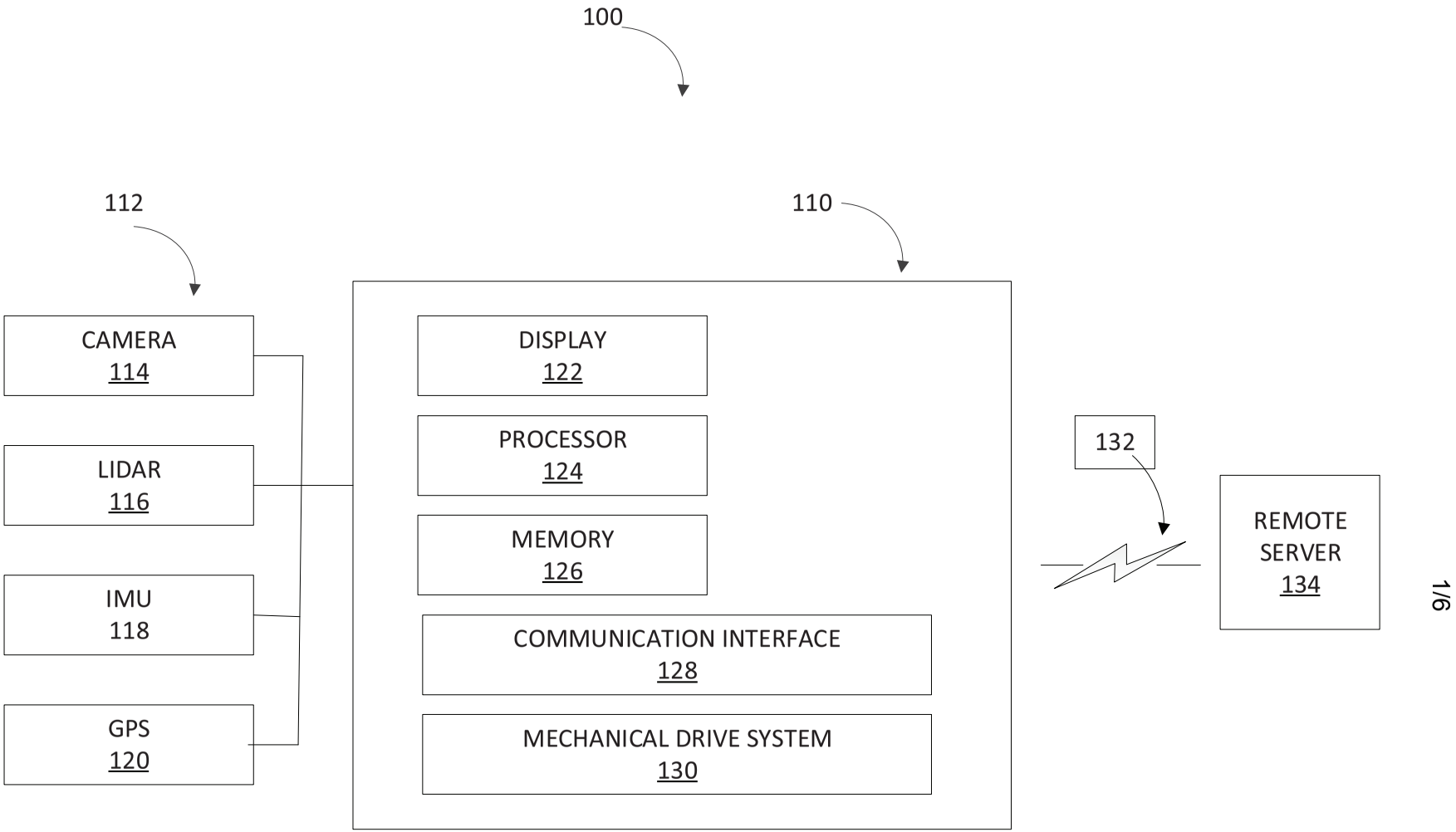

100
112
110
CAMERA
114
LIDAR
116
IMU
118
GPS
120
DISPLAY
122
PROCESSOR
124
MEMORY
126
COMMUNICATION INTERFACE
128
MECHANICAL DRIVE SYSTEM
130
132
REMOTE
SERVER
134

FIG. 1

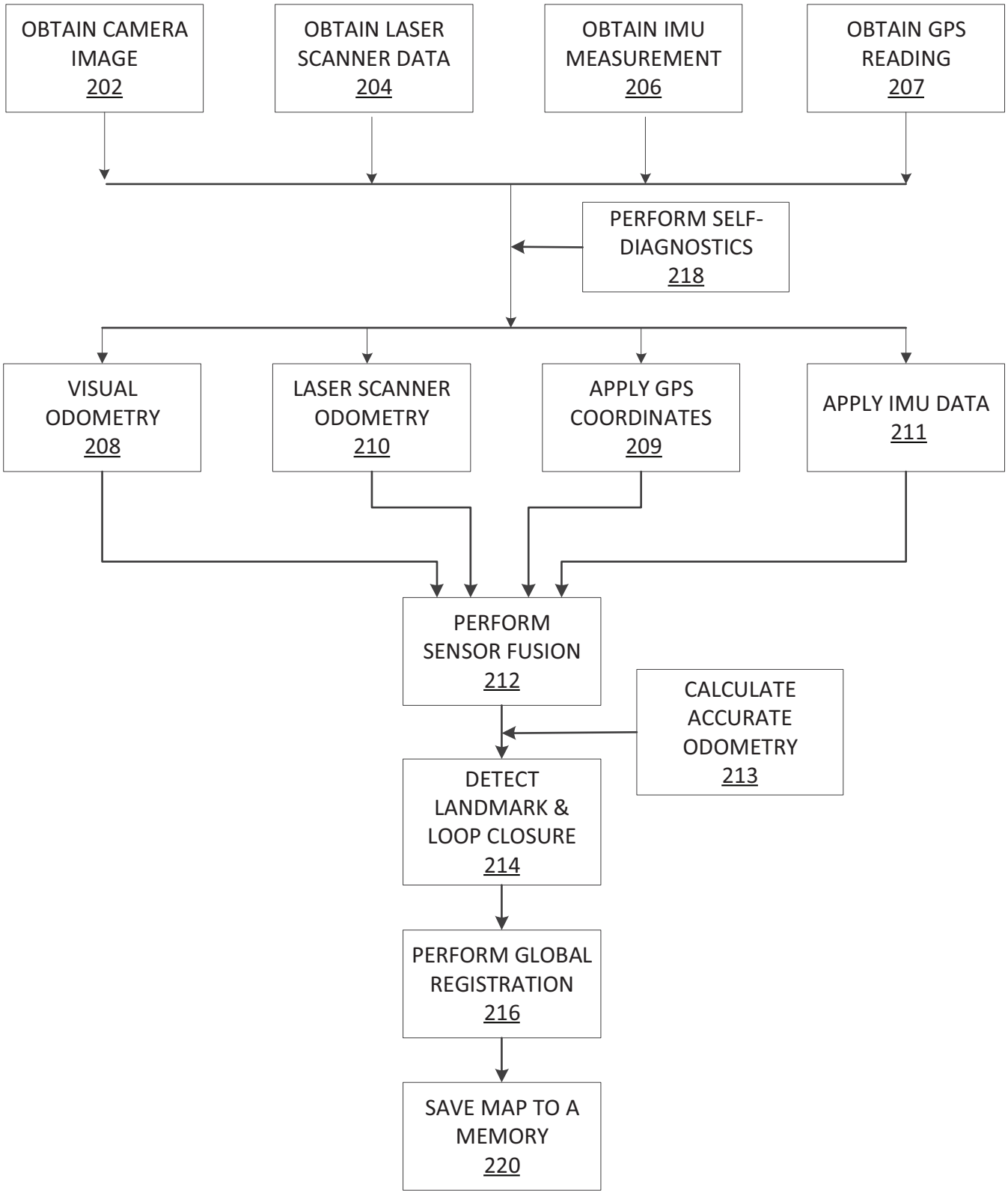

OBTAIN CAMERA IMAGE 202
OBTAIN LASER SCANNER DATA 204
OBTAIN IMU MEASUREMENT 206
OBTAIN GPS READING 207
PERFORM SELF-DIAGNOSTICS 218
VISUAL ODOMETRY 208
LASER SCANNER ODOMETRY 210
APPLY GPS COORDINATES 209
APPLY IMU DATA 211
PERFORM SENSOR FUSION 212
CALCULATE ACCURATE ODOMETRY 213
DETECT LANDMARK & LOOP CLOSURE 214
PERFORM GLOBAL REGISTRATION 216
SAVE MAP TO A MEMORY 220

FIG. 2

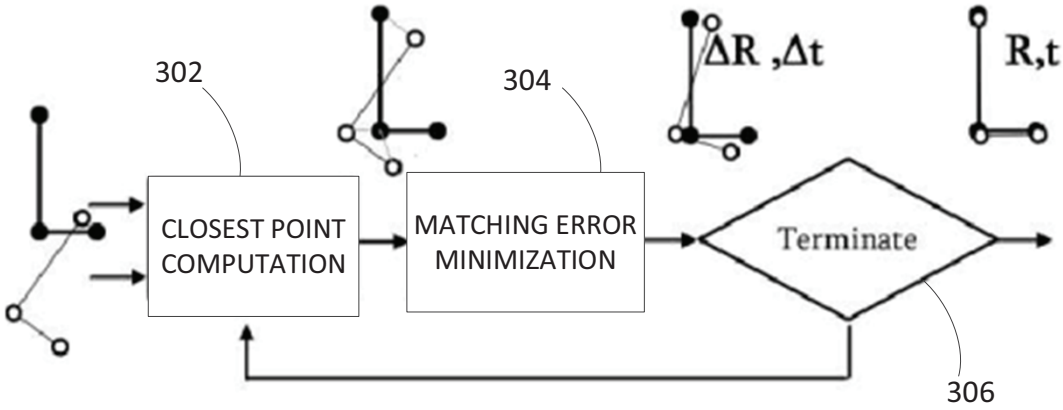

302
304
ΔR ,Δt
R,t
CLOSEST POINT COMPUTATION
MATCHING ERROR MINIMIZATION
Terminate
306

FIG. 3A

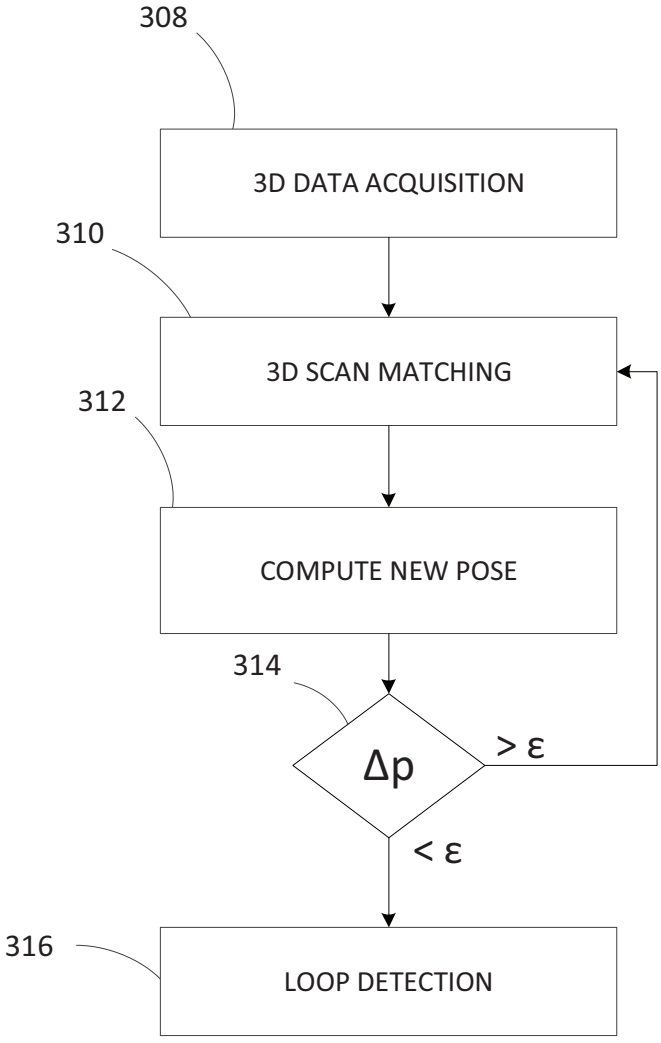

308
3D DATA ACQUISITION
310
3D SCAN MATCHING
312
COMPUTE NEW POSE
314
Δp
> ε
< ε
316
LOOP DETECTION

FIG. 3B

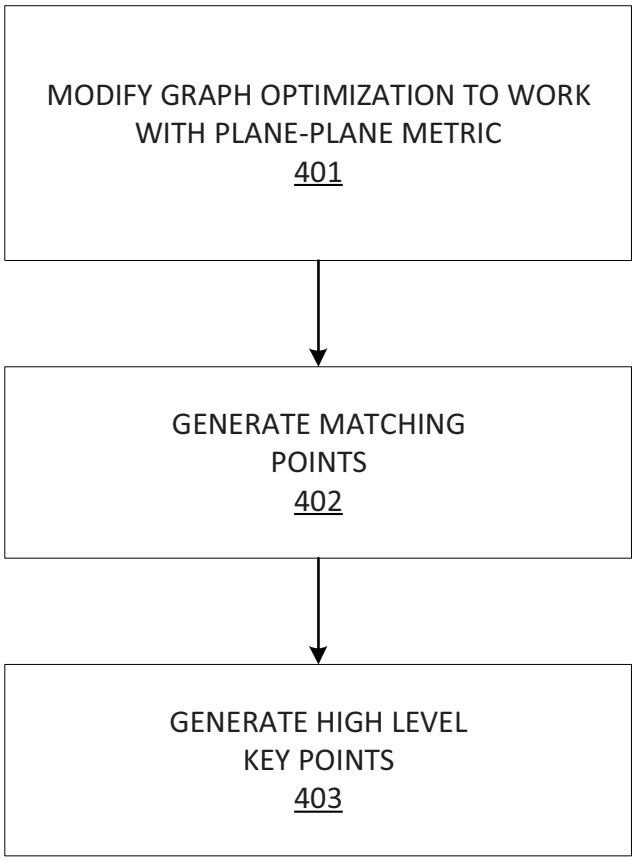

MODIFY GRAPH OPTIMIZATION TO WORK WITH PLANE-PLANE METRIC
401
GENERATE MATCHING POINTS
402
GENERATE HIGH LEVEL KEY POINTS
403

FIG. 4

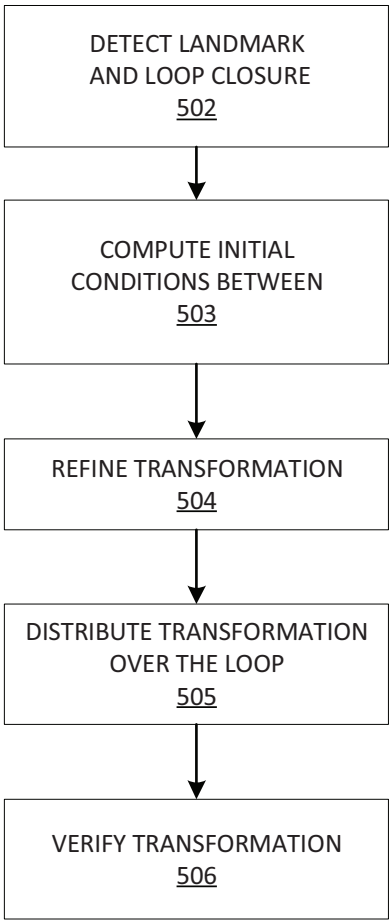

DETECT LANDMARK AND LOOP CLOSURE 502
COMPUTE INITIAL CONDITIONS BETWEEN 503
REFINE TRANSFORMATION 504
DISTRIBUTE TRANSFORMATION OVER THE LOOP 505
VERIFY TRANSFORMATION 506

FIG. 5

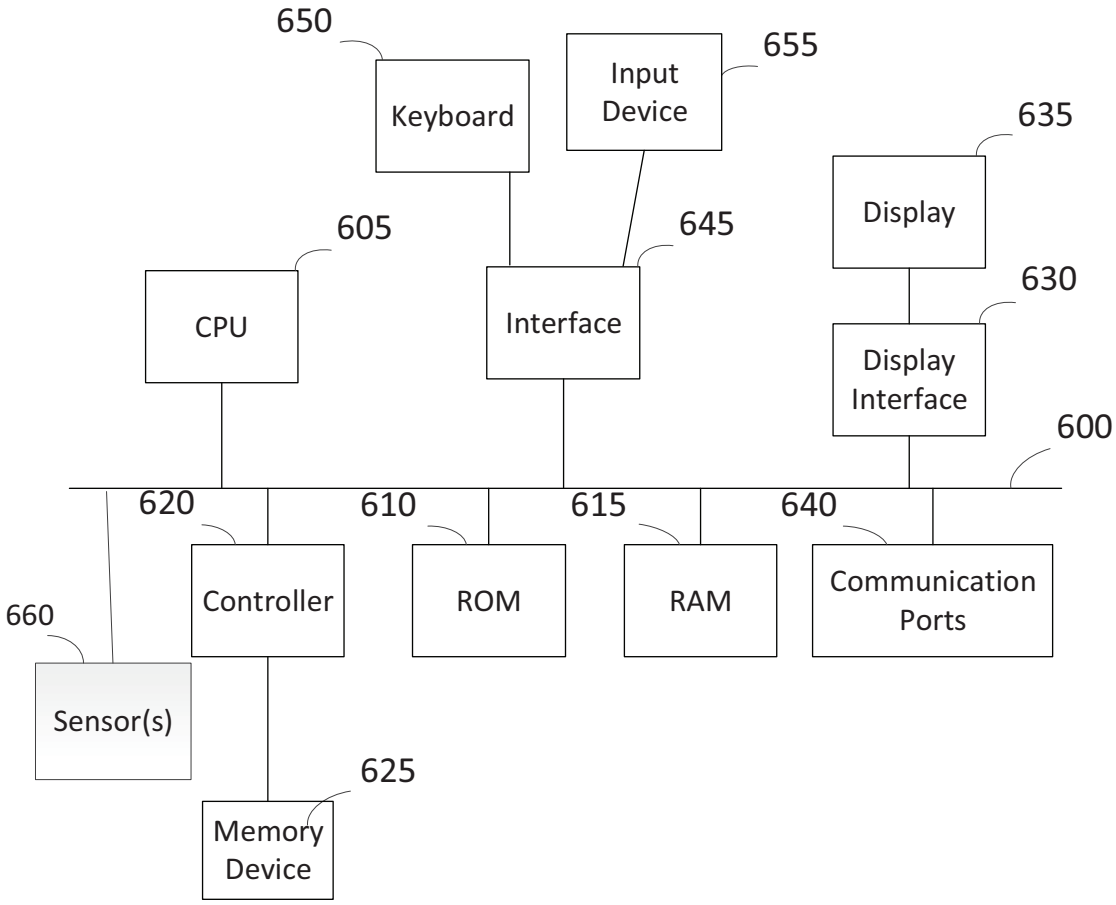

650
Keyboard
Input Device
655
635
Display
605
CPU
645
Interface
630
Display Interface
600
620
610
615
640
Controller
ROM
RAM
Communication Ports
660
Sensor(s)
625
Memory Device

FIG. 6