DISTRIBUTED INTELLIGENT ROBOTICS:

RESEARCH & DEVELOPMENT IN FAULT-TOLERANT CONTROL AND SIZE/POSITION IDENTIFICATION

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Abstract

This thesis presents research conducted on aspects of intelligent robotic systems. In the past two decades, robotics has become one of the most rapidly expanding and developing fields of science. Robotics can be considered as the science of using artificial intelligence in the physical world. Many areas of study exist in robotics. Among these, two fields that are of paramount importance in real world applications are fault tolerance, and sensory systems. Fault tolerance is necessary since a robot in the real world could encounter internal faults, and may also have to continue functioning under adverse conditions. Sensory mechanisms are essential since a robot will possess little intelligence if it does not have methods of acquiring information about its environment. Both these fields are researched in this thesis. In particular, emphasis is placed on distributed intelligent autonomous systems. Experiments and simulations have been conducted to investigate design for fault tolerance. A suitable platform was also chosen for an implementation of a visual system, as an example of a working sensory mechanism.

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I would like to thank my parents and my sister for always encouraging me to further my studies. I would also like to thank Vani for the countless hours she spent "keeping me company", while I worked.

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Distributed Intelligent Robotics:

Research and Development in Fault-Tolerant Control and Size/Position Identification

K.K. Subramaniam

Chapter 2.1.3.5, pg.23
Errata

On page 23, the notation $Q_{n,j}$ is used to describe a vertex, but the notation is not explained until page 24. $Q_{n,j}$ denotes the j^{th} vertex in the n^{th} section of a flow graph that has been divided into sections, in order to reduce complexity.

Chapter 2.2.4, pg.38
Errata

The following section is to be inserted at the end of page 38, to further explain the flow graph example:

"…erroneous transitions in dashed lines.

In considering the probabilities of erroneous transitions between states, it is important to recognize that the graph in figure 2-19 is an example of the erroneous transitions possible *only in the specific error situation stated.* Since the grey states represent unreachable states, the probabilities for erroneous transitions *from the preceding states* have rows that sum to one, since an erroneous transition must occur. This is coincidental in this case, and it is not necessary that the rows sum to one. The probabilities listed are the probabilities that an erroneous transition will occur in the specific example, and not the total probabilities for all possible erroneous transitions.

Figure 2-19…"

Chapter 2.3.2.2, pg.47
Errata

In Figure 2-23, a dashed arrow is used to show the erroneous transitions in the graph. Erroneous transitions are possible from vertices Q_1 to Q_1 and Q_1 to Q_3 (not Q_1 to Q_2, as indicated).

Chapter 2.3.2.2, pg.48
Errata

The third element of the G matrix is element $p_{1\text{-}3}$, and not $p_{3\text{-}1}$.

Chapter 2.3.2.3, pg.49
Errata

The references in the first paragraph are to the matrix M_{Qi}, and thus the first paragraph reads:

Here, M_{Qi} is the fault behaviour description of vertex Q_i. M is a $K \times N$ matrix, where K is the total number of faults modelled, and N is the total number of vertices in the flow-graph. Thus, element (2,1) of the matrix denotes the probability of an erroneous transition from Q_i to Q_1, in the presence of *fault type 2* – in a real implementation, this would be a particular type of fault.

Chapter 2.4.2, pg.54
Errata

Equation 2-23 written as:

$$\psi\overline{(x)^{-1}\,)}p(x)=q(x)\,rem\;s(x)$$

is in fact:

$$\psi(x)\overline{)p(x)}=q(x)\,rem\;s(x)$$

Chapter 2.4.3, pg.56, 57
Errata

Two figures are labelled as 'Figure 2-35' on pages 56 and 57. To correct this, the figure on page 57 has to be labelled as Figure 2-35b, in which case the last sentence on page 56 reads:

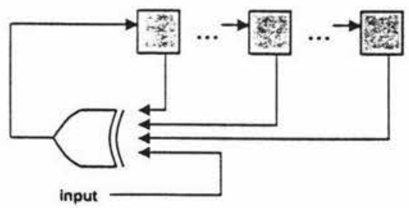
'In other words, the situation in figure 2-35b is possible.'

Also, the fourth sentence in Chapter 2.4.4 on page 57 must then read:

'Figure 2-36 below illustrates the insertion of an erroneous bit between the first and second bits of an 8-bit key.'

Chapter 2.4.4, pg.58
Errata

The shift register outputs are combined with an XOR gate, and thus the diagram is equivalent to:



Chapter 2.4.5, pg.63
Errata

The following statement is to be inserted after the first paragraph of page 63:

"…odd numbers of errors are detected.

Syndrome coding refers to an error checking method in which the error is detected by counting the occurrences of '1's and '0's in the resultant key. The number of occurrences can be compared with expected values, and there are many situations in which this checking scheme produces high coverage statistics.

When syndrome coding is used for…"

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