Automated Room Painting Robot - PaintBot

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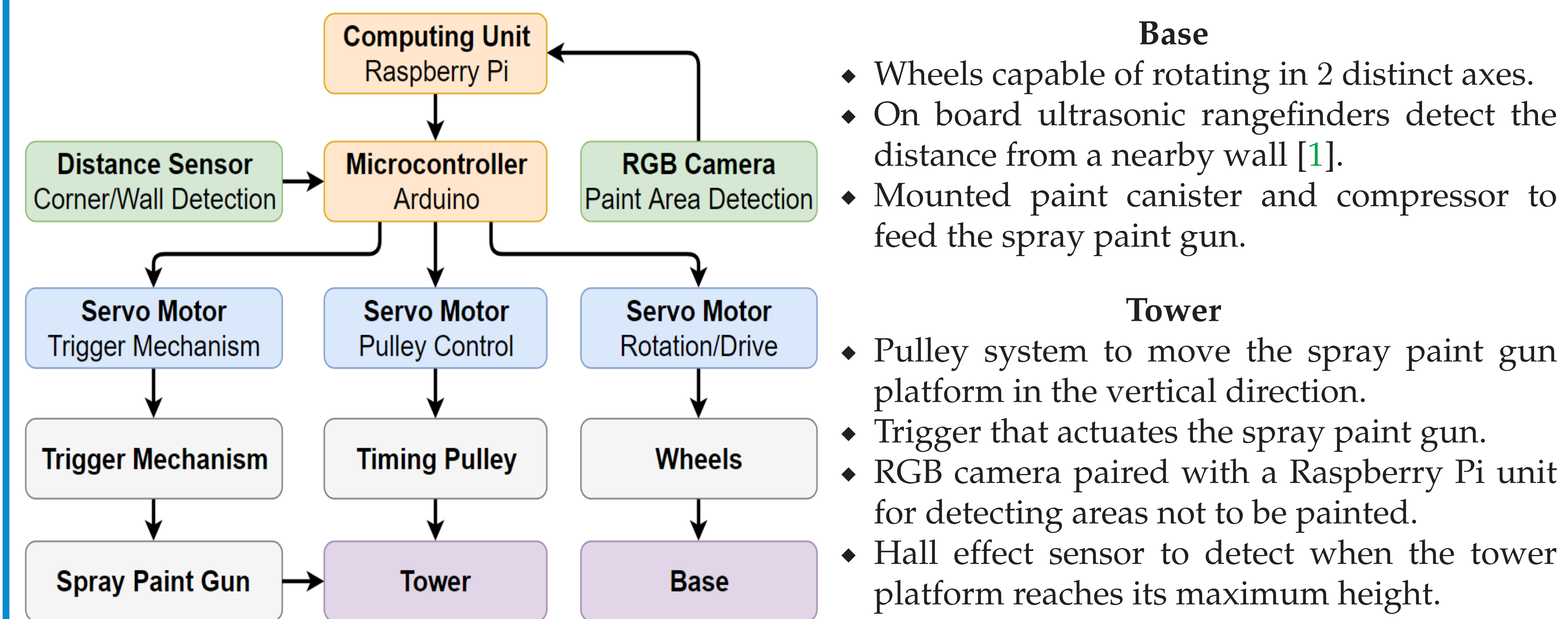
PaintBot Inc.

INTRODUCTION

The past century was marked by the automation of many manual processes, from assembly line manufacturing to home appliances. This trend of automation is continuing to breach new frontiers due to current advancements in robotics and machine learning technology. As a result, the team at PaintBot Inc. developed PaintBot - an innovative and high-tech solution which provides an automated and cost effective means for rapidly painting residential interiors.
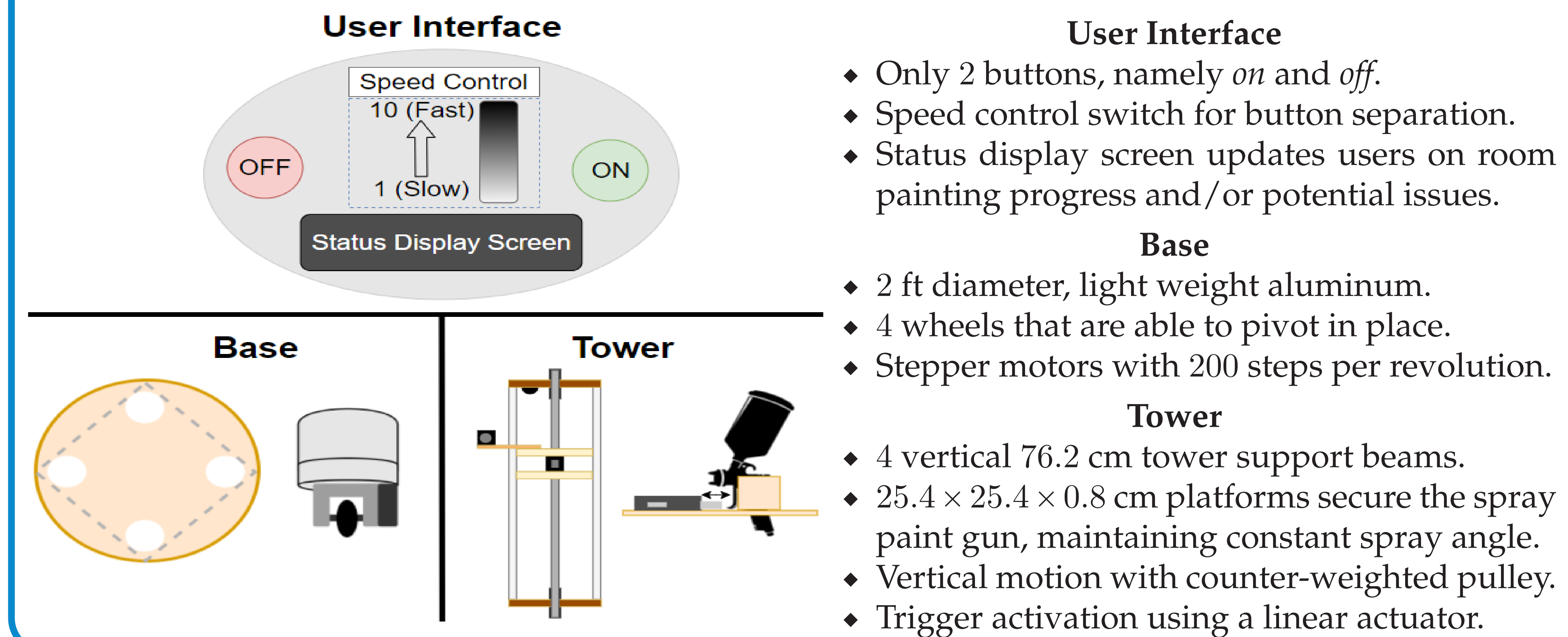
CORE REQUIREMENTS

The following details PaintBot's main functional requirements:
- Adjust position to correct distance from wall and turn around center to avoid any displacement.
- Travel along the perimeter of the room being painted while detecting surfaces/objects.
- Move the spray paint gun tower platform in the vertical direction at a constant velocity.
- Apply coats of paint evenly and accurately while avoiding areas that are not be painted.

SYSTEM OVERVIEW

Base
- Wheels capable of rotating in 2 distinct axes.
- On board ultrasonic rangefinders detect the distance from a nearby wall [1].
- Mounted paint canister and compressor to feed the spray paint gun.

Tower
- Pulley system to move the spray paint gun platform in the vertical direction.
- Trigger that actuates the spray paint gun.
- RGB camera paired with a Raspberry Pi unit for detecting areas not to be painted.
- Hall effect sensor to detect when the tower platform reaches its maximum height.

DESIGN

User Interface
- Only 2 buttons, namely *on* and *off*.
- Speed control switch for button separation.
- Status display screen updates users on room painting progress and/or potential issues.

Base
- 2 ft diameter, light weight aluminum.
- 4 wheels that are able to pivot in place.
- Stepper motors with 200 steps per revolution.

Tower
- 4 vertical 76.2 cm tower support beams.
- $25.4 \times 25.4 \times 0.8$ cm platforms secure the spray paint gun, maintaining constant spray angle.
- Vertical motion with counter-weighted pulley.
- Trigger activation using a linear actuator.

PRODUCT JUSTIFICATION

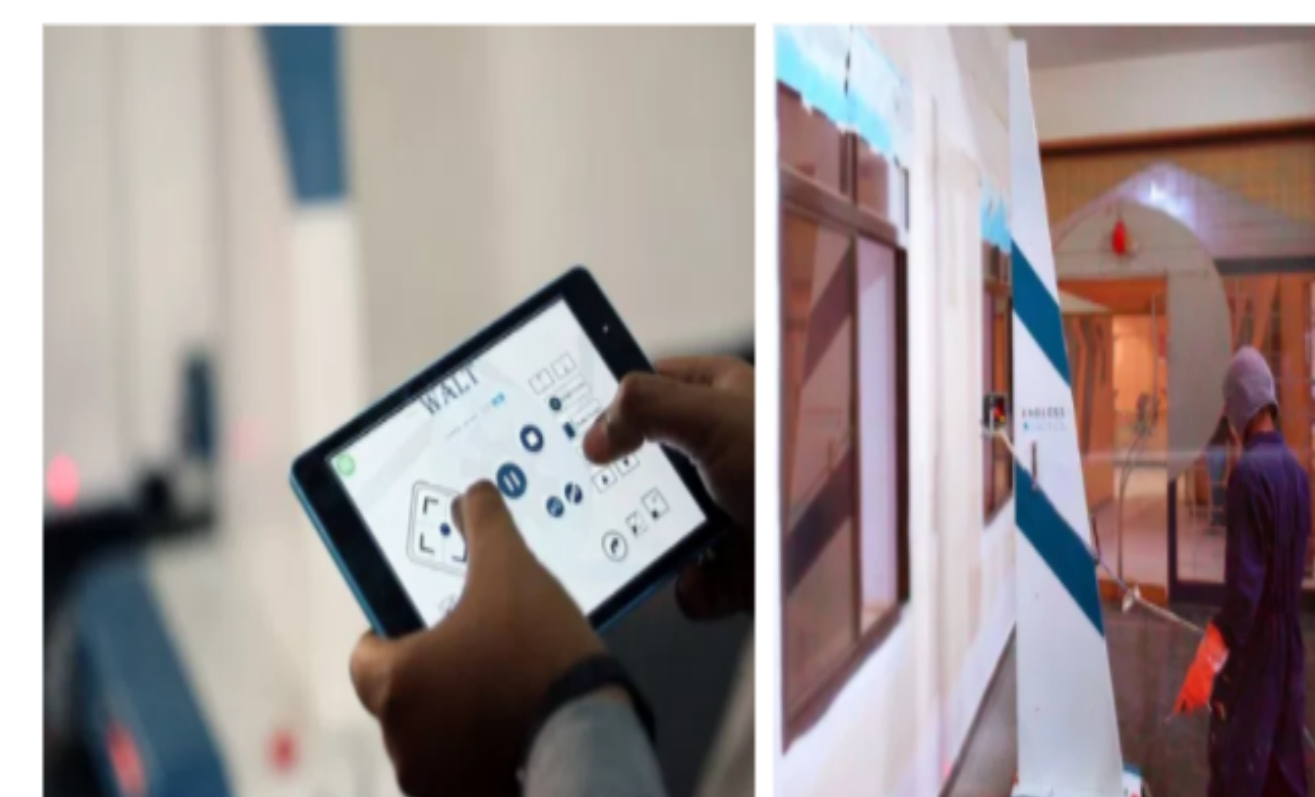**Risks**
- Components overheating.
- Paint fumes collecting inside/on PaintBot's surface.
- Damage to room walls, windows, or other objects.
- Painting unwanted areas.

Benefits
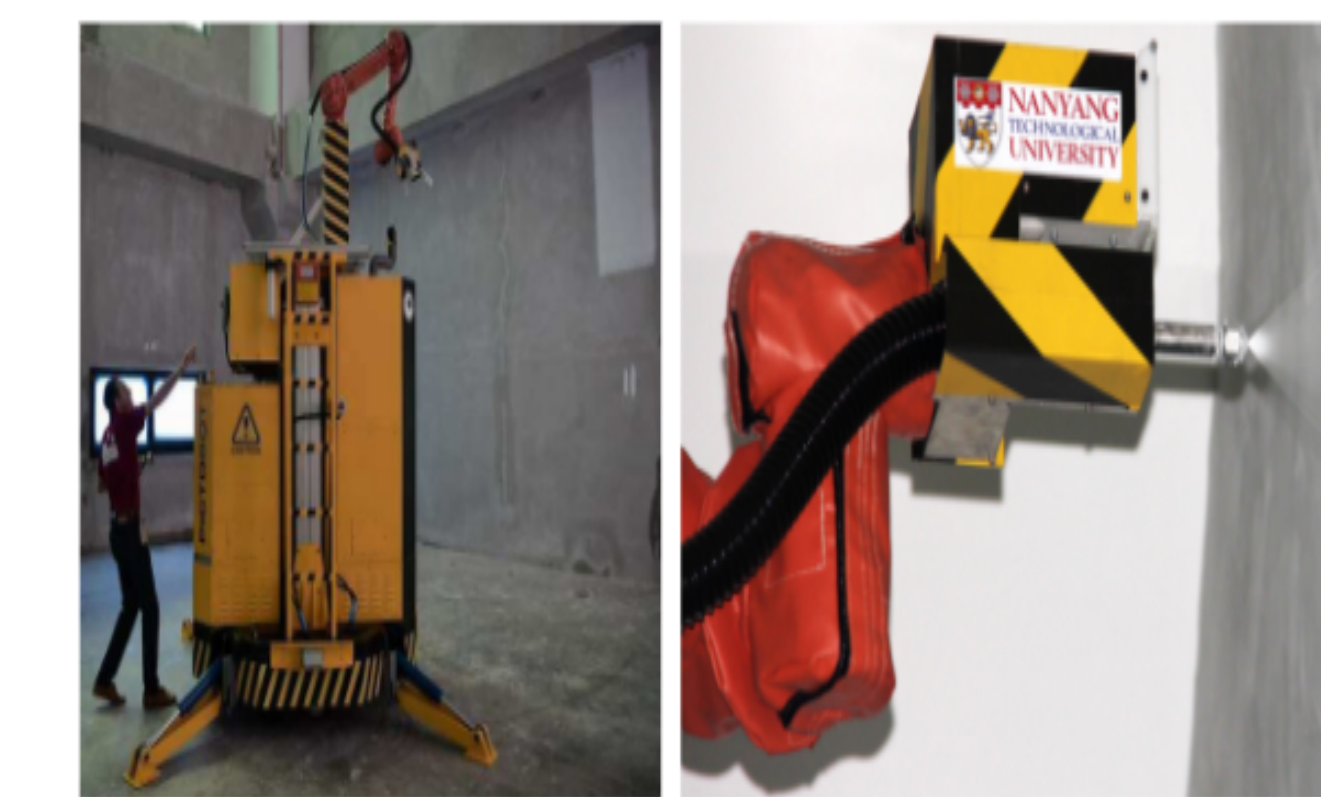- Reliable, efficient, and high quality service.
- User health and safety.
- Reduced long term costs.
- Limited competition for this type of automation.

COMPETITORS

Walt [2]
- PaintBot's main rival with $100,000 in funding.
- "10 fold increase in productivity of 3 workers".
- Not fully automated; navigation with mobile application.

PictoBot [3]
- $2 \times 2 \times 3.5$ meters with 10 meter arm reach.
- Impractical for use in residential buildings.
- Slow moving speed reduces room painting efficiency.

FUTURE WORK

PaintBot's Prototype and Final Product iterations will feature:

Prototype
- Thin, durable, and light aluminum construction.
- Cylindrical case, protecting the tower assembly.
- Spray paint gun that has built-in compressor & paint.

Final Product
- 9 ft height, targeting newly constructed apartments.
- Edge detection, for avoiding designated areas [4].
- Industrial spray paint gun to increase paint capacity.

CONCLUSION

At the push of a button, PaintBot will autonomously navigate around the perimeter of a room and accurately spray paint its walls.

PaintBot's core functionality includes:
- Circular footprint, providing stability and maneuverability.
- Pivoting wheels, allowing flexible and precise movement.
- Sensor systems, maintaining a uniform distance from walls.
- Tower assembly, enabling precise vertical spray positioning.
- Object detection, avoiding all areas that are not to be painted.

REFERENCES

[1] J. Borenstein and Y. Koren, "Obstacle avoidance with ultrasonic sensors," *IEEE Journal on Robotics and Automation*, vol. 4, no. 2, pp. 213–218, 1988.

[2] A. Murali, "Walt the bot is here to paint your walls, and it can do it 30 times faster than humans," https://goo.gl/WhncTq, 2017, [Online; accessed 11-Jan-2018].

[3] Y. S. Jo, "Saving time and manpower with Singapore-developed spray painting robot," https://goo.gl/agqvJi, 2016, [Online; accessed 10-Jan-2018].

[4] P. Dollár and C. L. Zitnick, "Fast edge detection using structured forests," *IEEE Transactions on Pattern Analysis and Machine Intelligence*, vol. 37, no. 8, pp. 1558–1570, 2015.