Use parametric equation of circle.

In approach 1, accumulation is done on 2D array. Not suitable for shared memory!

In approach 2, accumulation is done on 1D array. Suitable for shared memory. Three versions are proposed.

Version 1 (Based on Approach 2 Version 1)

(a, b) pairs are shared by thread-blocks. (x, y) pairs are shared by threads.

Thread-blocks (B0, B1, B2 …) sharing circle centers (a, b) and threads (T0, T1 …) sharing the points \{x0, y0\}, \{(x i, y i)\} in the image.

What if the image point (x, y) scanned by a thread is empty pixel?

Most of the threads will be idle if we consider binary image as a sparse matrix.

Conversion is carried out by threads in race condition. Each thread writes an item into the array and check whether the item is correct. If not, then it tries to write into next location.

Version 3 (Based on Approach 2 Version 2)

Conversion phase is applied similar to Version 2.

(r, b) pairs are shared by thread-blocks. (x, y) pairs are shared by threads.

Hough space initialization and copying operations are also done via unrolled loops to the contrary of the second version.

The parameter b cannot be adjusted with respect to the inequality. All rows are searched instead.

Hough Transform (HT)

- Hough Transform (HT) is a well-known technique used for detection of parametric shapes in image processing.
- Various optimizations are necessary in its implementation due to large memory and computational requirements.
- However, various optimizations are necessary in its implementation due to large memory and computational requirements.

Circle Detection using HT

- A 2D circle may be denoted by three parameters: center location (a, b) and radius (r).
- A circle is voted for if model parameters of the circle satisfy the points in input image (x, y).

There are two fundamental approaches for HT to detect circles.

\[ x = a + r \cos \theta \]
\[ y = b + r \sin \theta \]

Approach 1

- Use parametric equation of circle.
- Determine a range for r.
- Solve circle centers (a, b) for different r and (x, y).
- Vote for (a, b, r).

\[ (x - a)^2 + (y - b)^2 = r^2 \]

Approach 2 (Version 1)

- Use conventional equation of circle.
- Solve circle radius r for different (a, b) and (x, y).
- Vote for (a, b, r).

\[ a = \pm \sqrt{x^2 - y^2} \]

Approach 2 (Version 2)

- Solve circle center abscissa a for different (r, b) and (x, y).
- Determine a range for r.

\[ v - r \leq b \leq v + r \]

Vote for (a, b, r).

This research was supported by CUDA Research Center of Middle East Technical University