University of Salford

Centre for Robotics & Automation

CENTER FOR ROBOTICS AND AUTOMATION

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- Control, Learning Procedures
- Sensors
- Actuators
- Grippers
- Systems Architectures
- Haptics
- Simulation,V.R Environments

Applications

- Mobile Robotics
- Actuators for the nuclear industry
- Robotics in surgery
- Medical applications
- Automated Food assembly

Sector Activities

- E.P.S.R.C network on automated food assembly
- Food Manufacturing Engineering Group
- E.H.E.D.G
- Workshops/research brokerage events on automation in food manufacturing
- D.E.F.R.A / N.W.D.A initiative on food manufacturing

Drivers for Automation

- Consistency of product quality
- Economics
- Hygienic operation
- Traceability
- Supply chain integration
- Human factors
- Legislation

Technical Progress

- Advances in gripper design
- Innovative sensors and signal processing techniques
- Advanced control and error detection methods
- Advances in the design of high speed reconfigurable automation mechanisms

Technical Progress

- Advances in materials for hygienic design
- Advanced robotic systems for autonomous operation in sealed environments
- Availability of powerful management software for distributed automation

Special Factors

- Manipulation of soft fragile material and products with variable dimensions
- Need for hygienic manufacturing
- Requirement for easily reconfigured machines to meet changing product lines and market needs
- Emerging global standards based on e-commerce supply chain procedures

The Food Processing Industry

- Operates in a highly competitive and increasingly global market,
- Short product lead times are essential,
- Product life cycles are short and
- Margins are low.
- Feed-stocks are natural and variable,
- supply and demand are seasonal and regional
- 90% of production equipment is currently imported.
- Flexibility and efficiency are currently provided by operator adaptability.

The UK Sandwich Industry

- £4billion turnover
- Manually intensive, little automation
- A single factory can manufacture over 800,000 sandwiches per week
- Massive variety of types
- Orders received by 6.00 am for delivery commencing at 11.00 am same day
- Volatile customer preferences

Sandwich Assembly

Programme Objectives

- the handling characteristics and dynamics of sandwich structures (bread slices and filled sandwiches)
- analyse sandwich operator movements and manipulations to determine essential elements for an automated solution
- investigate, develop and demonstrate effective automation mechanisms for the key steps
- to demonstrate that such automation is appropriate for food factory conditions.

Design Philosophy

- Key problems requiring research identified through a joint RTO/University/Industry study using methodologies proven in non-food sectors
  - full specification to develop commercially acceptable production machines will be developed
- Solutions involving novel application of technology from a variety of sectors have been proposed
  - robust design environment limiting trial and error with simulation experience and technology available in team
  - experience of local intelligence in grippers

Design Approach

- Construction based on the modular machine tool concepts, with distributed drives where appropriate.
  - A mechatronic approach minimises the mechanical parts.
  - Robot prototyping makes the motion profile of the manipulators and machine sequencing programmable and rapid.
  - Novel grippers suitable to the environment and design constraints.
  - Control system with appropriate vision and sensory systems so that grasping actions and motion profiles can be optimised on-line.
  - Machine design that can cope with a wide range of product/dimensional variability, and can be adapted for new or upgraded products with the minimum of capital cost.

Design Approach

- Flexible and dexterous assembly of typical, difficult to handle sandwich components
  - (bread, meats, pastes, vegetables, fruits, etc.),
  - tolerating high levels of product variability at high speed
  - giving excellent presentation of sandwich to the consumer
- Development of robust manipulation solutions as tolerant to product variability as the human with exceptionally high reliability
- Rapid robotic prototyping of solutions tolerant of food environment, including improved cutting
- Delivering a flexible reconfigurable solution, given that the product life of a sandwich type can be a matter of weeks

Structured Problem Solving

- LINE INVESTIGATION
- MATERIAL STUDY
- END-EFFECTOR DEVELOPMENT
- TRANSFER MECHANISM DEVELOPMENT
- DESIGN EVALUATION AND SELECTION
- BUILD OF KEY DEMONSTRATOR RIGS
- TRIALLING AND EVALUATION OF RIGS

Conclusions

- There are a great number of repetitive tasks undertaken by operators in high care areas in the food industry.
- Approach adopted used a formal analysis methodology, design engineering tools and modular mechatronic technology
- Enables many tasks to be economically automated w
- assured reliability and
- minimal hardware redundancy as products change or variety increases to match the flexibility of hand operations.

- Support from DEFRA Link Contract AFM 173

Industrial Partners

- I.N.B.I.S
- A.M.T.R.I
- R.T.S Robotics
- F.M.E G
- Campden R.I

Food Manufacturing Engineering Group

- D.E.F.R.A
- E.P.S.R.C
- Nestle
- Unilever
- Northern Foods
- United Biscuits
- Marks and Spencers

- I.E.E
- B.B.S.R.C
- Siemens
- Invensis
- R.T.S.Robotics
- I.N.B.I.S
- N.W.F.A