Review of the Food Radar system for foreign body detection

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Manufacturing Technologies and Heat Preserved Foods MIGs, 4/10/16
On-line technologies for food process control

- Member funded project, 2014 – 2016
- Steered by Manufacturing Technology MIG

Objectives

- Review on-line sensing technologies and their potential for food process control
- Evaluate and demonstrate new sensor applications and their benefits
  - Practical evaluations
  - Technologies must be commercially available and suitable for online use
Progress

• Review of current technologies
  – R&D report 388 published 2015

• Review of Electrical tomography
  – R&D report 400 published 2016
  – Non invasive monitoring of homogeneity, sedimentation, aeration, complex flows etc.
Latest trial: Food Radar

- Foreign body detection system
- Practical trials conducted at pilot scale
- R&D report 412 available soon
Foreign bodies

- Solid objects present in food, but unintended/undesirable
- Intrinsic: derived from part of the material from which the food is made
  - e.g. bone, nut shell, egg shell, extraneous vegetable matter (stalks etc.)
- Extrinsic: other origin
  - Received in raw materials or contamination during process
  - e.g. glass, wood, metal, stone, plastic
Detection and removal approaches

- Physical separation – sieving, aspiration, magnets etc.
- Metal detection
- X-ray detection
  - Bone, metal, stones etc.
- Colour sorting, visible imaging
  - Externally visible objects only
- Technologies lacking for low density materials – plastic, wood etc.
Food Radar

- Patented microwave technology

- Manufacturer
  - Food Radar Systems
  - Gothenburg, Sweden
  - www.foodradar.com

- Applicable to pumpable products
  - e.g. sauces, jams, baby food, yoghurt with fruit pieces
  - Mainly water-based products
Food Radar

- IP67 enclosures
- Valve has EHDG certification
- 1.5 to 2.5" pipe diameter
- Up to 16 tonne/hour capacity
- Price: €110,000-180,000
Principle of operation

- Microwaves transmitted through product for different paths and frequencies.
- Foreign body changes detected signal amplitude
- Detection if this exceeds background signal for the food product by more than a threshold value
- Detection strength = number of channels with detection.
Principle of operation

- Two detection positions
- Detection at both positions in sequence triggers rejection valve
- Timing of detections determines timing and duration of rejection
Pilot system

• Trials conducted using pilot system at Food Radar, Gothenburg

• Products and foreign bodies selected by Campden BRI
Trial products

• Ketchup
• Strawberry jam
  – With whole strawberries
• Sweet and sour sauce
  – With vegetable pieces
    ~10-20mm
• Baby food
  – With pork and cauliflower
    pieces ~5mm
Foreign bodies

- Plastic
- Rubber
- Stone
- Glass
- Wood
- Cherry stone
- Bone
- Vegetable stalk
- etc.
Results

<table>
<thead>
<tr>
<th></th>
<th>Ketchup</th>
<th>Strawberry jam</th>
<th>Sweet and sour sauce</th>
<th>Baby food</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of trials</td>
<td>30</td>
<td>34</td>
<td>37</td>
<td>28</td>
</tr>
<tr>
<td>Number of items</td>
<td>28</td>
<td>32</td>
<td>29</td>
<td>21</td>
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<tr>
<td>detected</td>
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<tr>
<td>Number of items</td>
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<td>2</td>
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<td>7</td>
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<tr>
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<td></td>
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<tr>
<td>Number of false</td>
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<td>19</td>
<td>11</td>
<td>5</td>
</tr>
<tr>
<td>detections</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Most items detected for sizes $\geq 10\text{mm}$
- Extrinsic objects (plastic, rubber, glass, wood) and dense materials (cherry stone, bone) detected well.
- Vegetable stalk and insect not detected in sauce and baby food (too similar to product?), but woody corn cob detected.
- High false positives, probably due to bubbles.
  - ‘Airzip’ accessory claimed to solve this.
Scope for other applications

• Non-aqueous products?
  – Less suitable due to higher microwave absorbance. Has been used for pesto, not recommended for meat.

• Detection of intended particulate materials (fruit, nuts etc.)?
  – No. Detection based on outliers from background signal.

• Products at elevated temperature?
  – Not possible to test with pilot system
Conclusions

• The Food Radar system can detect many types of foreign body difficult to detect with other technologies, including plastic, rubber etc.
  – Only suitable for pumpable products
  – Detectable object size ~10mm
• High false positives in due to bubbles in trial, claimed to be addressed by ‘Airzip’ system
• Rated for food use, several systems already in use.
• Benefits for food manufacturers
  – Suitable for internal use to improve quality and reduce foreign body risk
  – Could reduce customer complaints, but difficult to guarantee performance for assurance
• Price: ~€110-180k