**Metamaterial Visual Output**

**Hi!**

# Idea

We can make metamaterials by 3D printing special repeating patterns

Metamaterial is a 3D printed cell structure.

Can we make metamaterial structures that change their appearance when we interact with them? One approach could be to create structures that reveal predetermined colors when force is applied. Students in UIT ’21 made a successful start on this idea.

3D Printer

PLA filament

TPU filament

Collection of exampled

Design guidelines

1. **concrete plans on how to explore the ideas**
   1. **What is interesting and novel about it**
   2. **Develop lines of thought around exploring ways to test the idea**
   3. **Refine these possible explorations into manageable chunks suitable for your project**

Food is our daily necessities, and what we can do with food package to extend its shelf life, optimize shelf exposure, detect food ripening stage, detect food freshness or reduce food waste. Through group discussion, there are two purposes to achieve for our interactive custom food packaging: 1) the food information will be shown to the customer, such as food origin, nutrition, handling, storage and transportation. 2) there is a sensor to sense storage condition of food package and food freshness to extend its shelf life.

Title: The Role and Importance of Packaging and Labeling in Assuring Food Safety, Quality and Regulatory Compliance of Export Products II: Packaging & Labeling Considerations

Authors: Andre Gordon; Rochelle Williams

URL: <https://www.sciencedirect.com/science/article/pii/B9780128142721000073>

# Possible Applications

Possible future: If it was already done and perfected by someone else, what would it enable that is not currently possible now or is it too hard.

The ideas we have were already done by some manufacturers. There is a system that contains a screen and an enabled surface to show the food information to consumer, such as nutrition and the amount of food left in the package, which help consumers know when they need to refill the product at home. There are labels that can detect any changes in the carbon dioxide levels in the air and aid in the distribution and shipping of fresh food products to indicate the freshness of food to consumer.

To enhance the interaction between consumers and the for product, we can have an NFC-enabled package, so the consumers can get more information about the food product, such as its origin, the handling, manufacturer and more information like the freshness of food, that are processed from other supporting applications.

So we start brainstorming, if we can explore other ways to detect the freshness and the ripening grade of food to suggest the best consume time for the customers and prevent food waste. For instance, through temperature (which we can use thermochromic ink to detect), other gas content in the air (maybe ammonia), or ph value and so on.

Lightning sensor on the object so the customer can be able to read the context on the object no matter what lighting is in the around environment.

Laser cutting cardboard, which can be folded or assembled into an object.

Similar idea we have thought was to design a package that can be dissembled into pieces and attach into another object.

# Related Papers

**Paper information (title, authors, URL)**

**How the paper is related to the idea**

**What conceptual and / or technological approach the paper took**

**What the skills, knowledge, and resources you think were involved in the work**

**What the authors did not do – what shortcuts did they took, what parts of the idea were only lightly sketched in or were unimplemented, what details were left to future work and so on.**

Title: Radio-Frequency-Identification-Based Intelligent Packaging: Electromagnetic Classification of Tropical Fruit Ripening

Authors: Cecilia Occhiuzzi; Nicola D’Uva; Simone Nappi

URL: <https://ieeexplore.ieee.org/abstract/document/9159579>

Keys:

Food package that gives informative digital content about the contained products. Estimates the ripening grade of fruits, which can reduce food waste, suggest customers when the fruits should be consumed. Engage customers through enhanced user experiences. Define the best time to consume and eat fruits.

Radio-frequency identification (RFID) with sensorless, low-cost labels, empowered with electromagnetic-based intelligence and automatic classification tools, may stimulate the widespread diffusion of this technology.

Food industry, Sensors, Monitors, RFID totem

Description:

This paper uses a scale-like Radio-Frequency-Identification-Based totem, including an object reader connected to a near field antenna, which detects the current contained fruit’s ripening grade and estimates when the fruit will achieve its ripening status. In addition, it informs the fruit origin and handling. The purpose is to suggest customers the best time to consume and eat the fruits, reduce the food waste, and help the retailer with shelf exposure. During the experiments, the authors concerned about fruit's firmness and complex permittivity to evaluate and classify the ripening grades. The authors did the experiments mainly on avocado, and they decide to involve other tropical fruits, such as mangoes and papayas in the future work.

Title: Using Technology in Smart and Intelligent Food Packages as a Communicational Tool with Consumers

Authors: Dina Elkhattat; Mervat Medhat

URL: <https://ieeexplore.ieee.org/abstract/document/9443994?casa_token=xr3XwgIyGwgAAAAA:O_iwrrmASfaSEhyImF6mspQFK5GvsdtXGDY79kJDz4Hq0RAHrLsdYZKS27mSe-tPiR1VBT3Zp1SIyg>

Increase the interaction with consumers and help them to ensure the quality of the product and interact with them technologically through sensors of the active packaging.

Increase interaction in three main stages: sensation, attraction and functionality.

Food packaging design,

Reduce the amount of food waste and support recycling, by connecting them through smartphone to review the detailed information in that context.

Title: Smart Packaging: definitions, models and packaging as an intermediator between digital and physical product management

Authors: Justina Lydekaityte, Torben Tambo

URL: <https://www.tandfonline.com/doi/abs/10.1080/09593969.2020.1724555>

To enhance the products functionality or experience in order to serve its primary initial purpose more effectively.

To improve consumer’s experiences through engagement and entertainment in both the retail and the usage environment.

Bridging the general consumer experience between digital marketing and physical shopping using packaging is a novelty in retailing and brand management.

Limitations are given from the modest proliferation of smart and interactive packaging into empirical contexts.

Title: Extended User Interface: NFC-Enabled Product Packaging for Enhanced User Experience

Authors: Justina Lydekaityte

URL: <https://link.springer.com/chapter/10.1007/978-3-030-50344-4_21>

Keys:

Microprocessors, sensors, actuators and wireless data-exchange supporting chips can be embedded, into packaging design creating an extended user interface – a touchpoint for a visual, tactile and digital encounter with consumers.

The purse is to investigate the current state-of-the-art and potentials of Near Field Communication (NFC) system

Form a strong link between manufacturers and their end-users.

Description:

Title: New Plans for Cans

Authors: Foreman, Marvin

URL: <https://www.proquest.com/docview/2409181050?pq-origsite=gscholar&fromopenview=true>

Digital print for beverage cans,

# Potential Explorations

**Prove a single, novel concept not to design a product or service.**

**What is the core concept of this exploration? Reduce it to the basics as much as possible!**

**What is the main conceptual and/or technological approach? That is, what would you do to explore the idea?**

**What skills, knowledge, and resources will be necessary?**

**Do you have any of the skills and knowledge? Are the resources available to you?**

**What is the bare minimum of implementation necessary to prove the concept? What can you leave out and how can you cheat on the parts that are not the core concept itself?**

**What is the rough progression of exploration? What are the first few steps?**

**How will you decide if you have succeeded?**