Exercise Sensor Networks - (till June 13, 2005)

Lecture 7: Localization in sensor networks

Exercise 7.1: Positioning without distance estimation

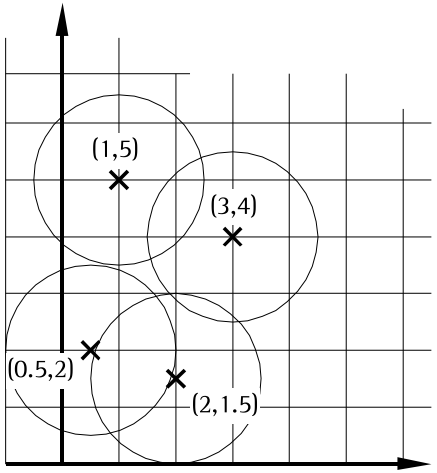
Nodes A and B do not know their positions but they can hear one another. Node A knows its neighbors (1,5) and (3,4) and B can hear its neighbors (0.5,2) and (2,1.5). The circular radios range of all nodes has a radios of 1.5 units.

a) Calculate whether (2,4) or (2,5) is a valid position for A.

b) In another setting only one node C is not positioned and a couple of neighbors exist with known positions. Again the distance between nodes can not be estimated but the position of C should be guessed (within its valid area). The radio range of all nodes is known.

   i) What is the upper limit for the error between the estimated node position and its true position and and where do the positioned nodes have to be located so that the maximum error can occur?

   ii) Can you image a configuration of nodes in which the error of the estimation can not become zero?



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Exercise 7.2: Relative localization by distance estimation

Node i was chosen as the center of the coordinate system of the whole sensor network. Another node k has also localized the neighbors of its own local view set within its own coordinate system. Now all nodes known to k but unknown to i should be added to node i's network-wide base.

a) Why do the neighbors of k have to be transformed at all to fit into the global base? Wouldn't it have been much easier if k had chosen its y-axis in order to point upwards and the x-axis to point to the right?

b) Draw a configuration of nodes in which the neighbors of a node k only have to be moved but not rotated in order to fit into the global coordinate system.

c) Find a case in which k only has to be rotated but not translated. What is unusual about this case (is it realistic?)

d) Find a case in which a translation, a rotation and mirroring of one exis is necessary.

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Exercise 7.3: Determination of local coordinates by distance estimates

Node A-G have different mutual distances which can be seen in the following table.

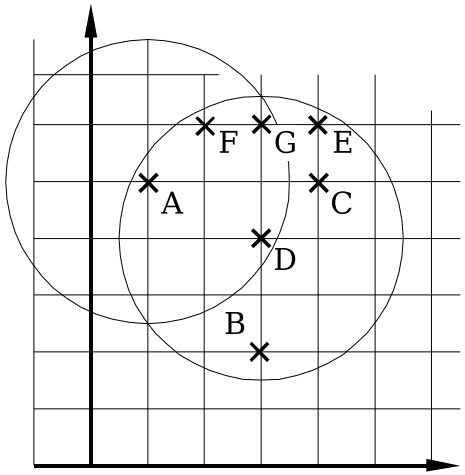
	A	B	C	D	E	F	G
A	0			2,24	3,16	1,41	2,24
B		0		2			
C			0	1,41	1	2,24	1,41
D	2,24	2	1,41	0	2,24	2,24	2
E	3,16		1	2,24	0	2	1
F	1,41		2,24	2,24	2	0	1
G	2,24		1,41	2	1	1	0

No table entry means that the connection no connection between nodes exists.

a) Which nodes are in particular suitable as origin of a global coordinate system and for defining the X-axis. Which nodes are least suitable and why?

b) Node C has itself defined a local coordinate system and chose node E for defining the x-axis and node G for determining the direction of the y-axis. Determine the global coordinate of the local position (1,1) being defined with respect to C.

c) What are the problems when localizing node B? How can the node be localized optimally under the given constraints? You only need to describe a proceeding, no actual coordinate.



The sketch above is an example for a distribution of nodes which meets the constraints defined in the table of distances. Other configurations are possible as well.

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