Medipix application in food QA

Preliminary assessment

Application of the MEDIPIX technology to:

- Food
    - All kind of food
    - Fruits: maturation, QC, DNA modification, hybrids
    - Possible applications
        - At farms
        - At grocery stores
        - In fruit processing factories
        - At home
- Water
    - Drinkable water
    - Swimming pools
    - Waste water

Who do we have to speak to:

- Medipix team
    - How does it work?
    - Is it possible to do that?
    - Scan over the whole tree?
- Agriculture fruit experts
    - How do you know if a fruit is mature?
    - What technologies are implemented for fruit maturity check?
    - Quality control of fruit?
- Grocery store
    - How much fruit waste?
    - How much fruit do you sell?
    - Would you be interested in such kind of technology?
- Household
    - What about food waste?

Other technology

- 2015. Q eye multi sensor
  Q Eye Multi-Sensor Quality Scanner Scans, Grades and Classifies Fruit for optimised Sorting

- Eagle Material Discrimination X-ray (MDX) Technology
  2012 Cost Effective Sensor Measures Fruits' Ripeness
  $1 sensor that detects tiny amounts of ethylene, a gas that promotes ripening in plants.
  Developed by MIT.
  Made a spin off from research: http://www.c2sense.com/solutions/

- 2015 New MIT Sensor Detects Spoiled Meat
  MIT have developed an inexpensive, portable sensor that can detect gases emitted by rotting meat.
  Small, no expertise required and connects to app to read out results.

- 2016 Handy Device + Phone App Tells if Fruit Is Ripe
  MIT made a portable spectrometer that scans fruit and wirelessly relays data to a smartphone app that tells you whether the fruit is ripe. $250. Developed for use by farmers at harvest time. Consumers can also use in grocery store.
  The technique should work on other fruit and vegetables in which chlorophyll fluorescence is significant, such as bananas and oranges. But the researchers will have to gather more data on different fruit in order to come up with a software model that works for each.

- 2014 Hand-Held Spectroscopy Tool Lets You Examine the Molecular Composition of Your Food
  Stared kickstarter
  2015. https://www.consumerphysics.com/ SCiO device.

- Clarifruit
  User scans the fruit (or a cluster of fruits) with built-in phone camera and with portable SCiO molecular sensor (or spectrometer). For agri industry and consumers.
  Startup currently in seed stage
  News article outlining capabilities

- X-ray Product Inspection Solutions for food industry
  This company provides solutions for packed and fresh food x-ray vision analysis.
  They do not apply spectroscopy for analysis.

- 2013. Image processing for smart farming: Detection of disease and fruit grading
  Research paper outlining use of image processing using MATLAB
  Looks complicated and time consuming

- 2017. Fruit Disease Detection Using Color Analysis and ANN with E-Nose

- 2015. Rapid detection and identification methods for *Listeria monocytogenes* in the food chain – A review

- 2013: Reducing food loss and waste:
  http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.360.951&rep=rep1&type=pdf

- 2017:https://reader.elsevier.com/reader/sd/AD89EF1868A31C80A21B1BC753249DFBA23640747E5FF2B0D7CC66C1F73F315569370EC821C2CDAC0CC6505A03754B04
  Using laser Doppler vibrometer in apples. Non-destructive firmness assessment of apples using a non-contact laser excitation system based on a laser-induced plasma shock wave.

- 2013:https://ac.els-cdn.com/S0924424713003580/1-s2.0-S0924424713003580-main.pdf?_tid=f38b812b-b58f-4423-a6ca-40f47597d1b1&acdnat=1534150538_1ad5c781e892d11de24e2c2c29152b04
  Piezoelectric transducers for real-time evaluation of fruit firmness. Part I: Theory and development of acoustic techniques.

Interview with M. Campbell

- Medipix energy resolution limited to 2kV, quite low to perform XRF analysis
- Cost reduction sustainable if 10.000 pieces per year production (due to ball-boding automatization)
- Available an X-ray box for test measurements
- Best application in transmission with varying X-ray wavelength at input
- Only TSMC granted for Medipix chip production

Interview with a seeds and fertilizers supplier from Elanco in Greece

- Very expensive technology to be used in fruits.
- Most of the times through optical examination you can determine if a fruit is edible or not.
- Perhaps it could be used in watermelons.
- In most cases there are already other ways to tell about the ripeness of a fruit. For raisins for example they use instruments that detect the deflection of light and cost around 200€ - 300€.

Interview with Achema (company with scientific equipment) in Greece

- There is no actual interest in this kind of device in Greece.
- It is too expensive to be used. There are other cheaper ways.
- Maybe 2-3 (non Greek) companies that transporting fruits could use Medipix to determine for how long could the fruits survive in their fridges.

Final summary

Expensive technology that has not a strong fit for food ripeness analysis, while food safety technology is a mature and competitive market.

Strengths

- Huge amount of detail gathered from images

Weaknesses

- **High cost**: Chips and x-ray machines are expensive
- **Size**: Can only be used to x-ray relatively small objects
- **Can’t scan entire trees** or crops with x-ray
- Can do based chemical composition (water, fat, protein etc), but **can’t detect bacteria levels or disease so easily**
- Not a strong fit for food ripeness analysis

Opportunities

- Could maybe be used for analysis of genetically modified food during the process.

Threats

- Competitive market - food safety technology is a mature market