Wireless quality monitoring in the food chain

Demo Abstract

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1 The Idea

Abstract

The pre-processing of measurement data inside a wireless sensor node reduces the volume of communication. A model that predicts the effects of temperature deviations on the quality of fresh food products was developed for two different sensor platforms. Optimized integer arithmetic enables to calculate the predictive model on existing sensor hardware.

Shelf life as scale for food quality

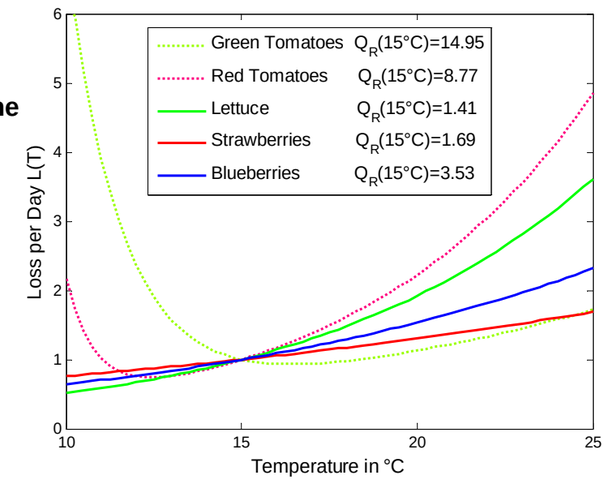
The quality of food can be described as the number of days that are left until the quality drops under an acceptance limit (color losses, taste, texture …). This shelf life can be re-calculated as a function of the temperature or transport history of the product.

(Photo by Cool Chain Group, Bremen)

2 Shelf life modeling

A mathematical model calculates the loss per day L(T) as a function of storage / transport temperature (T). The activity of biological processes is calculated according to the Arrhenius law for reaction kinetics

$$k = k_R \cdot e^{\frac{E_A}{R_{Gas}} \cdot \left(\frac{1}{T_R} - \frac{1}{T} \right)}$$



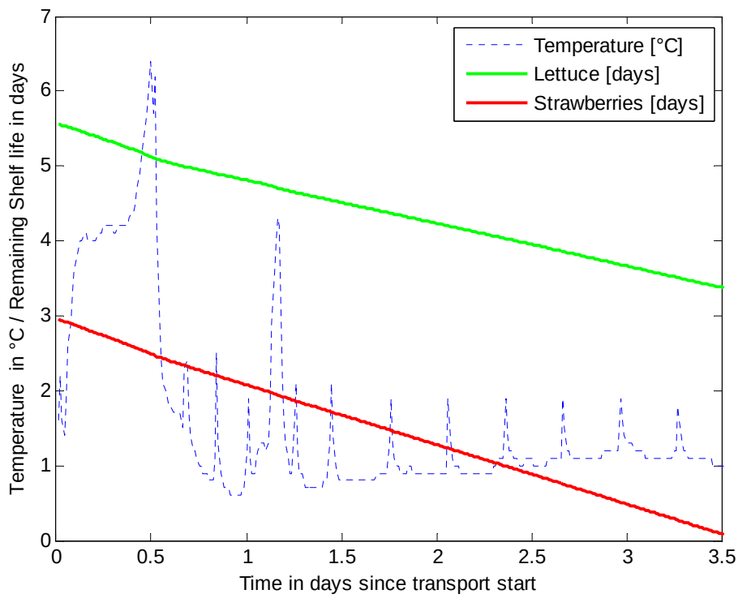
Products that are sensitive against "chilling injuries" are modelled by a set of two Arrhenius functions.

$$L(T) = \frac{k_1(T) + k_2(T)}{k_1(T_S) + k_2(T_S)}$$

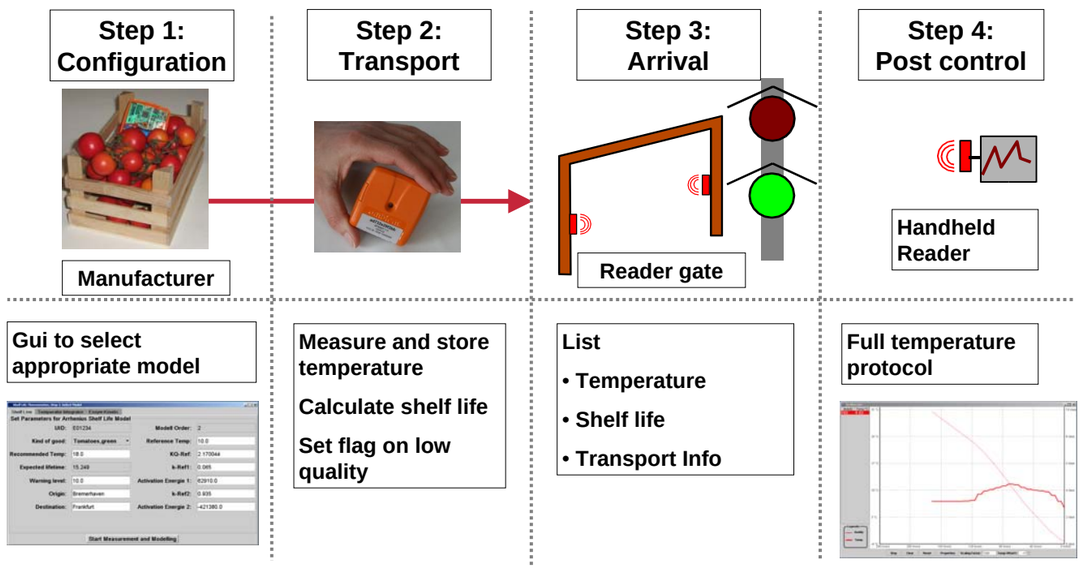
3 Changes in shelf life

All food products have individual initial values of shelf life and temperature sensitivities. The graph compares the shelf life of two products that are transported under the same conditions.

(Measured temperature during sea transport)

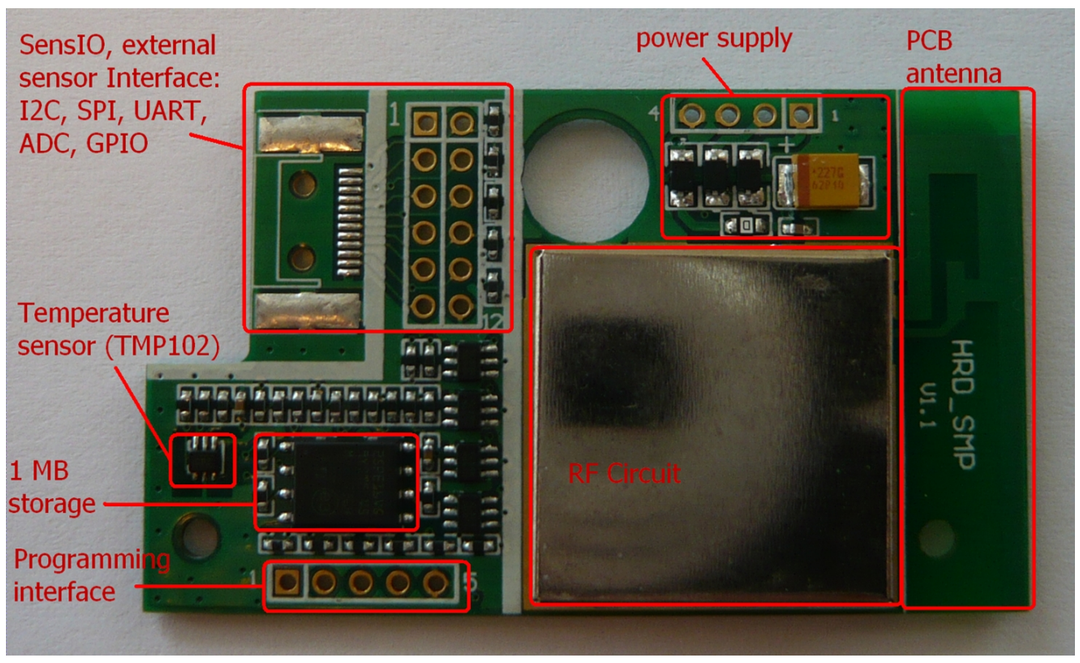


4 Chain supervision by intelligent RFID



In future application, the smart active RFID tags will supervise the whole transport chain and indicate at arrival whether the product is still in proper condition

5 Sensor hardware (SP-3000)



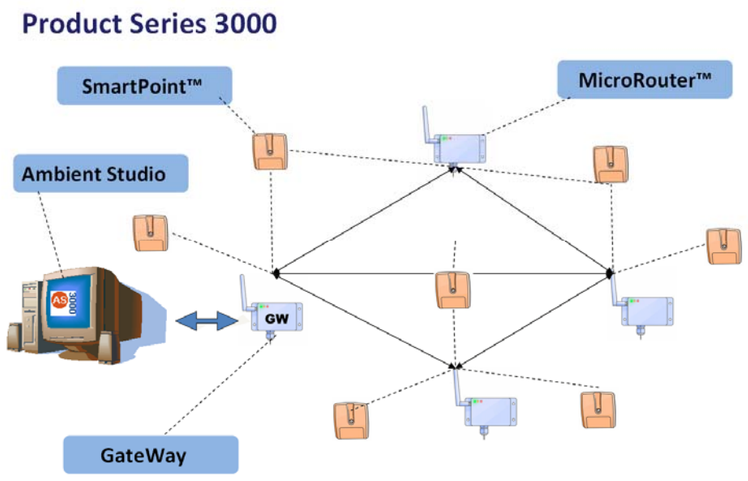
6 The wireless sensor network

Multi-hop:

Enabling the communication between a MicroRouter and the Gateway when they are not within radio range

Self-organizing:

Devices discover and join the network without configuration. Network also dynamically adapts to changes like adjusted range due to environmental interference. .



Self-healing:

When a relaying MicroRouter fails, alternative paths are used to deliver data at the destination.

Energy-efficient:

Both SmartPoints and MicroRouters use mechanisms to minimize the energy consumption.

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