**PROBLEM DESCRIPTION**
- Power systems network is a highly complex topological arrangement of electrical components
- Transmission networks can be classified as a multi-planar, bidirectional multi-graph with Hamiltonian cycles
- Visual aid fails to identify intricate features of the graph viz.. loops, cycles, minimum cost paths, etc.
- Loops or Hamiltonian cycles are essentials to accommodate unscheduled flows (USFs)
- Objective: Identification and selection of sufficient loops in a given network to accommodate USFs

**LOOP DETECTION ALGORITHM**
- Proposed algorithm is derived from A* heuristic algorithm and Dijkstra’s algorithm
- Loop detection algorithm is agnostic to system size i.e. applicable to both test and practical systems
- Each transmission line is assumed to be a bidirectional edge
- Sufficiency condition: All the edges should be traced at least in one direction and no loop sequences be duplicated

**NETWORK REDUCTIONS**
- Two major network reduction steps employed in are successive nodal collapse and heuristic wave search
- Successive nodal collapse: Forming smart adaptive edges by collapsing all 2 degree nodes successively
  - STOP if min(degree) > 2
- Heuristic wave search: For an active network, determine the locally minimal complex node as the starting vertex
  - On distinct outward and inward paths an intersection of imaginary waves is sought
  - STOP first intersection of waves
- Cost function: Minimum number of nodes in a loop are preferred

**FLOWCHART**

**TEST NETWORK #1**
- IEEE 14 bus test system can be completely solved by successive nodal collapse only

**TEST NETWORK #2**
- IEEE 30 bus test system under analysis needs both the reduction techniques
- Successful nodal collapse reduces the network significantly from 30 nodes to 5 nodes
- 4 loops are identified in addition to ones obtained in successive collapses (7 loops)

**CHALLENGES**
- Memory management issues for bulk interconnections due to data sizes
- No visual aid available to troubleshoot for programming errors
- Challenges: Multicollinearity issues observed for system matrix formed for USF estimation

**CONCLUSIONS**
- Application of graph theory techniques to detect loops in power system networks
- Accurate loops detected for relatively simpler test systems
- Implementation on practical bulk interconnections under development
- Alternating between two reduction methods is the next step

**REFERENCES**

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