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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 ?
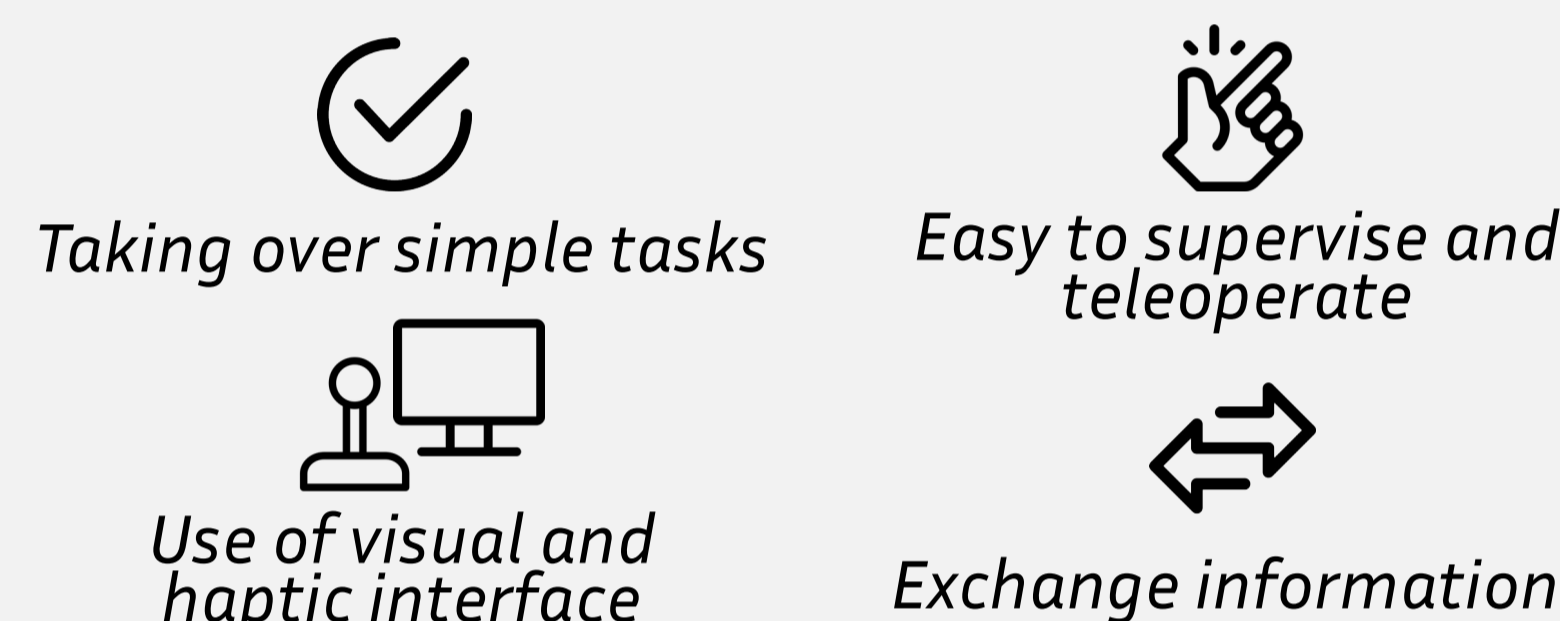
Tasks analysis

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

Break down task   *Label task*

- Automatable
- Supervised
- Requiring teleoperation
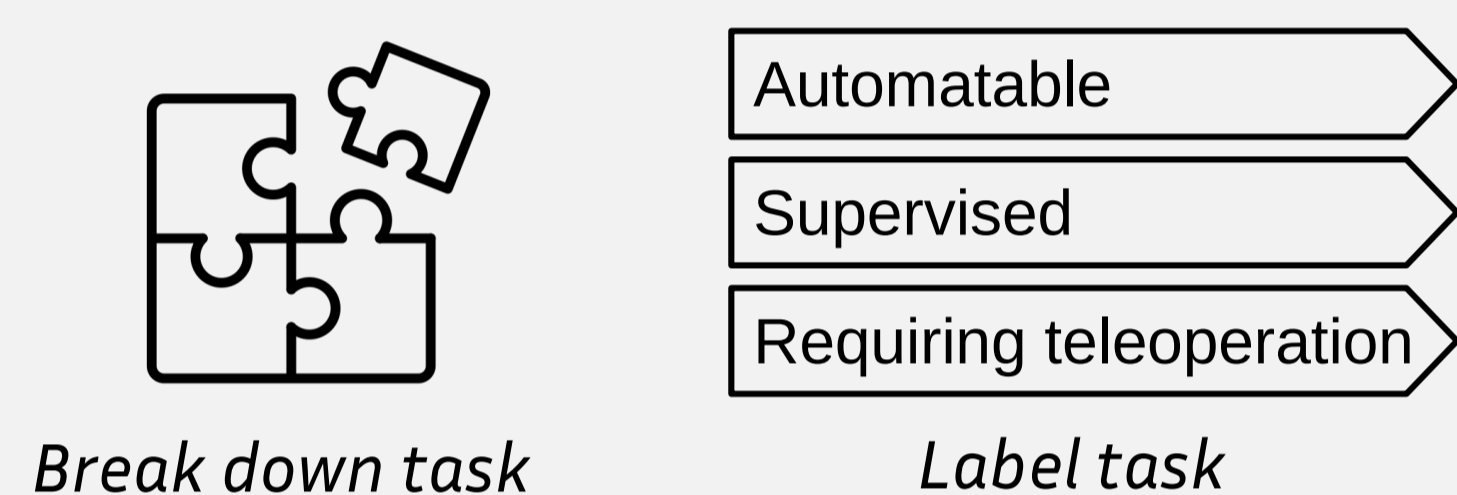
➡ Give hardware and control requirement.
➡ Indicate needed information.

Sharing autonomy

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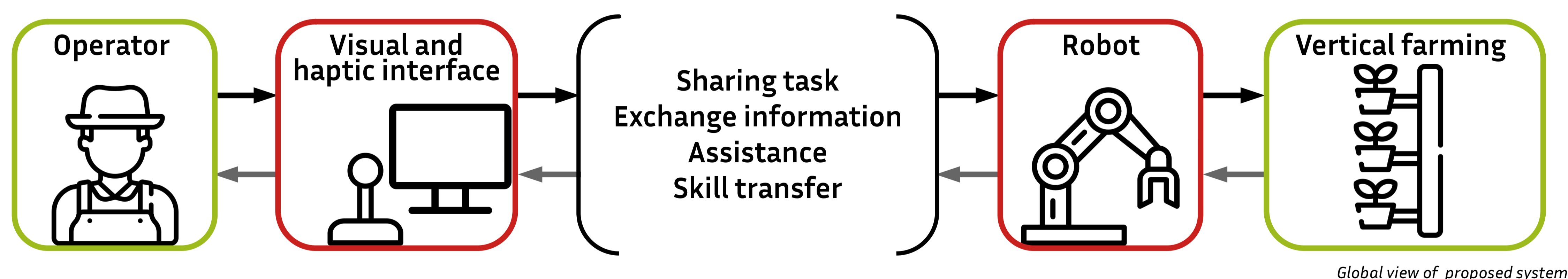

Taking over simple tasks   *Easy to supervise and teleoperate*

Use of visual and haptic interface   *Exchange information*

➡ Keep human expertise.
➡ Improve operator comfort.

Skills transfer

How to improve robot assistant skills ?

Data acquisition through teleoperation   *Establish dataset based on task analysis*
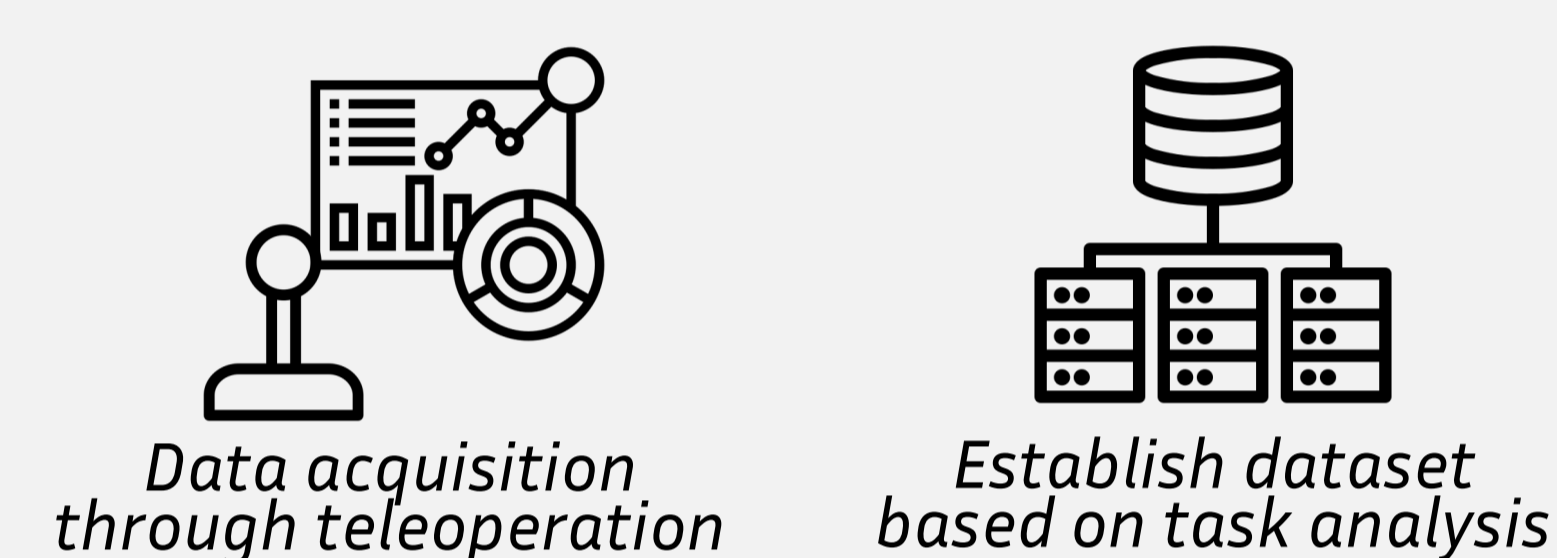
➡ Set up data acquisition routine.
➡ Increase robot autonomy.

Operator → Visual and haptic interface → Sharing task / Exchange information / Assistance / Skill transfer → Robot → Vertical farming

Global view of proposed system

Co-control

Co-control consists of the collaboration of a human user and a robot to reach a goal. The whole question is in the **arbitration** and in the **authority** that will be given to operator intent, depending on **task** and exchanged **information**.
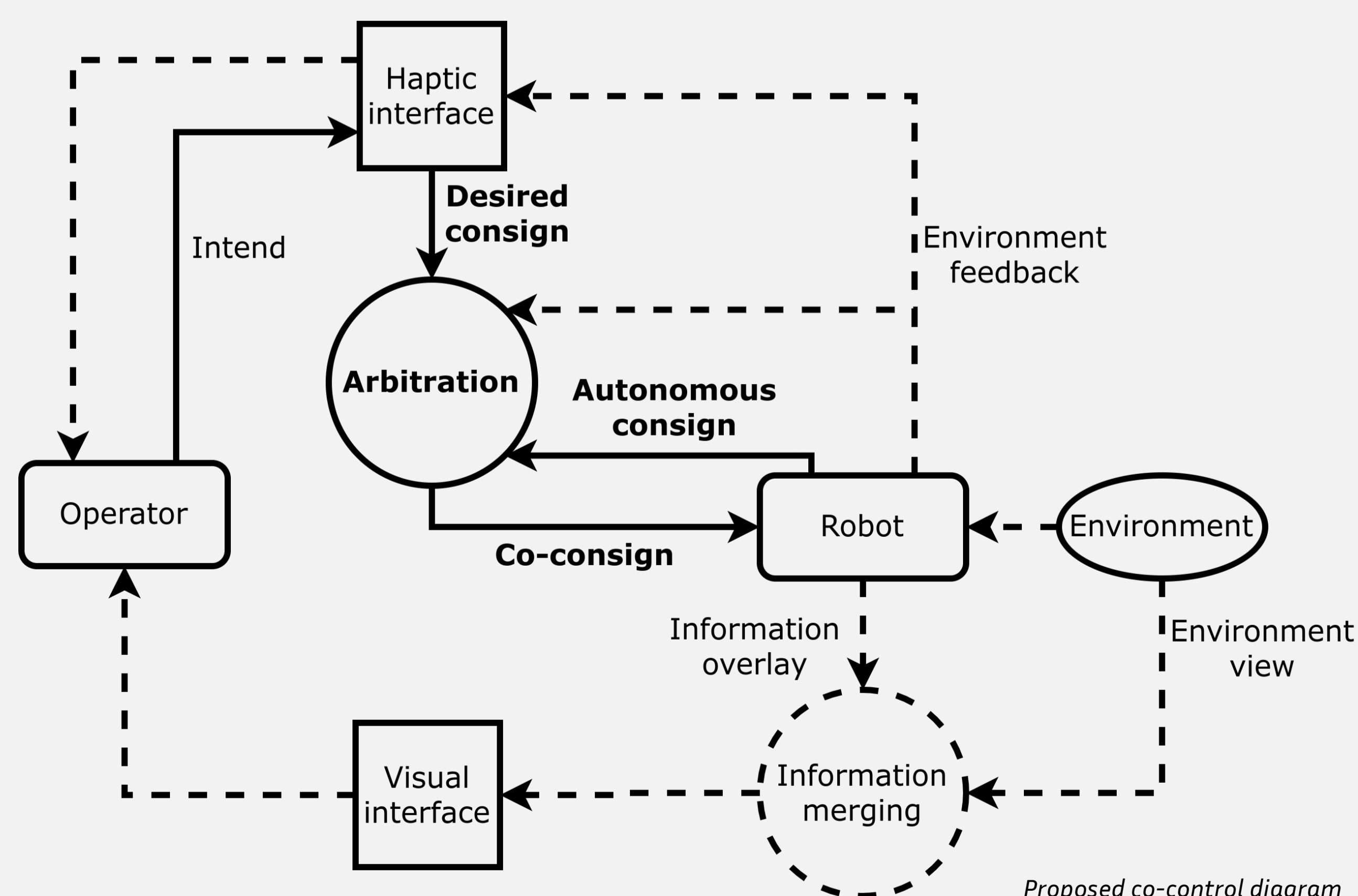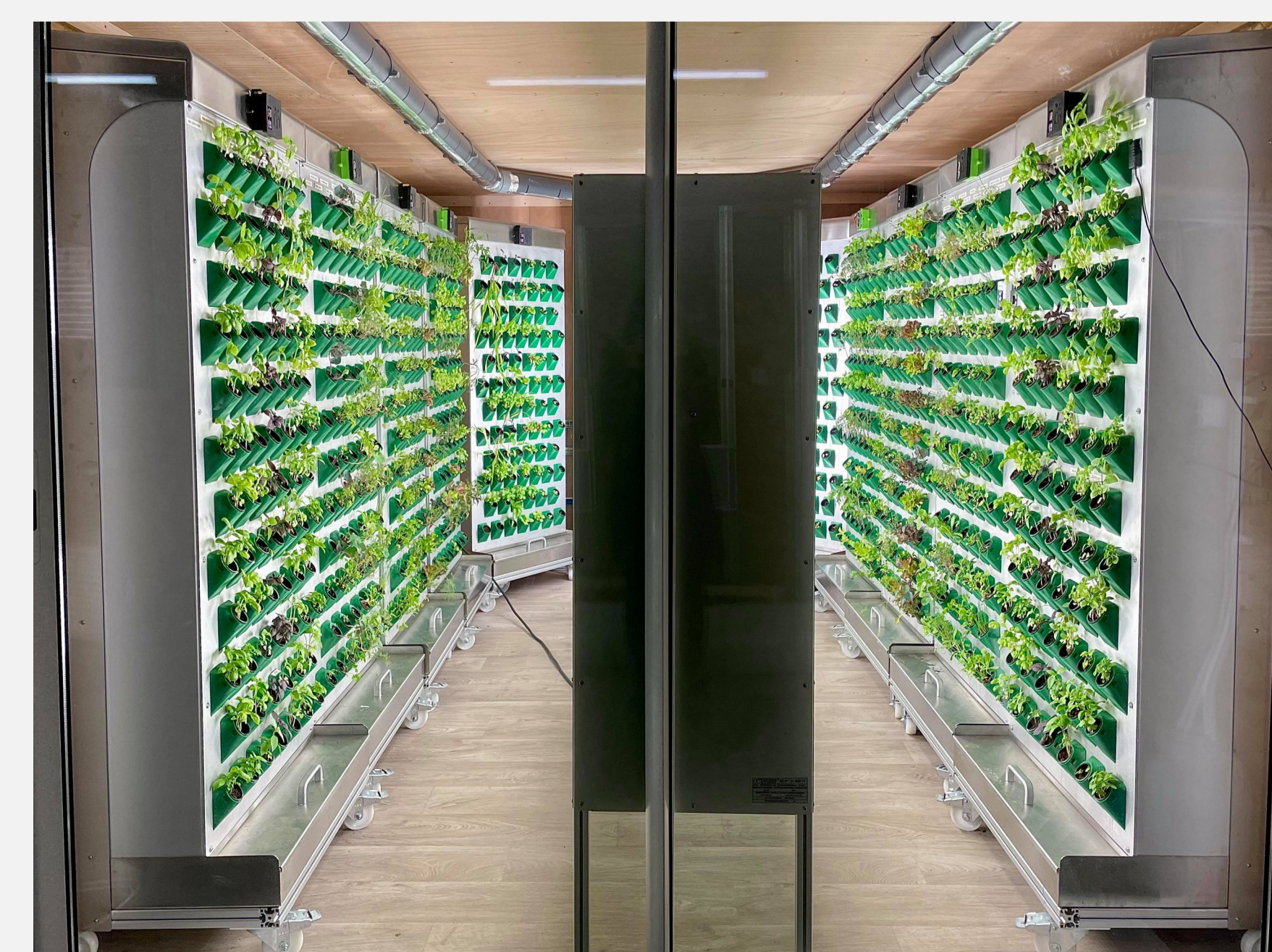

Proposed co-control diagram

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