Human-Robot Collaboration to Improve Brazing Quality and Productivity”

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Introduction

What is brazing:

- Brazing is a well-established manufacturing process for a range of different safety-critical components.

Unique advantages provided by brazing:

- It provides unique features over other joining methods including the ability of joining dissimilar materials and providing ductile and strong joints with low costs.

Challenges and opportunities in brazing:

- Brazing process is still largely dependent on manual operations. Driven by the desire for automation and smart manufacturing into the fourth industrial revolution (also referred to as Industry 4.0), robots are capable of safe, collaborative working with operators is promising to perform brazing with higher accuracy and efficiency.
- Among many procedures of the brazing process, the brazing filler metal (BFM) deposition process (pre-placement) is one of the most significant variables in producing qualified joints, while very few research is conducted to establish the link between the process parameters of deposition and the joint quality. The lack of research is due to the hard modelling of the process and it requires re-programming when dealing parts with different geometry, which greatly impedes the process automation and digitisation. Nowadays, it is still common in the industry field to apply BFM by an experienced operator manually with brushes or applicator guns in which the repeat accuracy and efficiency of the human operator is hard to be guaranteed.

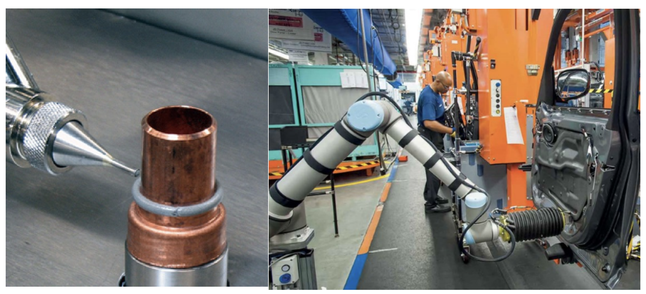


Figure 1. (Left) Brazing Filler Metal Dispensing[1]. (Right) Collaborative Robot[2].

Key requirement of this system:

- safety, accuracy, efficiency, intelligence, accessibility

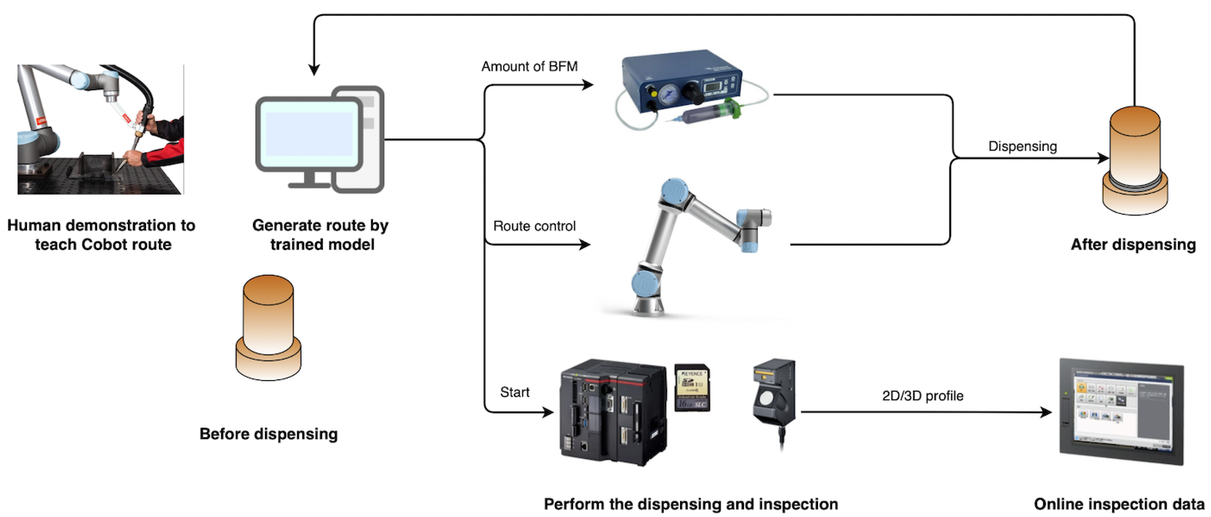
Aim

The purpose of this system is to:

- Digitise the process for quality control and analysis.
- Investigate the influence of parameters such as contact angle and braze volume to the quality of joints.
- Propose an automated method for accurate high-volume brazed joints inspection.
- Propose an algorithm for robot assisted automated BFM pasting.
- Investigate the relationship between the BFM deposition morphology and the brazed joints.
- Propose a framework of safe, fast, accurate and cost-efficient method for automated brazing to substitute the original human operation which is less accurate and efficient enough.

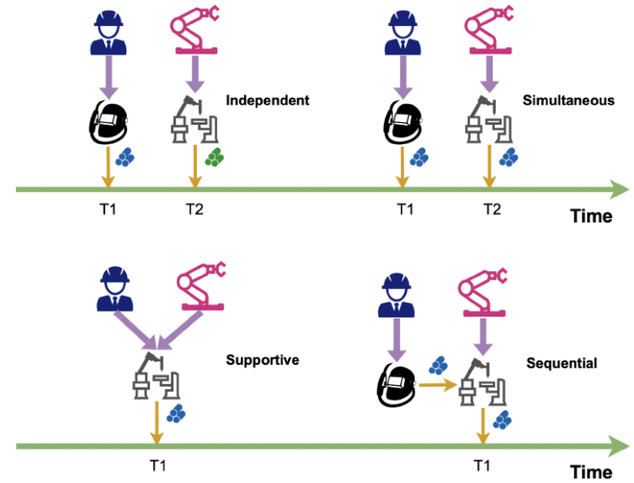
Methodology

1. The robot will be taught by demonstration on compliance mode.
2. During this process, an industrial camera will be used to observe the process to understand the context and target part.
3. Meanwhile, a laser scanner will be used to scan the part to record the part profile before dispensing.
4. Once the demonstration is done, the robot will perform the same process on the parts in its field of view.
5. The performing of the application includes recognising the part, move towards the part and perform the dispensing with the corrected route



Human robot collaboration mode

There are four types of human-robot collaboration mode[3]. One of our main difficulties is finding a mode for Cobot to perform dispensing accurately and efficiently while ensuring the safety of human operators.
Independent: The operator and Cobot share the same place while doing different jobs.
Simultaneous: Cobot and operator work on the same workpieces at the same or different times.
Supportive: Both the operator and Cobot need to work on the same working pieces and towards the same goal.
Sequential: Where human and Cobot work on the same piece but process the piece in a sequential manner.



[1]. Image address: https://www.finsmes.com/wp-content/uploads/2018/11/collaborative-robots-in-the-automotive-indistry_2.jpg

[2]. Image address: https://vacaero.com/wp-content/uploads/2016/03/Fig_8.gif

[3]. El Zaatari, S., Marei, M., Li, W., & Usman, Z. (2019). Cobot programming for collaborative industrial tasks: An overview. *Robotics and Autonomous Systems*, *116*, 162–180. https://doi.org/10.1016/j.robot.2019.03.003

Acknowledgments

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