Efficient Matching by Movement Approximation

To find out a best matching, a straightforward approach is to enumerate all the possibilities. The search space is huge as there is a combinatorial number of potential matchings between two object sets. However, most of the matchings can be avoided by only searching through the corresponding objects in a limited area. The area of the initial object should therefore cover all the objects in the subsequent scene that can be potentially matched to the initial object. We use a circular region to represent such area. The circle centre is located at the centroid of the initial object and the radius of the circle is the maximum shift of the centroid. The radius is calculated by $V \times T$ where V is the maximum velocity of the object while T is the time gap between the initial and subsequent scene. The calculation ensures the circle adaptable to different time gaps. We call this circle as $movement\ bounding\ circle$(MBC).

The MBC can be divided into four quadrants to further restrict the search area. A quadrant is said to be open if all the objects in that quadrant can be considered as potential correspondence of the referred object, otherwise the quadrant is closed. An initial object will be matched with one of the subsequent objects within the open quadrants while the outside ones will not be considered.

Given a MBC C, if we want to explicitly talk about the quadrants that are open, we write $C^{(i,j)}, (i,j) \in \{-,+,*\}$ wrt. the given MBC, where $(+,+)$, $(+,-)$, $(-,-)$, $(-,+)$ correspond to the top-right, top-left, bottom-left, bottom-right quadrant respectively. $(*,*)$ refers to an arbitrary quadrant.

We can also distinguish the relative distance between two objects into three meaningful classes, namely touch, reachable, and non reachable. An object O can touch another object O' by one of its contact sectors. O' is reachable to O if O' is within the MBC of O otherwise non reachable. The s

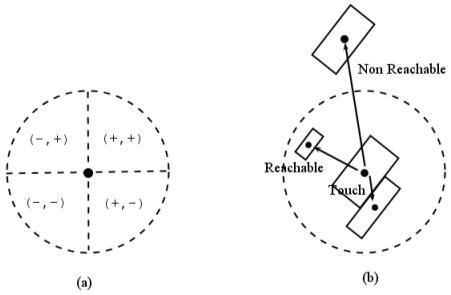

Figure 1: (a) The four quadrants of a MBC (b) Qualitative distance with respect to object A and its MBC

We can infer the open quadrants of an object by approximating the movement direction of the object, i.e. estimating which of the quadrants the object is most likely to be in at the next time point.

Object movement can be inferred from impact. Knowing the direction and the force of an impact, one can approximate the subsequent movements of the objects affected by the impact, directly or indirectly. When the impact information is not available, we can still approximate the movement by analysing structural properties, e.g. the stability of an object or a group of objects. An object is stable when it is supported and remains static. A unstable object will have two possible motions: 1) free fall if it has no supports. 2) fall to the side where supports are absent.

We demonstrate the movement approximation by the stability analysis in the Angry Birds scenario where bird hit usually come from the left.

(**?**) proposed four kinds of supports that can make a solid rectangle stable in Angry Birds scenario and provided the corresponding GSR configurations. We approximate the stability of the objects using those GSR configurations. A stable object may become unstable if it lost support due to a bird hit, and this may create a chain of effects if the object also supports other objects. By accessing the bird trajectory, we can determine which object will be hit by the bird, and approximate the resulting stability accordingly (See Figure). For those unstable objects, the open quadrant is set to $C^{(*,-)}$. We can get a more restricted area, $C^{(+,-)}$ or $C^{(-,-)}$, by analysing the object falling direction. E.g. A right leaning rectangle will fall to right if there is no support at the right side, and the open quadrant is $C^{(+,-)}$ (see Figure).

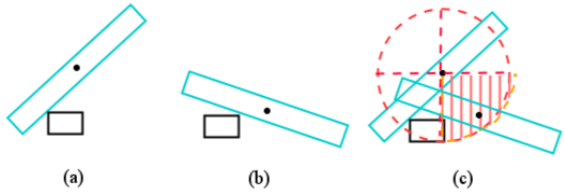

Figure 2: (a) the object in cyan is supported via one-edge support (b) a subsequent scene by removing the right support (c) The estimated open quadrant (shadowed area)

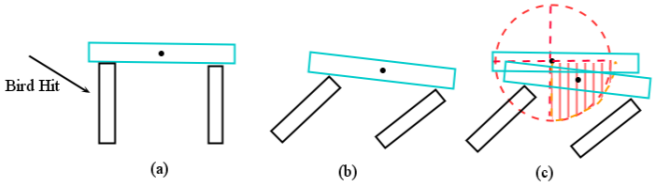

Figure 3: (a) the object in cyan is supported via one-edge support, and a coming impact indicated by the arrow (b) a subsequent scene after a bird hit (c) The estimated open quadrant (shadowed area)