RSSI based indoor tracking in sensor networks using extended Kalman filters

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The first symptom of a disease of a cow is very often a change in behavioural patterns related to reduced activity, decreased feed intake, and increased time spent lying [2]. Increased activity such as increased walking together with reduced time spent on eating and lying is typical indicators for cows in heat [4]. To monitor the behavioural patterns of cows in order to detect diseases and oestrous of cows a wireless sensor network with access points (APs) based on the Bluetooth protocol has been established in the barn at the Danish Cattle Research Centre. This network is able to communicate with several devices (tags) mounted on the cows and data from the tags is stored on a central data server. A tag mounted on the cow's leg measures whether the cow is lying or standing. The received signal strength indicator (RSSI) between tags and APs are recorded over time using a tag mounted on the back of the neck of the cow. The positions and walking behaviour of a cow may be estimated using the measures of RSSI. Supplementary data from feeding stations and milking robots form together with the sensor network data the basis on which biometric models of behavioural patterns is currently being developed. Here we discuss the method currently being implemented to estimate the positions of cows. The RSSI from a tag recorded with timestamps at each AP is used to estimate the distance between the tag and the APs if signals from a tag are received at three APs or more. The logarithm of the signal strength from a tag at a certain AP is supposed to be a linear function of the distance between the tag and the AP but a non-linear function of the position between the tag and AP. An extended Kalman filter [1] is set up by defining two sets of equations: the system and observation equations. The system equation (linear) governs the position and velocity of the tag. The position of the tag at a specific time is the position last time we measured to which is added how far the tag has travelled since then with a velocity driven by a white noise process. The observation equation (nonlinear) relates the position of the tag to the received signal strength at the APs measured with some noise. Due to the way the Bluetooth protocol is specified RSSI from one tag may not necessarily be sampled at the same time at other APs. Therefore a preprocessing of data is used to align the measurements in time. This is done using a Kalman filter on a local level model [3] to smooth and align the data. Using the extended Kalman filter on the preprocessed data gives an estimate of the route of the tag. The positions on the route together with the information from the lying/standing tag may be used to calculate different measures of activity to be used in subsequent modelling. This talk will present the positioning algorithm and the results from the algorithm to be used in calculating some activity measures.

References

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