**OCTAGONAL-AXIS RASTER PATTERN FOR IMPROVED TEST ZONE SEARCH MOTION ESTIMATION**

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**INTRODUCTION**

- HEVC bit rates are 40-50% smaller than in H.264 [1], but the encoding process is up to 500% more complex [2]
  - Much larger number of partitions evaluated in Motion Estimation (ME)
- Test Zone Search (TZS) is a fast ME algorithm
  - Great coding efficiency, close to Full Search
  - Used in the reference HEVC encoder
  - Still, most of HEVC encoding complexity is due to ME
- This paper proposes OARP: a novel search pattern for Raster Search step on TZS
  - Based on an analysis of the best match distributions along the ME search area
- Average TZS time reduction of 60.91% was achieved, with a negligible BD-rate increase (0.037%)

**THE TEST ZONE SEARCH ALGORITHM**

- TZS has four different steps: Motion Vector Prediction, First Search, Raster Search and Refinement
  - Raster Search step finds only 0.4% of the best block matchings on average [3]
  - Raster Search is the only step that fully exploits the search area
- The average processing time distribution (rightmost column in Fig.1) of TZS algorithm in different PU sizes indicates:
  - Prediction: 3%
  - First Search: 13%
  - Raster Search: 75%
  - Refinement: 9%

**Fig. 2(a)-(c) shows a distribution analysis of best block matching positions after each execution of Raster Search**
- Fig. 2(a) and (b) are corner cases that represent the two most uncommon distributions among all videos analyzed
- Fig. 2(c) shows the average distribution for all videos
- Fig. 2(d) presents the Octagonal-Axis Raster Search
  - Exploits the observed characteristics in heatmaps
  - Reduces in 75% the number of search points in the original Raster Search
  - Covers 62.3% of the total best block matchings

**BLOCK MATCHING DISTRIBUTION IN RASTER**

- Compression efficiency and Computational complexity was computed in terms of Bjøntegaard Delta rate (BD-rate) and processing time, respectively
- The same conditions in Box 1 were used to evaluate the proposed pattern, except for the video sequences

<table>
<thead>
<tr>
<th>Video Sequences</th>
<th>BD-rate (%)</th>
<th>Total TR (%)</th>
<th>TZS TR (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PeopleOnStreet</td>
<td>-0.051</td>
<td>23.21</td>
<td>56.85</td>
</tr>
<tr>
<td>Steam,LocomotiveTrain</td>
<td>0.034</td>
<td>11.88</td>
<td>56.10</td>
</tr>
<tr>
<td>BasketballDrive</td>
<td>-0.029</td>
<td>20.93</td>
<td>59.55</td>
</tr>
<tr>
<td>Kimono</td>
<td>-0.072</td>
<td>13.58</td>
<td>52.19</td>
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<tr>
<td>CampingParty</td>
<td>-0.005</td>
<td>30.04</td>
<td>68.16</td>
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<tr>
<td>ToddlerFountain</td>
<td>-0.030</td>
<td>16.08</td>
<td>56.96</td>
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<tr>
<td>CatRobot</td>
<td>-0.025</td>
<td>22.88</td>
<td>61.71</td>
</tr>
<tr>
<td>DaylightRoad</td>
<td>-0.058</td>
<td>28.78</td>
<td>65.66</td>
</tr>
<tr>
<td>Average</td>
<td>-0.037</td>
<td>21.57</td>
<td>60.91</td>
</tr>
</tbody>
</table>

**Table I: Experimental results for OARP**

- OARP leads to an average complexity reduction of 60.91% for TZS and 21.57% for the whole encoding process, with a BD-rate increase of 0.037%  

**CONCLUSION**

- The proposed search pattern, named Octagonal-Axis Raster Pattern (OARP), was designed to efficiently exploit the search area in the Raster Search step of TZS
- A decrease of 60.91% in TZS complexity was achieved, with a negligible BD-rate increase of 0.037%
- When implemented in the HEVC reference software, an average total encoding time reduction of 21.6% is achieved
- OARP is compatible with other fast Motion Estimation algorithms that employ Raster Search, and can be jointly implemented with other complexity reduction strategies

**REFERENCES**