Feeding Cells with Robots

a *Robots In Quarantine* submission to BRDG Studios

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Introduction

Feeding adherent cell culture is a key protocol within a broader set of techniques used in laboratories around the world to grow and study samples of specific types of mammalian cells. These cells have proven useful in countless applications, including pharmaceutical drug screening, individualized cancer treatments, and biological test kits to determine hormone levels in patients. With these and a host of other new technologies coming to market there has been a blossoming need for laboratories to grow these cells at manufacturing scale. However, the process of culturing adherent cells is quite delicate and is only ever performed by highly trained laboratory technicians. In fact, many labs where I've worked in the recently needed teams of technicians each devoting multiple hours of specialized manpower every day just for feeding.

Proposal

In this document, I will show that Universal Robots' UR5e would be able to perform the entire adherent cell culture feeding process, far more quickly and accurately than humans do. This use case has the potential to alleviate a significant bottleneck in cell manufacturing while also creating savings in material costs, and improving product consistency. I would use a residency at BRDG Studios to build a proof-of-concept cobot-automated adherent cell feeding setup that could be marketed directly to cellular biology laboratories as well explore and innovate new ways to work and play in conjunction with robots.

Adherent cell feeding process

1. Pick up a flask from a stack of flasks (see Figure 1).
2. Twist off the flask’s cap.
3. Vacuum the old liquid out of the flask with an aspirating pipette (see Figure 2).
4. Fill the flask with fresh liquid from a hand-held piping system (see Figure 3A).
5. Twist on the flask’s cap.
6. Add the flask to a stack of finished flasks.

Adherent cell feeding key requirements

- Must be a sterile process.
    - Ultimately this process needs to be performed in a sterile hood with all surfaces maintaining sterility.
- Must be gentle.
    - Refill fluid cannot be poured too powerfully or jerkily against the cell layer.
    - Rotation speeds must also be smooth and speed controlled.
- Must be quick.
    - When the flask is in the holder and the liquid pools at the bottom, the cells can’t be out in the air for more than about 30 seconds.

Traditional Materials

Figure 1. A set of flasks used for adherent cells.

Figure 2. A typical aspirating pipette and waste reservoir for aspirating liquid during adherent cell feeding.

A)

B)

Figure 3.

A) A technician piping in media (liquid cell food) by hand in a biological safety cabinet.

B) A typical piping system, which could feasibly be used for this task by an always-sterile robot arm.

Overview Setup

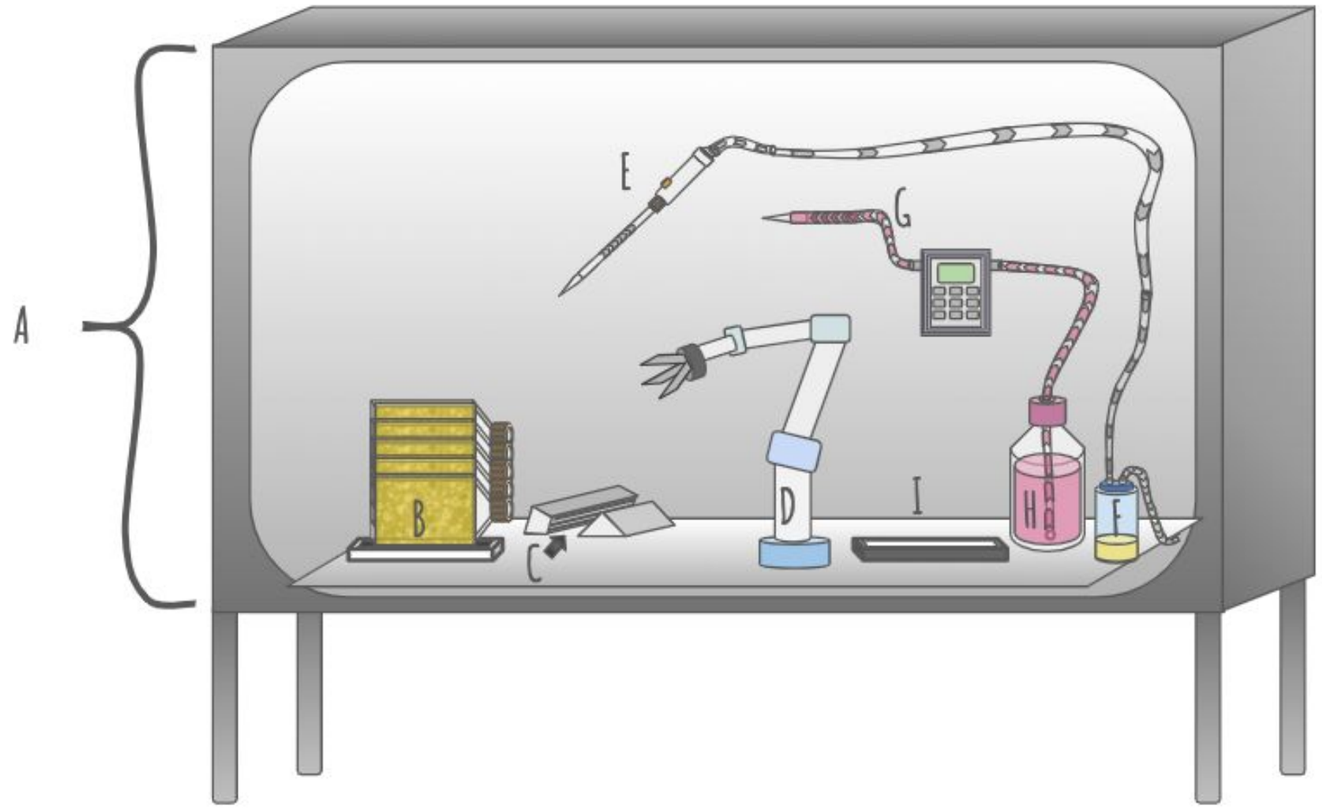

Figure 4. The proposed robot arm setup for adherent cell feeding. **A)** Within a laboratory hood (a standard sterile cabinet H:60in, W:72in), there is **B)** a designated spot for the technician to place a stack of flasks in need of feeding, **C)** a specially-designed slot capable of holding the rectangular bottom of a flask at the perfect angle, **D)** a UR5e Universal Robots robot arm, **E)** an aspirating pipette connected to a powerful vacuum, attached to **F)** a waste reservoir. Also in the cabinet, **G)** an automatic media (cell food) piping system, attached to **H)** a fresh media reservoir, and **I)** a designated spot for the robot to stack finished flasks.

How a UR5e could perform adherent cell feeding

The following steps are illustrated in Figure 5 on the next two pages.

1. Pick up the top flask from a stack of flasks.
2. Place into a slot capable of holding the bottom of a flask and twist off cap.
3. Place cap to the side. Pick up the aspirating pipette.
4. Insert aspirating pipette into flask. Vacuum out liquid.
5. Remove and set aspirating pipette to the side. Pick up the media fill pipette.
6. Insert media fill pipette. Fill with fresh liquid via a liquid piping system.
7. Remove and set fresh liquid pipette to the side.
8. Pick up the cap. Replace cap onto the flask.
9. Pick up the flask. Rotate the flask into the correct orientation.
10. Gently set the flask down on the finished flask stack.
11. Repeat until the stack is complete.

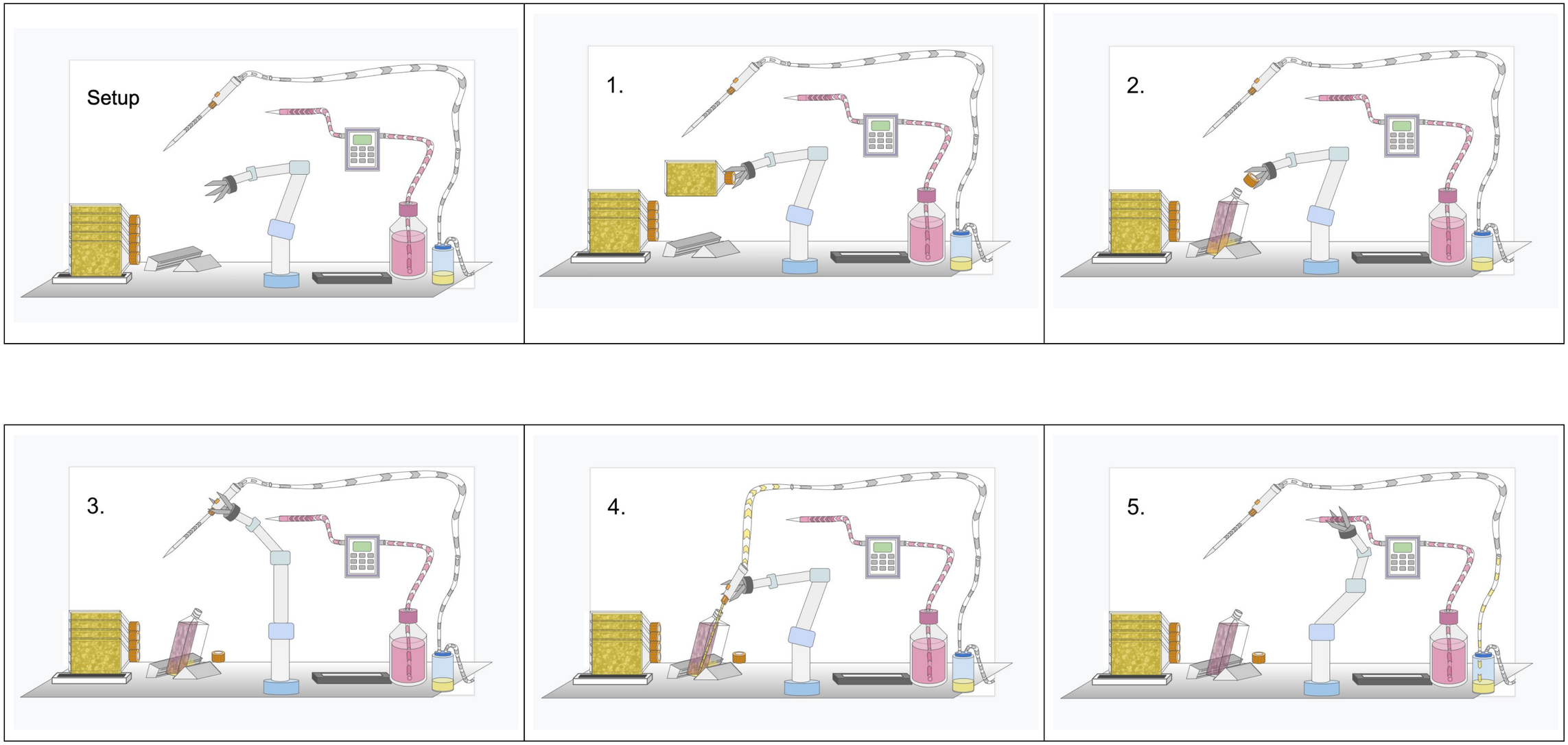

Figure 5A. The proposed cobot-automated process for adherent cell feeding. Steps 1-5.

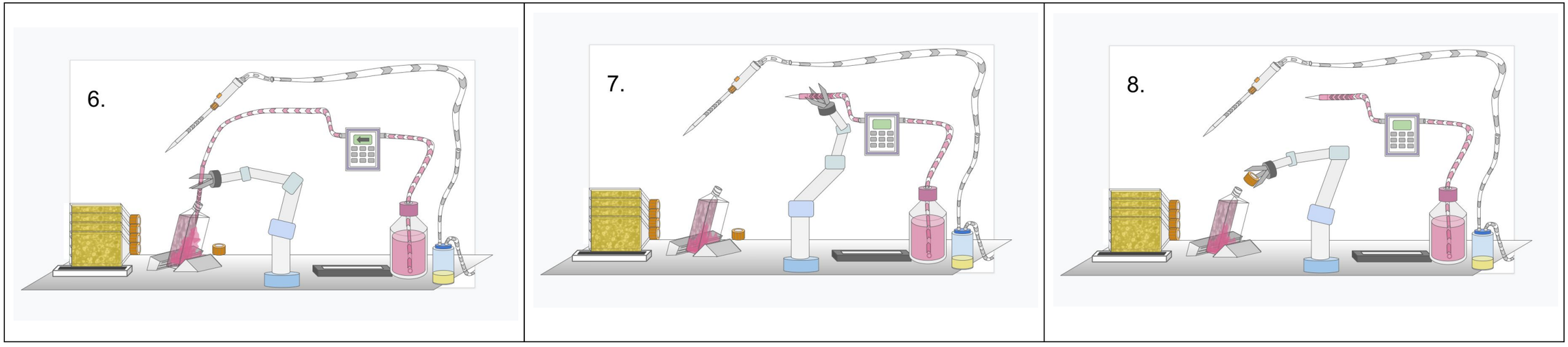

Figure 5B. The proposed cobot-automated process for adherent cell feeding. Steps 6-11.

Advantages to using this robot

- Standardizes the process, removing multiple sources of human error:
    - Variations in volume measurements
    - Variations in time intervals
    - Contamination of sterile surfaces
- Assists, but does not replace workers.
    - Helps workers spend more time on the important stuff like innovation and problem solving without removing someone from the workforce.
- Significantly reduces plastic waste.
    - The technician no longer needs to enter the process's sterile area, so we can use significantly less protective equipment.
    - By replacing hand-held pipettes with a pumping system, we no longer need a fresh pipette tip for every flask.
- Plentiful next steps.
    - The task of feeding adherent cells is just the beginning of operations these robots could do to assist cell culture technicians.

Thank you so much for your consideration!

Regards,

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