make a serious affection on the hashing algorithm [20] since all image blocks in content will be modified due to the phase distortion.

In order to eliminate the effect of the padded pixels (caused by the loose rotation) on image blocks, our strategy is to apply only the central content of an candidate image for block-based hashing, such as the circled region marked in Fig. 2 (d). In such a way, we can avoid the effect of the resulted redundant pixels. For the rotated images as plotted in Fig. 2 (e) and (f), only the central part in the blue circle is chosen for hashing.

![Diagram](image_url)

Fig. 3. Effective block region under the loose rotation mode (see the circle).

For a clear description, in this paper we denote the circle radius in Fig. 2 (d) as the radius of Effective Block Region (EBR), in length \( R \). According to the principle of geometry mathematics, the \( R \) value can be derived from the following Equations (8) and (9).

Denote the original image as \( \square ABCD \), which is rotated by using the ”loose” mode with the angle \( \theta \), and then be normalized to the same size as the original one. As shown in Fig. 3, the square \( \square EFGH \) is the rotated version of \( \square ABCD \) with the loose mode. In this case, the difference between \( \square ABCD \) and \( \square EFGH \) indicates the resulted redundant pixels. In referring to Fig. 3, we have the following the geometric relationships:

\[
\begin{align*}
EF \cdot \cos \theta + FG \cdot \sin \theta &= AB \\
EF \cdot \sin \theta + FG \cdot \cos \theta &= BC,
\end{align*}
\] (8)