CowBhave Localization Instructions

The data is available at https://zenodo.org/.

1. Data structure
   1. Raw data files

The Ruuvi tag messages with the tag accelerations were received by the receiving stations (Raspberry Pi) and transferred to a computer. The collecting program running on the computer separated the messages related to different tags and stored in the files RuuviData\_TagTT\_YYYY-MM-DD-HH.csv, where TT is the tag number (1-25), YYYY, MM, DD and HH are the year, month, day and hour. The files include the following fields:

1. Receiving station number (1-10),
2. Receiving moment of the receiving station in format “2019-11-28T17:00:05.751”,
3. Number of tag (1-25),
4. RSSI measured by the receiving station,
5. Number of message sent by the RuuviTag,
6. Five triplets of the accelerations (X, Y, Z) measured by the RuuviTag,
7. Receiving moment of computer collecting data consisting of year, month, day, hour, minute, second, millisecond.

The files can be read by the function *ReadRuuviDataCSV*.

When the Ruuvi tag messages were not transferred to the collecting computer, they were stored on the receiving stations in files RuuviData\_TagTT\_StST\_YYYY-MM-DD.csv, where TT is the tag number (1-25), ST is the receiving station number (1-10), YYYY, MM and DD are the year, month and day. The files can be read by the function *ReadRuuviDataRaspPiCSV*.

* 1. RSS data files

The RSS received by all the receiving stations at all available moment for a single tag for a single day is stored in files RSSData\_TagTT\_YYYY-MM-DD.csv, where TT is the tag number (1-25), YYYY, MM and DD are the year, month and day. The files were generated from the raw data files by the function *Main\_RawDataMerging*. The files include the tag number, the Ruuvi tag message number, the sampling moment and the RSS values from all the receiving stations. The files can be read by the function *ReadRSSData*.

* 1. Accelerations data files

The accelerations measured by the tag at all available moment for a single tag for a single day are stored in files AccData\_TagTT\_YYYY-MM-DD.csv, where TT is the tag number (1-25), YYYY, MM and DD are the year, month and day. The files were generated from the raw data files by the function *Main\_RawDataMerging*. The files include the sampling moment and the X, Y and Z components of the tag acceleration. The files can be read by the function *ReadAccData*.

* 1. Auxiliary files
     1. Tag attaching table

During the experiment, the tags were attached to different cows for specific period. The information about the cow number and the periods is written in the file TagCowNoFittingRef.csv only for the periods when the reference was available, and in the file TagCowNoFitting.csv for the entire experiment. The file can be read by the function *ReadTagCowNoFitting*.

In the table the rows correspond to the tag number, and the columns correspond to the experiment day. During the days with empty cells the tags were not attached or fallen.

* + 1. Barn and localization system structure

The information about the location of the receiving stations, barn mapping points and obstacles for the cow motion is written in the file BarnSystemStructure.csv. The information is used for calculating the RSS depending on the distance between the mapping points and the receiving stations locations, calculating the emission and transition matrices for the Viterbi algorithm and drawing the barn map. The file can be read by the function *ReadBarnSystemStructure*.

* + 1. Feeding and drinking reference

The feeding and drinking reference for the experiment period was generated by the Hokofarm system measuring the feed and water intake and was stored in the FeedingData.csv and DrinkingData.csv files. The files include the cow number, number of the feeding or drinking station and feeding or drinking periods. The files can be read by the function *ReadReferenceFeedingData*.

* + 1. Milking reference

The milking reference for the experiment period was generated by the Lely Astronaut robot and was stored in the MilkingData.csv file. The file includes the cow number, milking periods. The file can be read by the function *ReadReferenceMilkingData*.

* + 1. Body position reference

The cow body position (standing, lying and walking) and the cow location at the mapping points achieved from the video decoding was stored in the files Reference\_BodyPosition\_YYYY-MM-DD.csv, where YYYY, MM and DD are the year, month and day. Each file contains reference for all cows at the corresponding day. The files include the cow number, number of the mapping point where the cow was located, body position and location or body position time intervals. The files can be read by the function *ReadReferenceBodyPositionData*.

* + 1. Feeding behavior reference

The cow feeding behavior (feeding, ruminating, nothing and drinking) achieved from the video decoding was stored in the files Reference\_FeedingBehavior\_YYYY-MM-DD.csv, where YYYY, MM and DD are the year, month and day. Each file contains reference for all cows at the corresponding day. The files include the cow number, feeding action and the time intervals. The files can be read by the function *ReadReferenceFeedingBehaviorData*.

1. Tag features experiment data processing

RSS propagation experiment

RSS-orientation dependence experiment

1. Localization data processing

Preprocessing of the raw data from the Ruuvi tags

Localization

Comparison with references

Demonstrations for the paper