ted, the associated connectivity graph, denoted by G_i, is searched for hannel connecting $\mathbf{q}_{init}$ to $\mathbf{q}_{goal}$.

simple first-cut planning algorithm is the following:

1. Compute a rectangloid decomposition $\mathcal{P}_1$ of Ω. Set i to 1.

2. Search the connectivity graph G_i associated with the decomposition $\mathcal{P}_i$ for a channel connecting the initial cell containing $\mathbf{q}_{init}$ to the goal cell containing $\mathbf{q}_{goal}$. If the outcome of the search is an E-channel, return success. If it is an M-channel, proceed to the next step. Otherwise, return failure.

3. Let Π_i be the M-channel generated at Step 2. Set $\mathcal{P}_{i+1}$ to $\mathcal{P}_i$. For every MIXED cell κ in Π_i, compute a rectangloid decomposition $\mathcal{P}^\kappa$ of κ and set $\mathcal{P}_{i+1}$ to $[\mathcal{P}_{i+1}\backslash\{\kappa\}] \cup \mathcal{P}^\kappa$. Set i to $i+1$. Go to Step 2.

he search of G_i at Step 2 can be guided by various heuristics. In

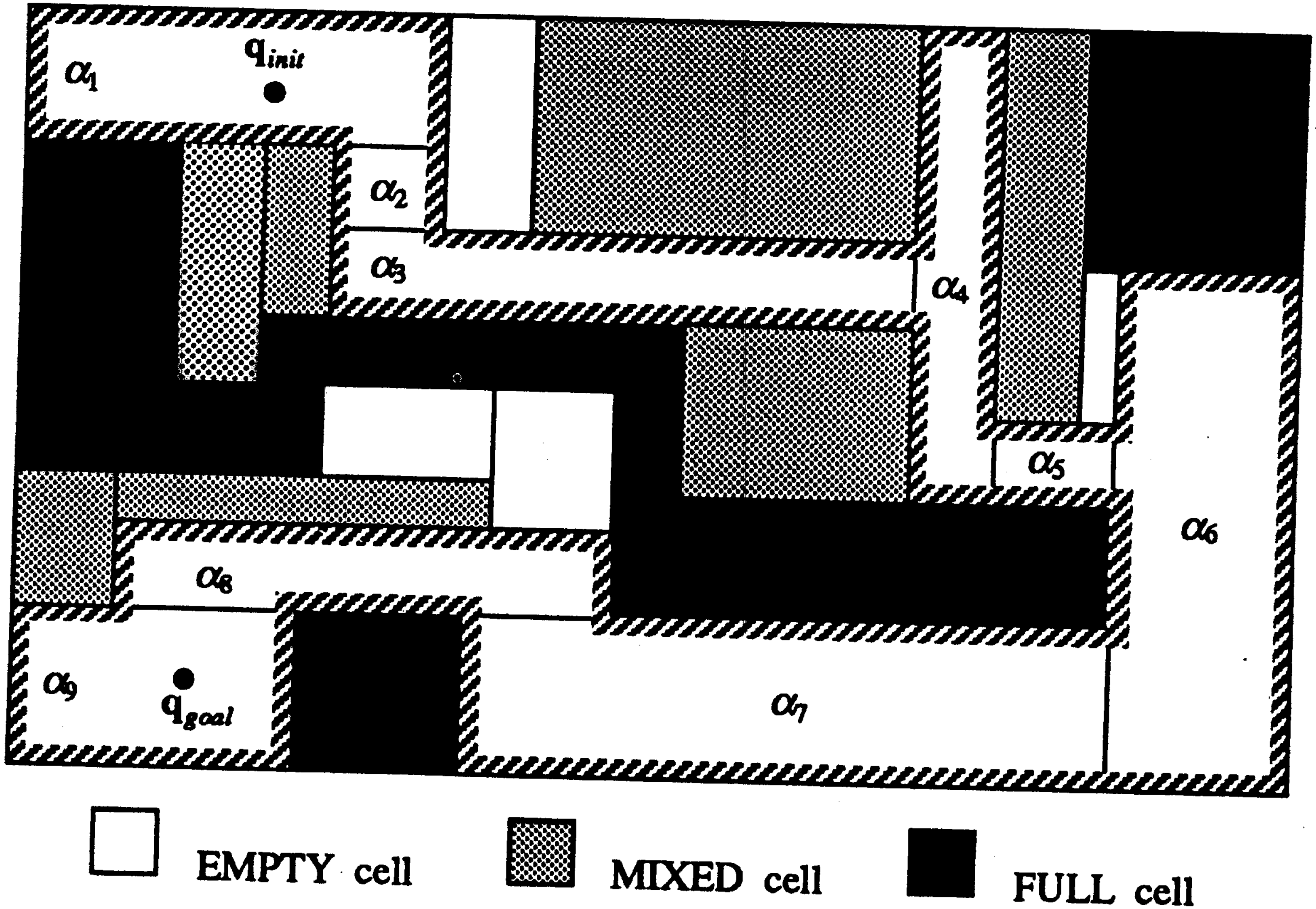
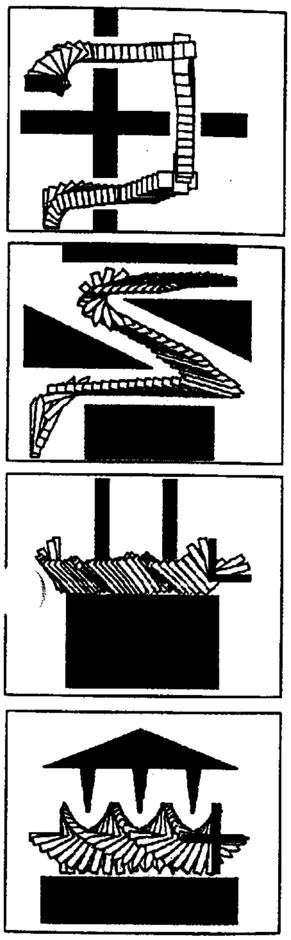


Figure 1. A channel is a sequence of adjacent cells which are either EMPTY or MIXED. If all the cells are EMPTY the channel is said to be an E-channel, otherwise it is said to be an M-channel. This figure shows an E-channel (striped contour) in a two-dimensional space. It connects the two cells that contain the

How to divide a mixed cell further and label the subdivided cells?

"Divide & Label"



ɔy a planner based on the
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dren of a cell κ have the
each edge of κ into two

f $m = 3$, it is called an
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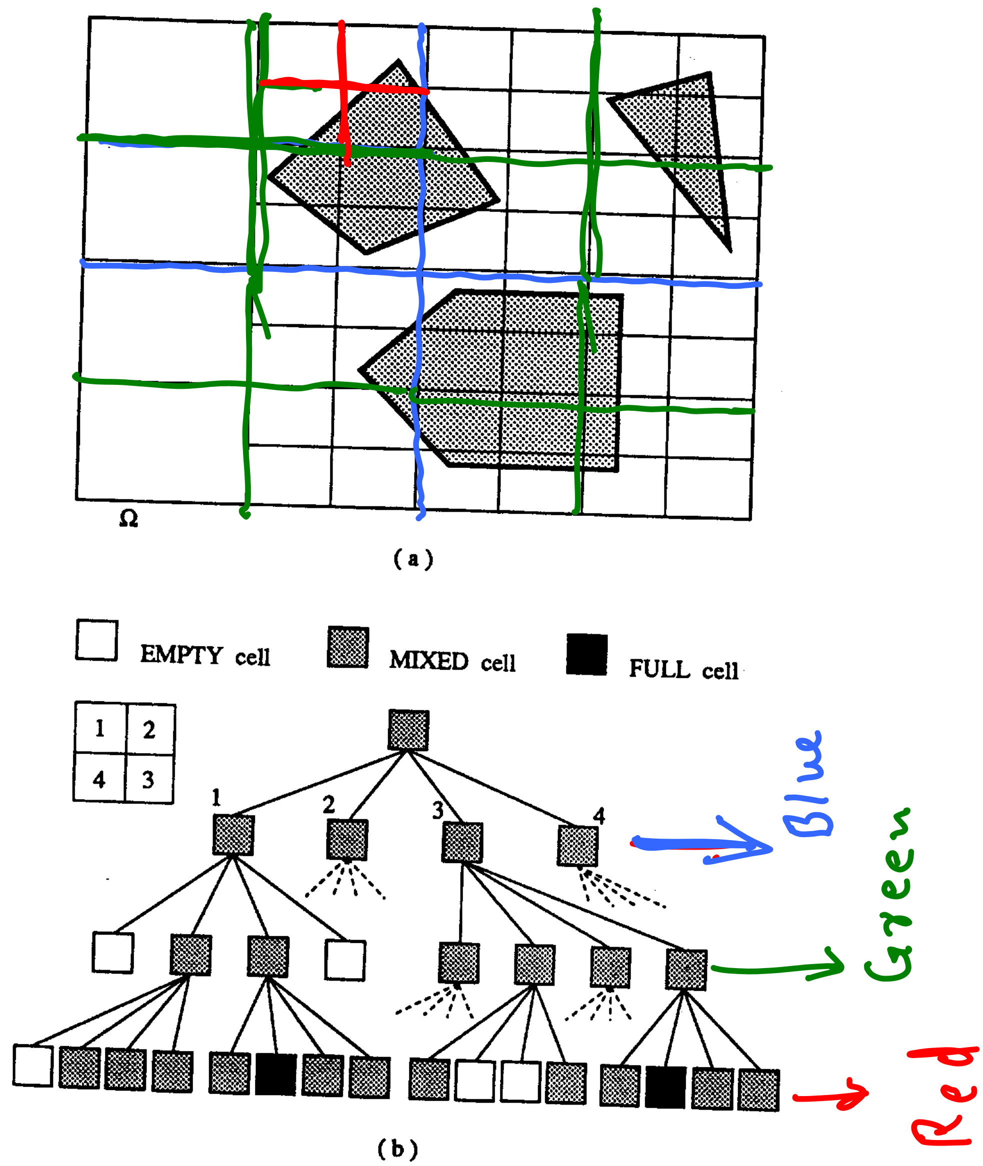


Figure 4. A quadtree decomposition of Ω is obtained by recursively dividing Ω and the generated MIXED cells into smaller cells. The division of a cell creates four new rectangloid cells of equal dimensions. Figure a shows the quadtree decomposition at depth 3 of a simple configuration space. Figure b shows a subset of the corresponding tree.

Note Title 1/28/2010

Cell Labelling:

Recall CB: $V_i \; \cancel{V}_j \; e_{ij}$

$i \in$ # of obs

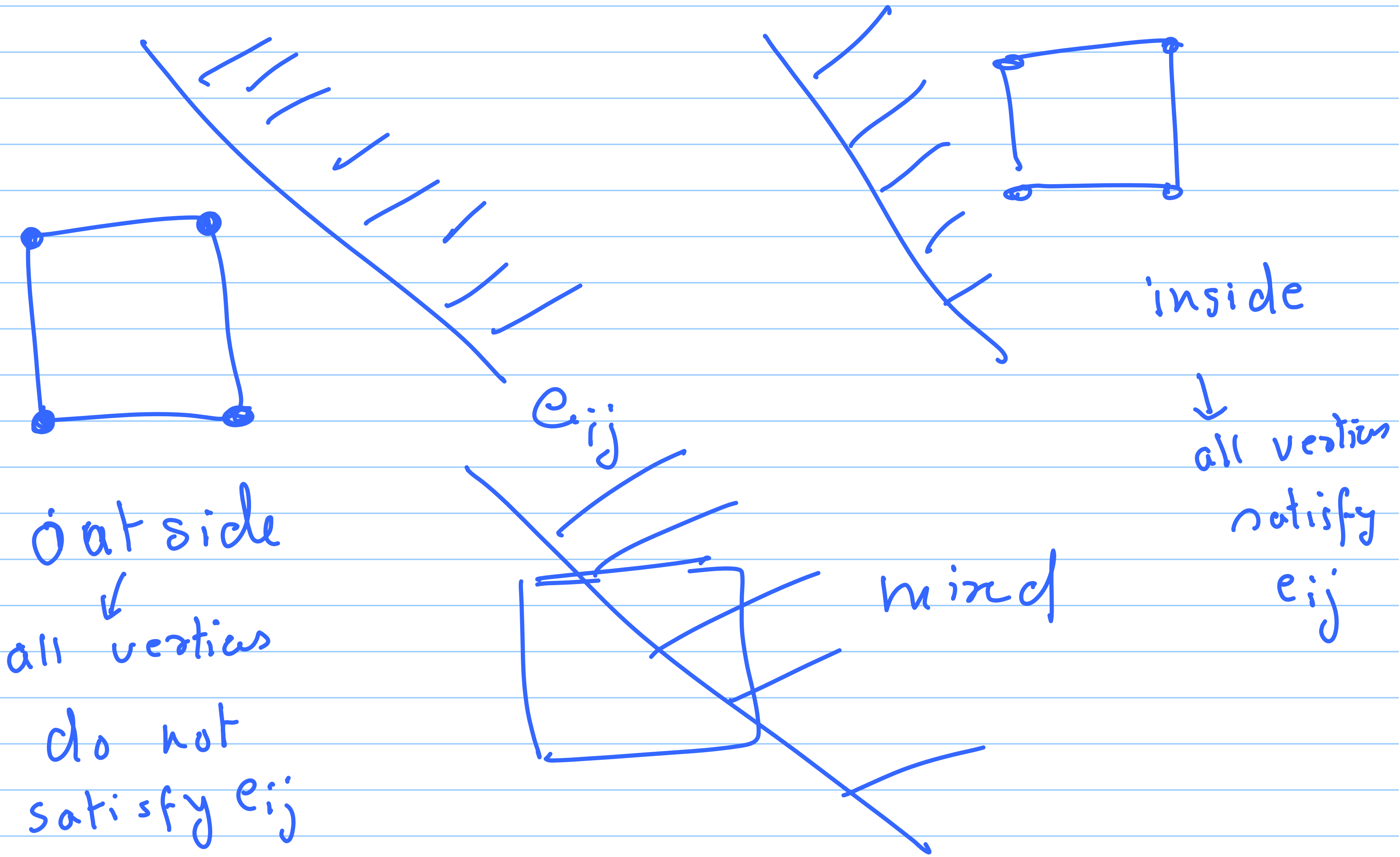
$\underbrace{}_{\text{one convex obs.}}$

$j \in$ # of vertices

first in $\mathbb{R}^N$: polyg. case

"Cells are convex" no rot.

So need to test only vertices



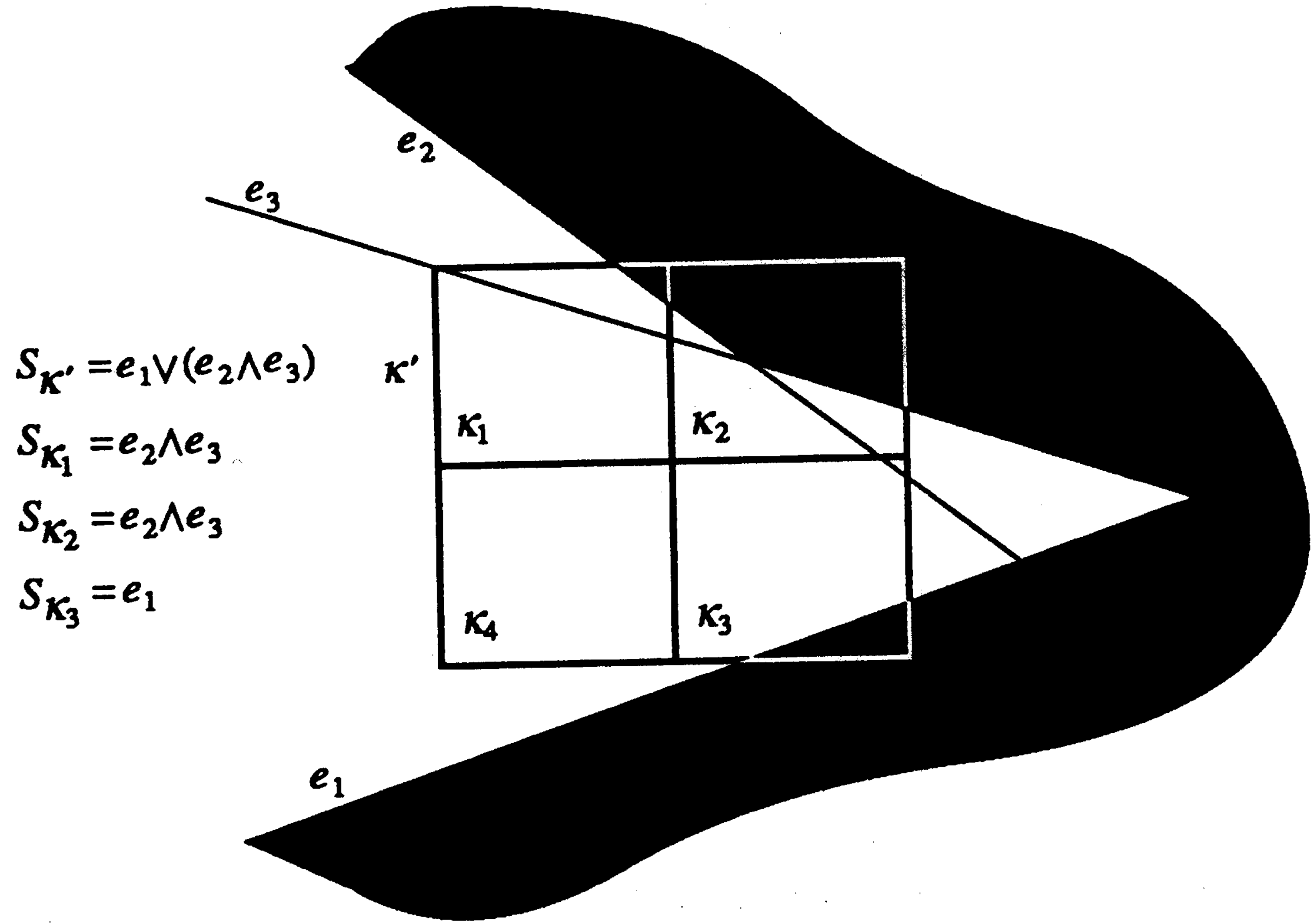


Figure 6. This figure illustrates the simplification of a C-sentence when new cells are created and labeled. The sentence $S_{\kappa'} = e_1 \vee (e_2 \wedge e_3)$ is associated with the MIXED cell κ'. When this cell is decomposed (in a quadtree fashion), four new cells denoted by κ_1 through κ_4 are generated. Both κ_1 and κ_2 are

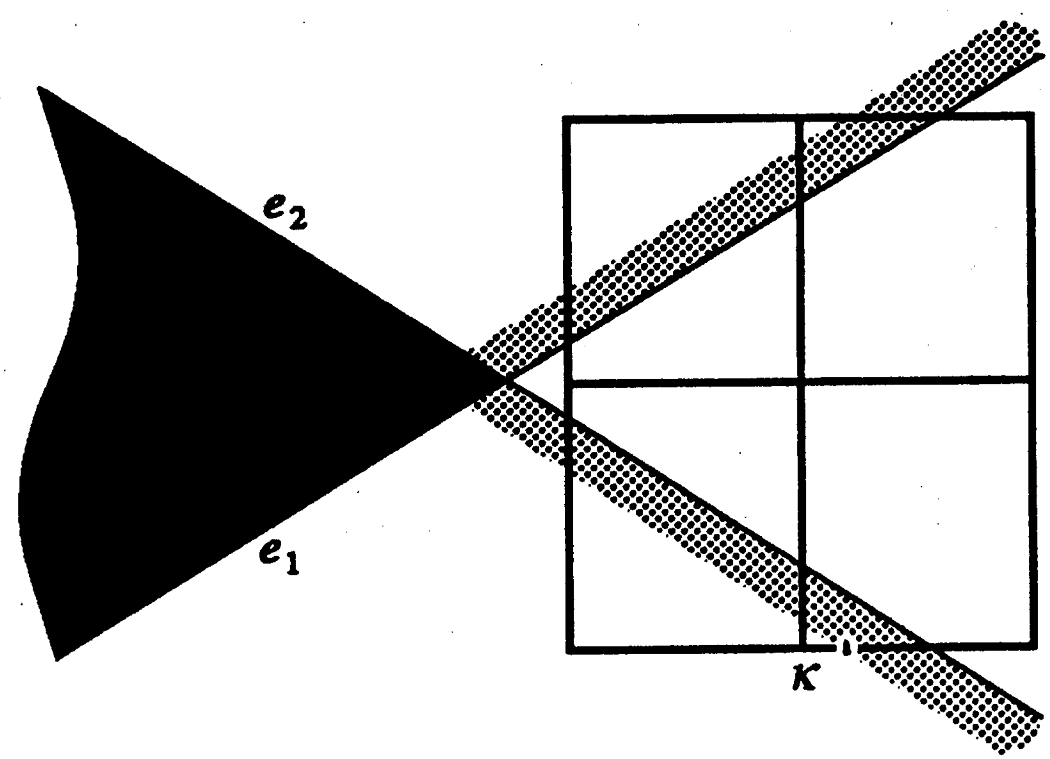
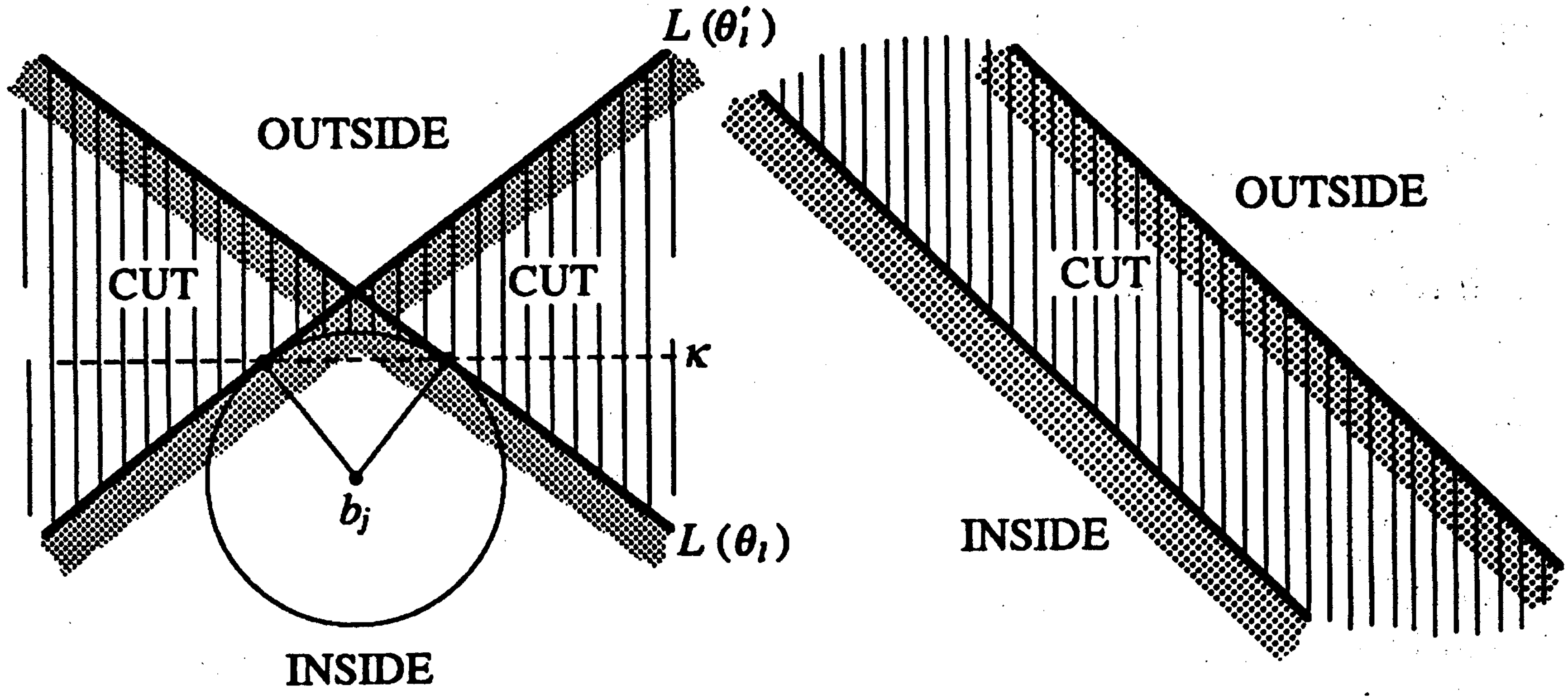


Figure 7. This figure illustrates how a cell κ gets labeled as MIXED though it has no intersection with the C-obstacle region. Assume that the C-sentence associated with the parent cell of κ is $e_1 \wedge e_2$. Since κ is cut by both e_1 and e_2, κ is labeled as MIXED and the C-sentence $e_1 \wedge e_2$ is associated with it. However, no point in κ satisfies e_1 and e_2 *simultaneously*. This incorrect (but conservative) labeling results from the fact that each C-constraint is individually considered as a half-plane. The error is eventually corrected at a deeper level in the quadtree decomposition. (The "inside" side of a C-constraint line is shown

C : $\mathbb{R}^2 \times SO(1)$ or $\mathbb{R}^2 \times S^1$

polygon with trans + rot.

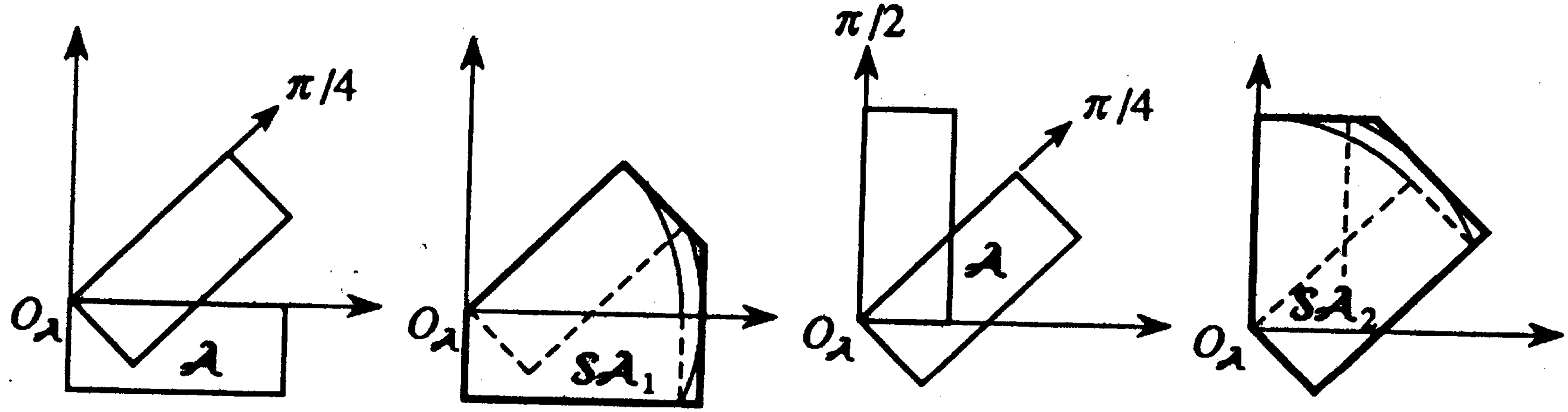


(a) (b)

Figure 8. This figure illustrates the projection of the portion of the C-surf $a(\theta)x + b(\theta)y + c(\theta) = 0$ which is comprised in the angular interval $[\theta_l, \theta_l']$ i the xy-plane. When the C-surface is of type A, the projection is the reg swept out by a line rotating around an obstacle vertex b_j (Figure a). When C-surface is of type B, the projection is the region swept out by a translat line parallel to an obstacle edge E_j^B (Figure b). In both cases, the project divides the plane into three regions designated by OUTSIDE, INSIDE, a

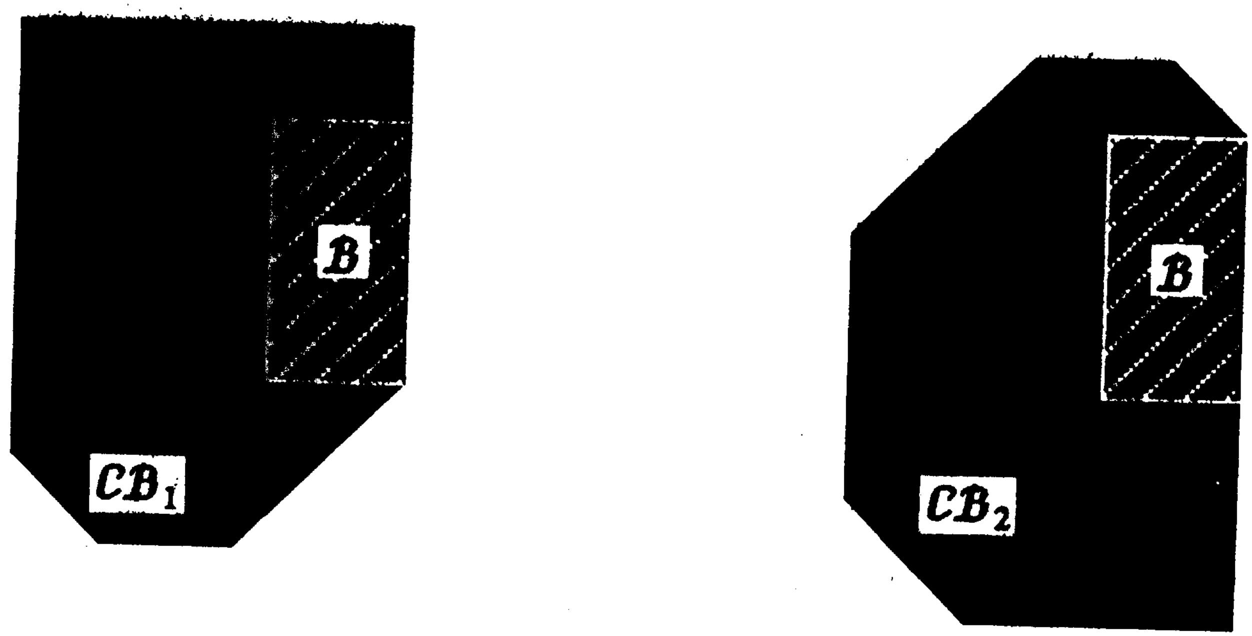
ORIENTATION SLICING :

" Approximate " approach



slice [0, $\pi/4$]   slice [$\pi/2$, $\pi/4$]

(a)



(b)