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Charged Particle Tracking by Pattern Recognition and Event Reconstruction

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It has been a high demand for the investigation of charged particle tracking making use of pattern recognition and event reconstruction [1], which have been of high significance towards the design, efficiency and resolution of tracking detectors. Special demand is directed to the detectors upgrade during the Long shutdown 2 (LS2) over 2018-2020 at CMS, CERN following the current RUN 2 (2015-2018). Approaches in global and local methods of track pattern recognition are essential. In case of global methods of track pattern recognition, all detector hits are treated similarly, while local methods considers good seeds. In global methods, pattern can be easily recognized when there is a finite number of possible patterns. In this case, a template can be defined for every single pattern, the so called template matching, i.e., pattern-to-template correspondence. The Fuzzy Radon transform with its special form, Hough transform [2], is another global method in which the track pattern recognition allows taking the precise resolution of the tracking detector into consideration. There have been several challenges towards the improvement of tracking detectors and one of which is track finding, rather than its efficiency, as the most time consuming part of the event reconstruction. Both geometric and reconstruction efficiencies are demanded to be obtained precisely to guarantee an accurate total efficiency of track finding, which is the fraction found of true particles. This requires that reconstructed tracks that does not match to true particles (ghost tracks) and the particles reconstructed more than once (track clones) have to be excluded. Ghost tracks are caused by noise hits or hits from different particles, while track clones may be attributed to a kink in the track or the use of two algorithms that find same tracks. Another challenge arises when many hits correspond to a single event, i.e. large multiplicity. This leads to a high occupancy, which in turn results in overlapping tracks and ghost tracks, but can be fixed by keeping the detector granularity high. Several other challenges are awaiting new approaches of tackling in the context of the contribution in the R&D upgrade activities at CMS towards the upgrade work during LS2.

References:

1. "Pattern recognition and event reconstruction in particle physics experiments," R. Mankel, Reports on Progress in Physics 67, 553 (2004).
2. P.V.C. Hough, Machine Analysis of Bubble Chamber Pictures, Int. Conf. on High Energy Accelerators and Instrumentation, 554–556, CERN, 1959.

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