

The Intelligent Container – What can MEMS do for Logistics of Food?

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Abstract: One third of the food produced on earth is never eaten, but lost. A considerable loss of food during transport could be prevented, if modern sensor technology would be used to manage the supply chain. The Intelligent Container project aims at reducing losses of food in transport by using sensor and communication technology and to improve supply chain management. The environment of the fruit during transport is observed concerning temperature, humidity and acceleration. The remaining shelf life time is continuously estimated. The status of ripening and decay of fruit is monitored looking at ethylene – a gaseous ripening indicator of many fruit. New micro gas chromatography systems are developed for the ethylene detection. For autonomous decisions, shelf life estimators and other decision support tools are embedded in the sensor network.

Keywords: Intelligent Container, sensor networks, logistics, mold detection, ethylene sensor, FEFO

I. INTRODUCTION

Out of the food produced on this world, two third are eaten, on third is loss. Gustavsson [1] found that losses occur by the consumer, but more losses occur during production, transport and retailing.

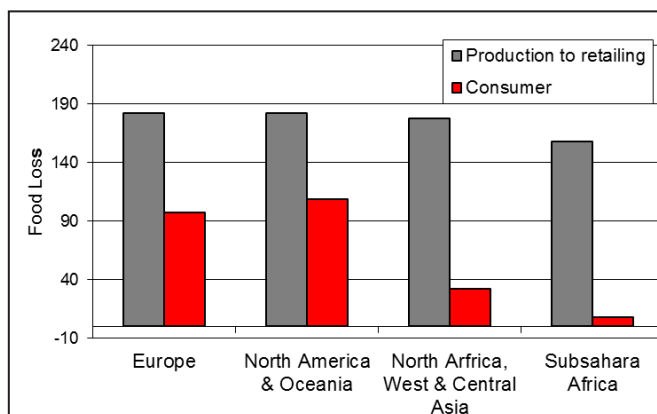


Figure 1: Food loss per capita in kg/year [1] for different parts of the world. Adapted from Gustavsson et. al. [1]

Consumer losses differ a lot between first and third world, but losses due to production and retailing do not differ much. A considerable part of these losses is caused by quality problems in the transport chain. Temperature and humidity are badly controlled, dangerous states such as premature ripening and decay of fruits are not detected, mould fungus infection destroys food. MEMS sensors and wireless sensor networks can identify problems, allow better control and help to reduce the losses.

II. HOW CAN REAL TIME DATA IMPROVE THE SITUATION?

Sensor networks can supply real time data about the transport and storage processes. How might these data be used for improvement? In logistic processes, the chances to interfere are very limited. Imagine a cooled reefer container on a ship suffering from a hot spot, caused by a failure in stowing which cuts off convective flow. The sensor network detects fruits starting to rot at this hot spot. We cannot increase the cooling power because overcooling will harm other fruits that are close to the air inlet. Nor can we change the stowing to allow the cool air to flow. But still, there are valuable action possibilities.

A. Changing the logistic chain: Dynamic FEFO

When I know that a certain load is in danger, I can give notice to the receiving harbor to care for this reefer first of others. In road transport, I can reallocate it to a closer customer. Even if the load definitively is lost, real time information is useful: I do not transport freight which will be lost at the destination, this way I save cost, fuel and import taxes. Furthermore, I can start replacement to be shipped asap, this way avoiding problems with unsatisfied customers.

The classic paradigm of logistics is First in – First out (FIFO). The charges are processed in order of their arrival. Due to computer control of the logistic chain, these days a new logistic paradigm is taking over: First expire - First out (FEFO). Those charges which are closer to their defined expiration date are processed preferentially. Sensor networks will allow advancing even more: Those pallets or freight items, which are actually closer to their decay, will be processed first. The time to decay is called “remaining shelf