goal

In a concern of local production and frugality in the consumption of resources, **indoor farming** provides an interesting solution. Moreover, this type of farming commonly use climate control, with the use of **vertical farming**, this leads to generate an optimal microclimate to grow any kind of plant. In this type of highly controlled environment, human presence could disrupt the stability, except that in such a living environment **human expertise** is mandatory. The aim of this thesis is to keep human expertise via the use of **teleoperated robot** and **co-control methods**.

How to design a co-control methods that allow to keep human expertise and help operator accomplishing tasks ?

Tasks analysis

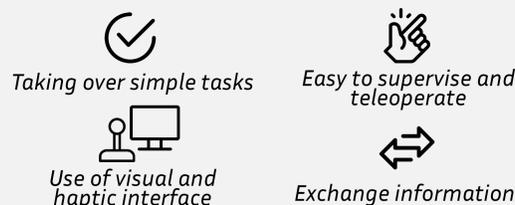
How to describe a task in order to reproduce it with a robot ?



- ⇒ Give hardware and control requirement.
- ⇒ Indicate needed information.

Sharing autonomy

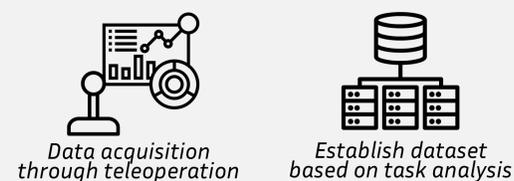
How to assist human while preserving its position as an expert decision-maker ?



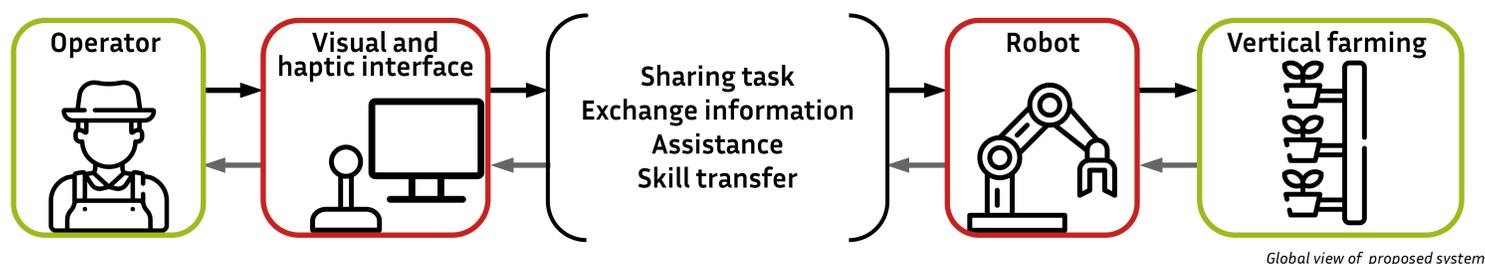
- ⇒ Keep human expertise.
- ⇒ Improve operator comfort.

Skills transfer

How to improve robot assistant skills ?



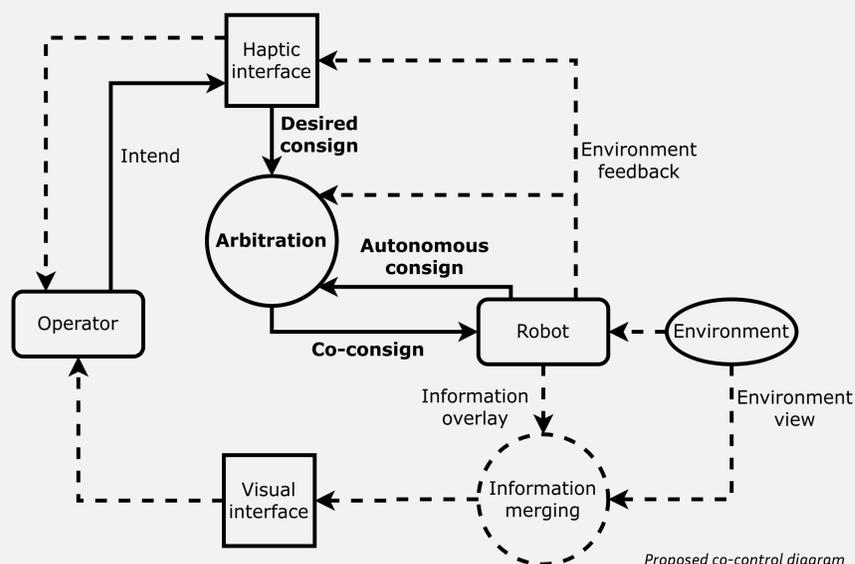
- ⇒ Set up data acquisition routine.
- ⇒ Increase robot autonomy.



Global view of proposed system

Co-control

Co-control consists of human-robot collaboration to reach a goal. The whole question is in the **arbitration**, or which weight to give to both autonomous and operator consign in a final co-consign. Also, it is about given the **authority** to the operator or the robot depending on the **task** and the exchanged **information**.



Proposed co-control diagram

Farm3

This PhD thesis is part of a partnership between the Auctus team at **INRIA** and the company **Farm3**. Farm3 is a French start-up specialized in soil-less and aeroponic vertical cultivation in controlled climate. To that purpose, they made the FarmCube, a vertical farm of 12 square meters, that can host up to 5000 plants.

In this way, vertical farming as experiment in the FarmCube represent the ideal **sensitive dynamic environment** that require a telerobotic system based on shared autonomy.



Picture of the FarmCube