University of Wales, Aberystwyth
Centre for Intelligent Systems

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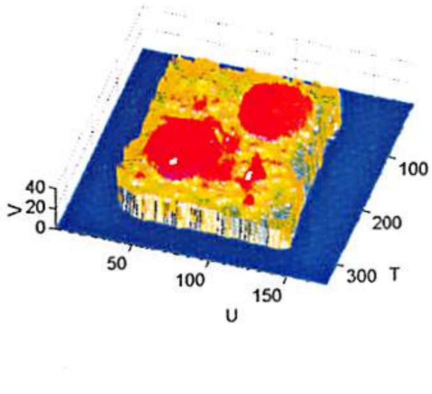
Food Assembly by Learning from Examples
Teaching by Example for Flexible Automation in Food Product Assembly

Motivation and Aims

Snack-food assembly is normally a labour intensive process undertaken, for hygiene reasons, in chilled environments. This leads to discomfort for the workforce and can lead to difficulty in recruiting workers. In turn, this can limit expansion and also leads to difficulty in recruiting staff able to undertake certain of the more skilled manual operations. Automation is well established where production runs are large and changes of product type are infrequent. However, short runs with frequent changes of product, and, particularly, the introduction of new product types, require flexible automation that can be reconfigured easily without the need for the involvement of specialists in computing or robotics. The aim of this project is to research and demonstrate sensing and control techniques that permit food assembly tasks to be specified to robotic systems simply by showing examples of the results required. The types of operation to be considered include placement of objects onto substrates, and the formation of certain materials into various surface profiles.

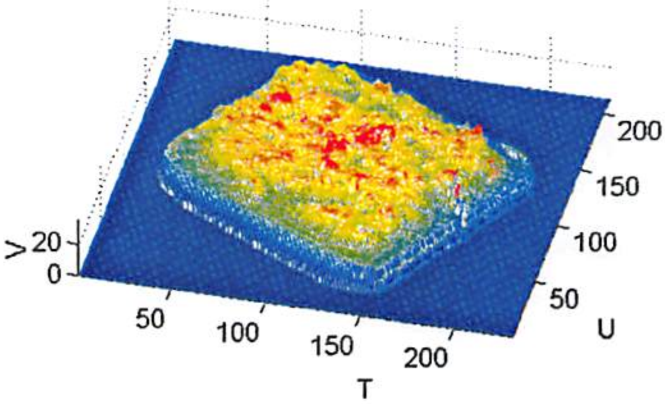


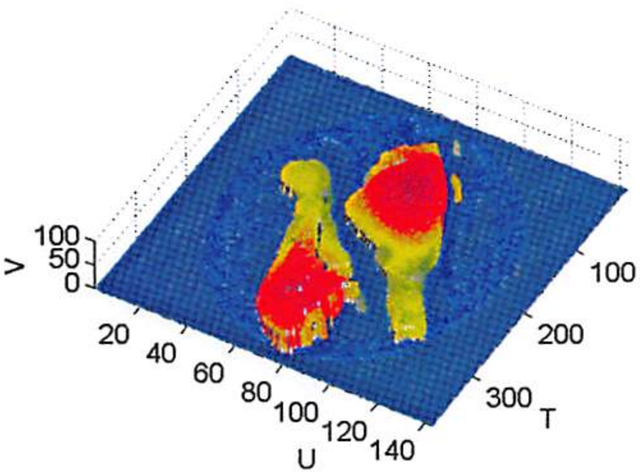
Method

The work builds on previous work in autonomous grasping of food items [2]. The underlying method uses models formed by means of 2.5 dimensional profile sensing. A hand-built example of the product is scanned by the system. When a partly completed product is then presented the necessary robot motions are derived to bring about the desired manipulations to produce an end product which resembles the example taught to it. The system is designed to be able to accommodate the large degree of natural variations in substrates and components when assembling products. The work is being undertaken on an Adept 1 manipulator but it is recognised that in an industrial environment a low cost manipulator with fewer degrees of freedom would be more appropriate and the methods developed allow for this. All sensing and control is achieved via an external PC.

Current Status

A paper describing the proposed system and preliminary experiments has been presented at an international conference [1]. We have since conducted further extensive experiments on simulated and real food components which have demonstrated the robustness and placement accuracy of the system to within an average of 2.5mm for three example products: cucumber slices on bread substrate, sausage slices on bread substrate and chicken breast pieces on lettuce substrate. Further investigations have centred on extending the system to deal with spreadable materials.





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[1] T. G. Williams, J. J. Rowland, M. H. Lee and M. J. Neal. *Teaching by Example in Food Assembly by Robot.* In Proc. IEEE Intl. Conf. on Robotics and Automation, San Francisco, USA, April 2000, pp 3247-3252.

[2] M. J. Neal, J. J. Rowland and M. H. Lee. *A behaviour-based approach to robotic grasp formulation: experimental evaluation in a food product handling application.* In Proc. IEEE Intl. Conf. on Robotics and Automation, Albuquerque, USA, April 1997, pp 304-309.

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