Topological Robot Localization in a Pipe Network

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Robots can be used to inspect water pipe infrastructure, more precisely locating faults and improving maintenance.

Localization is fundamental to these robots. While *metric* localization is commonly used in mobile robotics, discrete *topological* localization would allow efficient path planning and localization, which is an advantage for a resource limited robot.

This work presents the use of measured distance travelled m from odometry in a Hidden Markov Model based localization method.

$$b'(s') = M(m|s)O(o|s)T(s'|s,a)b(s) \quad (1)$$

The University Of Sheffield.

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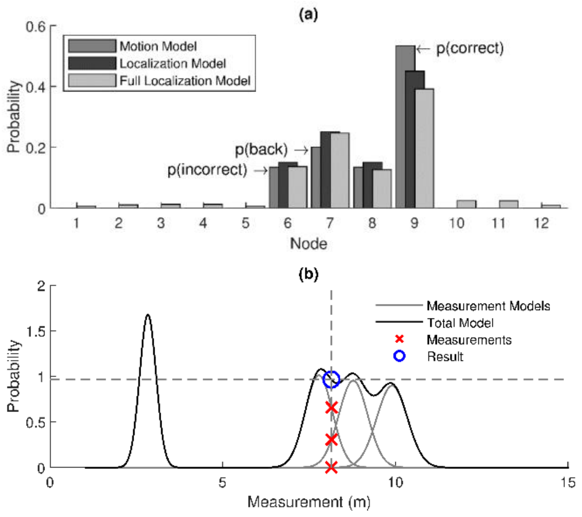

Fig. 1. (a) An example discrete transition model for a robot at state 7 in a 12 state network. (b) The proposed measurement model, finding the likelihood of a measurement given a particular transition with a number of possible paths and corresponding path lengths.

This is used as well as typical observations of the surroundings o and knowledge of actions a to improve the estimate of state s, $b(s)$. This method is illustrated by Equation 1, which uses the models for measurement, observation, and transition using the models in Fig. 1.

In simulation, the use of measured distance m is shown to improve the accuracy of the localization estimate from an error rate of 0.6 using only observations o to 0.18. A small subset of these experimental results in the network in Fig. 2 is shown in Fig. 3.

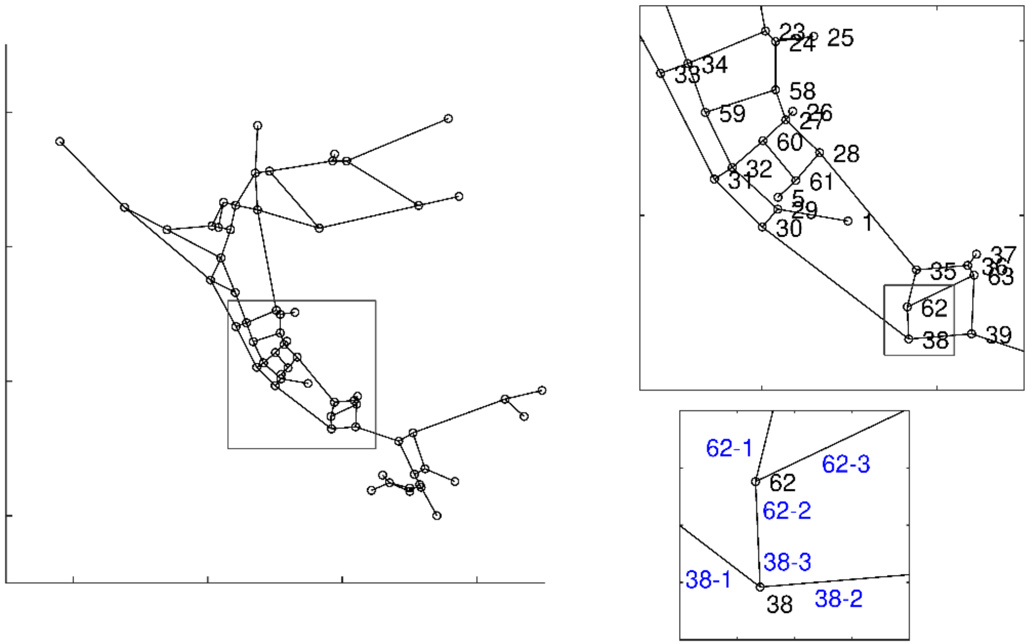

Fig. 2. An example network map. The states in the discrete state space for topological localization are labelled. Each junction is described by a discrete index. Each pipe is described by two indices, one corresponding to each adjacent junction.

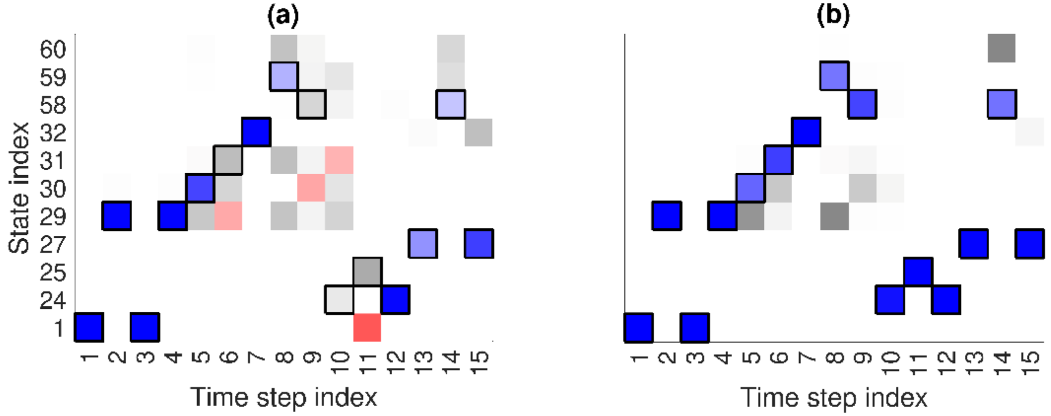

Fig. 3. The belief vector $b(s)$ illustrated over 15 time steps. The darkness of the colour corresponds to the belief value. The largest value at each time step is labelled in blue if it is correct, and red otherwise. The correct value is highlighted with a black border. (a) shows the result without use of measured distance, (b) shows the improvement seen by using measured distance.