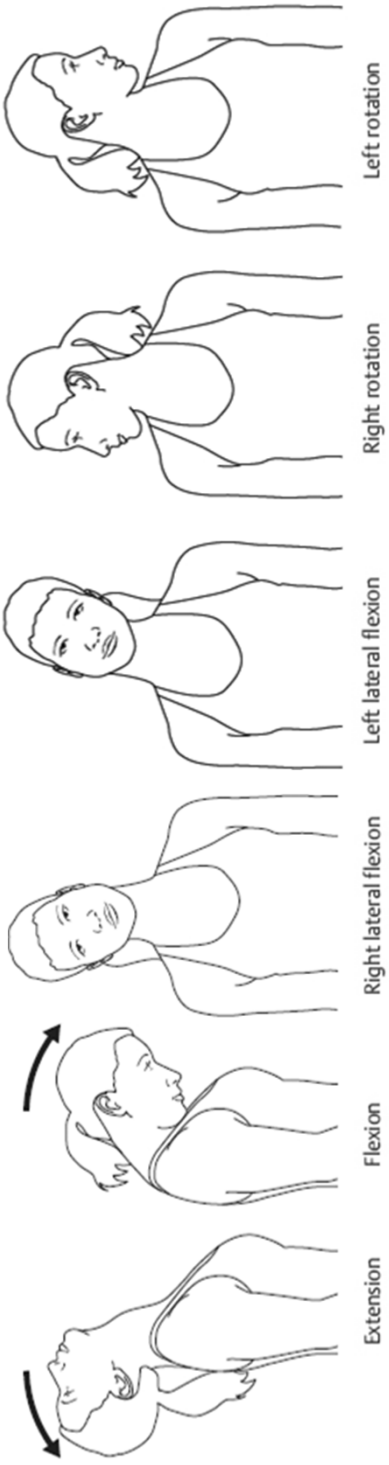

Extension
Flexion
Right lateral flexion
Left lateral flexion
Right rotation
Left rotation
100

Figure 1



Figure 2B

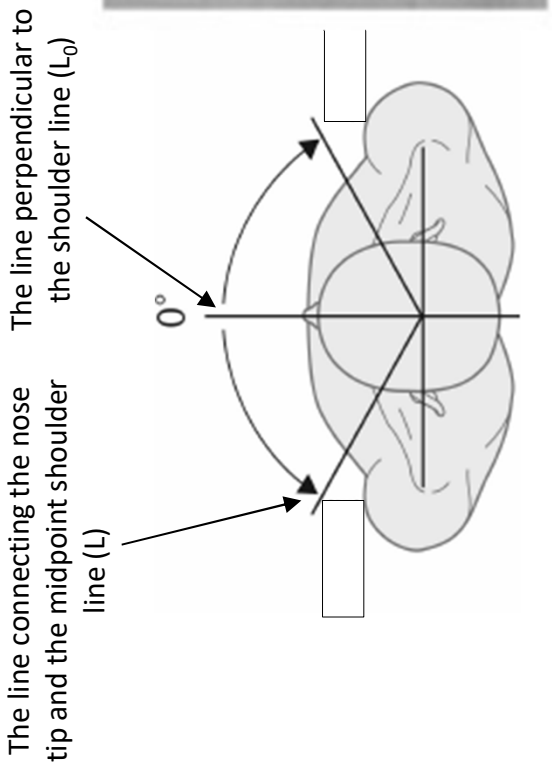


Figure 2A

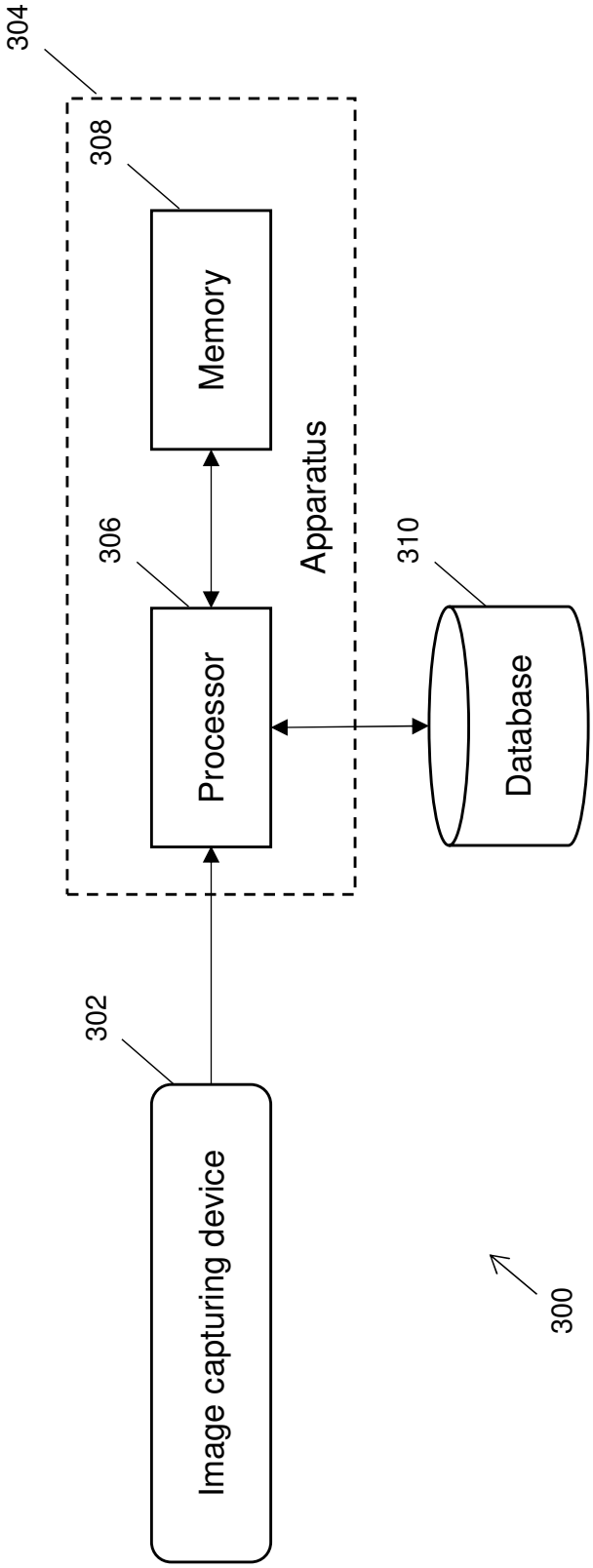

304
308
Memory
Apparatus
306
310
Processor
Database
302
Image capturing device
300

Figure 3

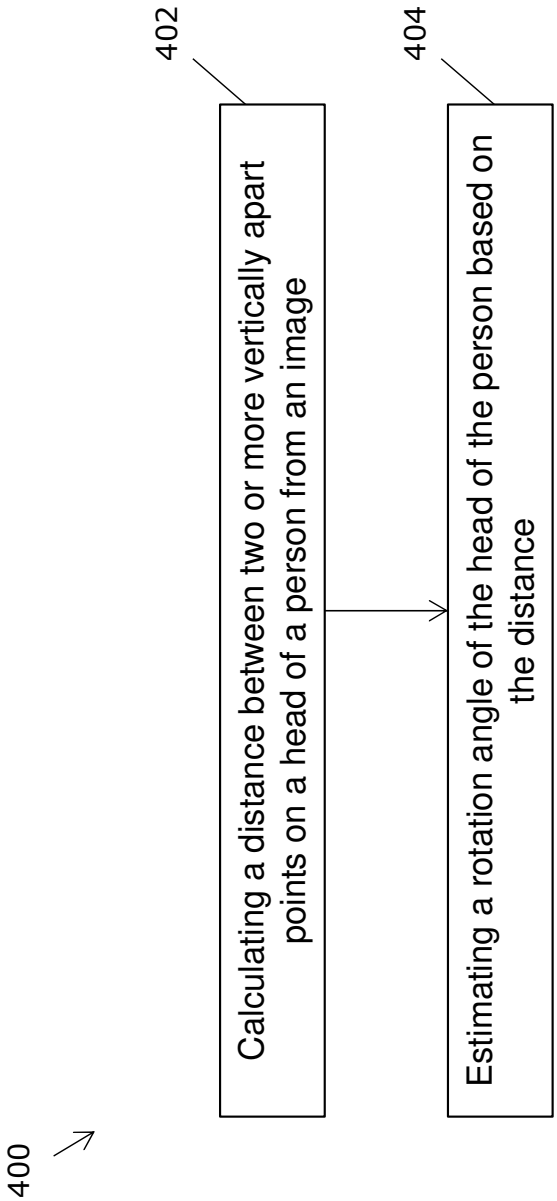
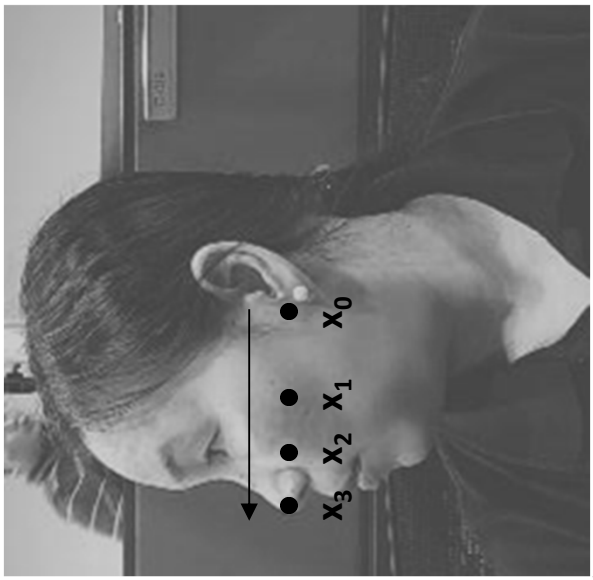

400
402
Calculating a distance between two or more vertically apart points on a head of a person from an image
404
Estimating a rotation angle of the head of the person based on the distance

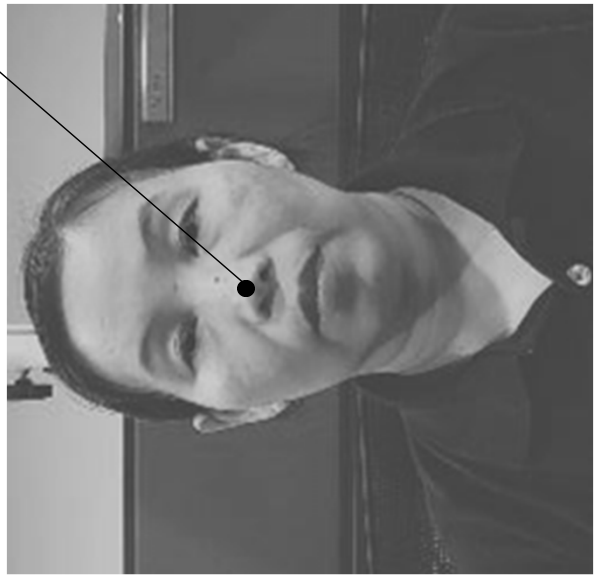
Figure 4



510

Figure 5B

502



500

Figure 5A

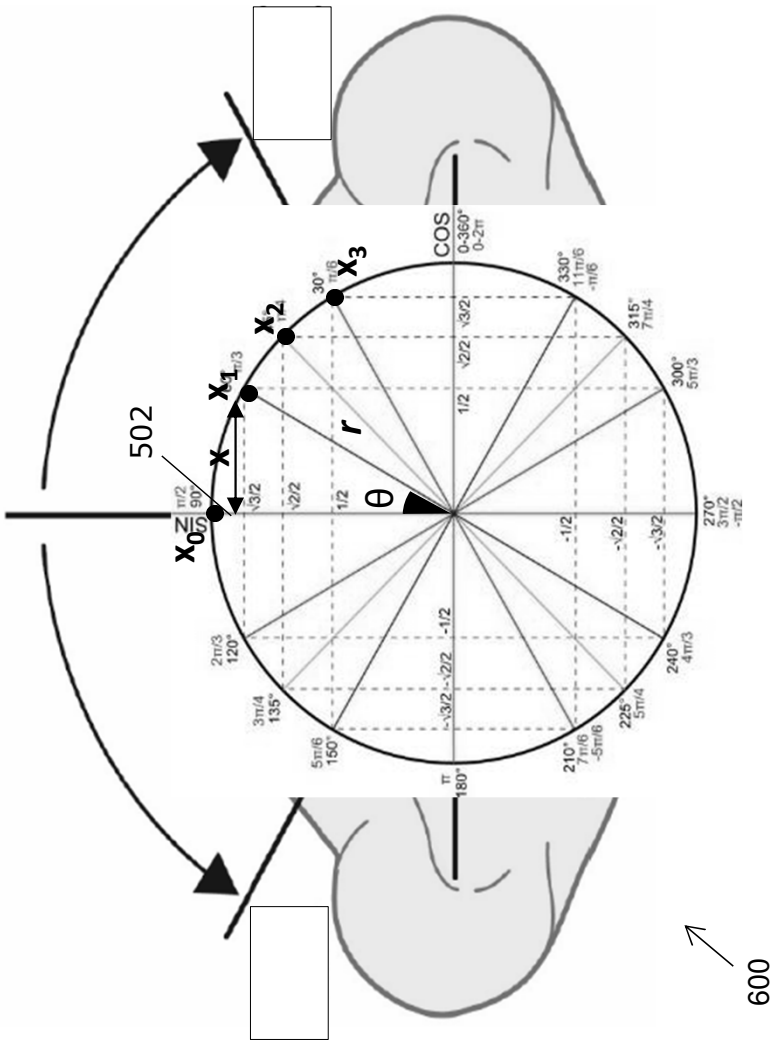


Figure 6

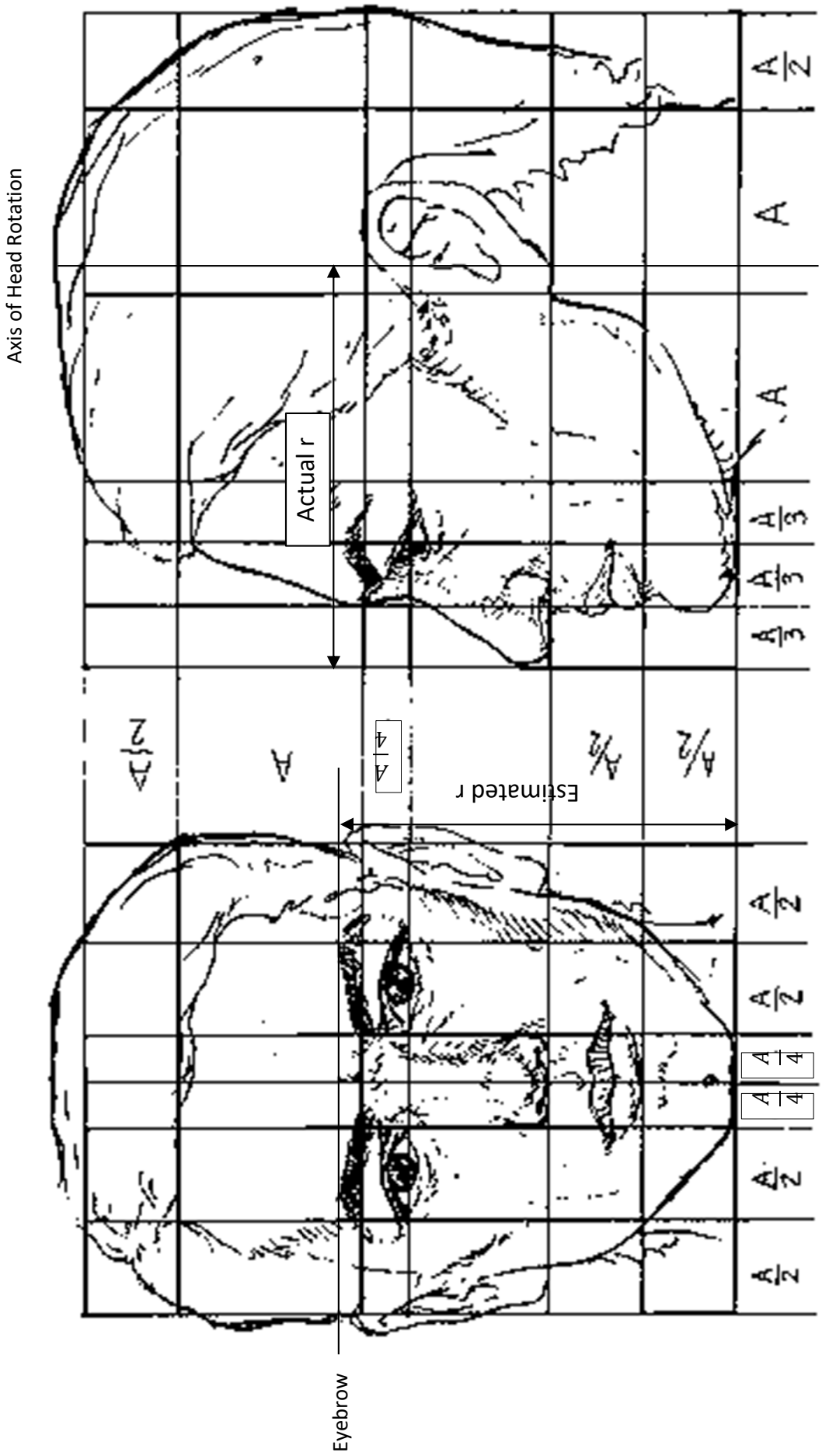


Figure 7

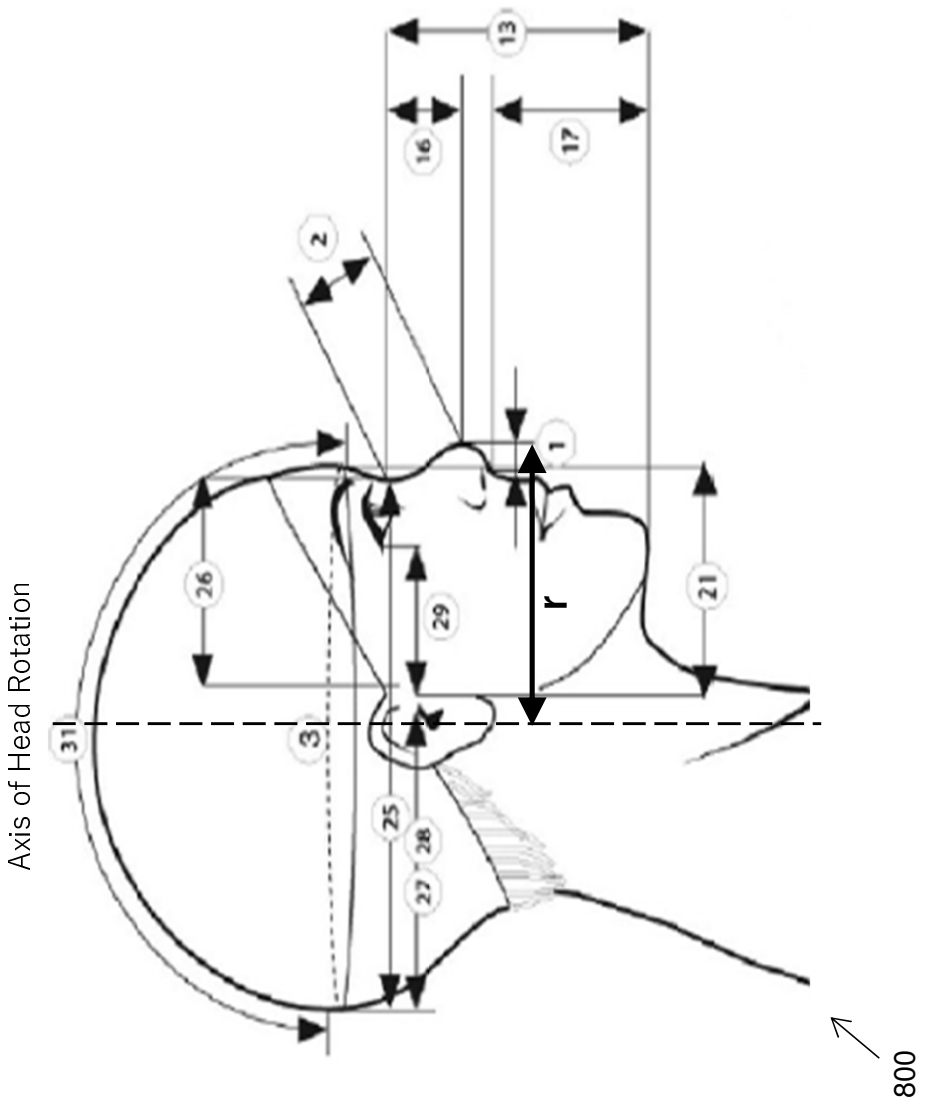


Figure 8

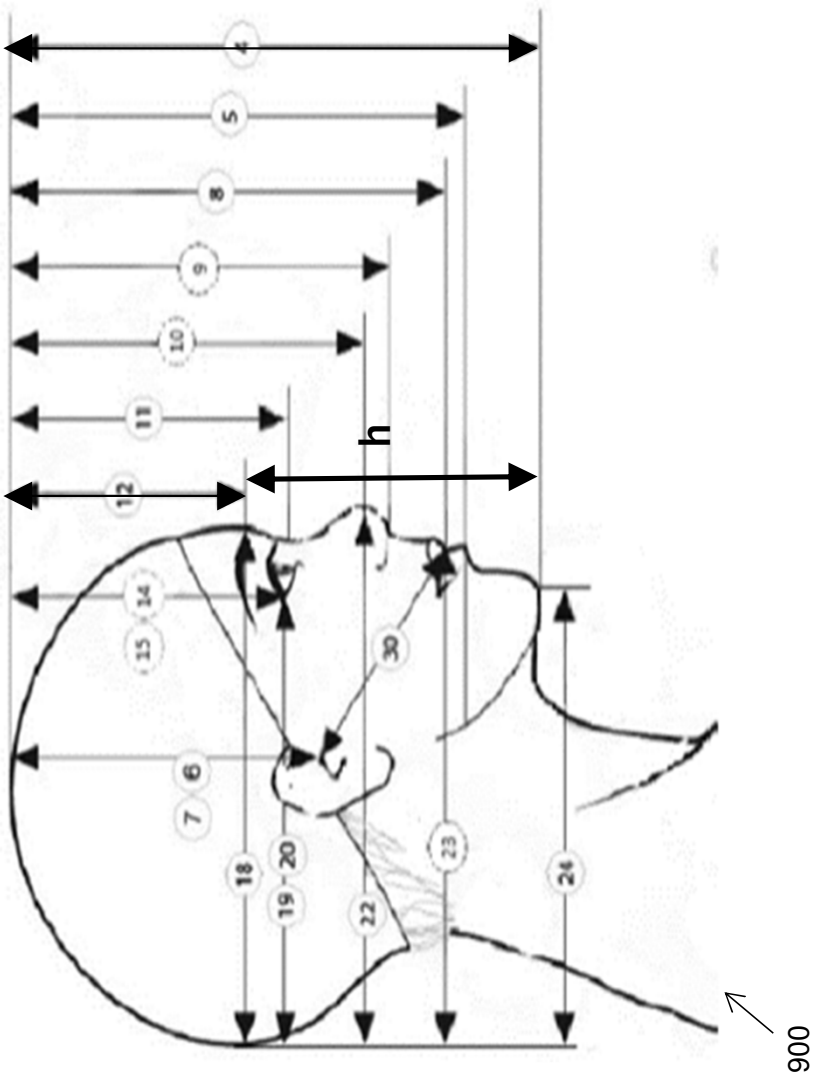
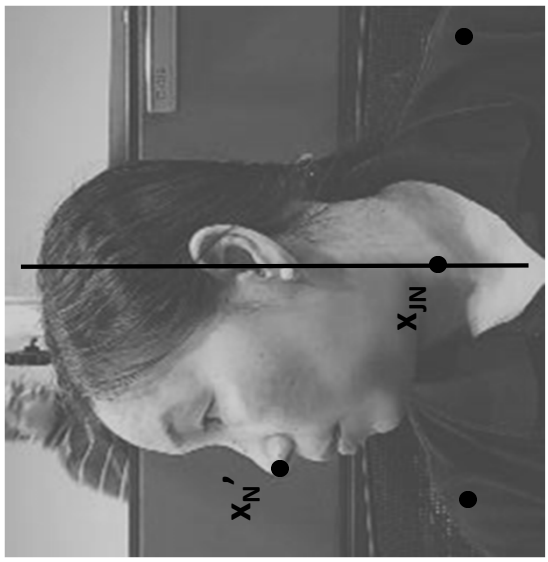


Figure 9



1010

Figure 10B



1000

Figure 10A

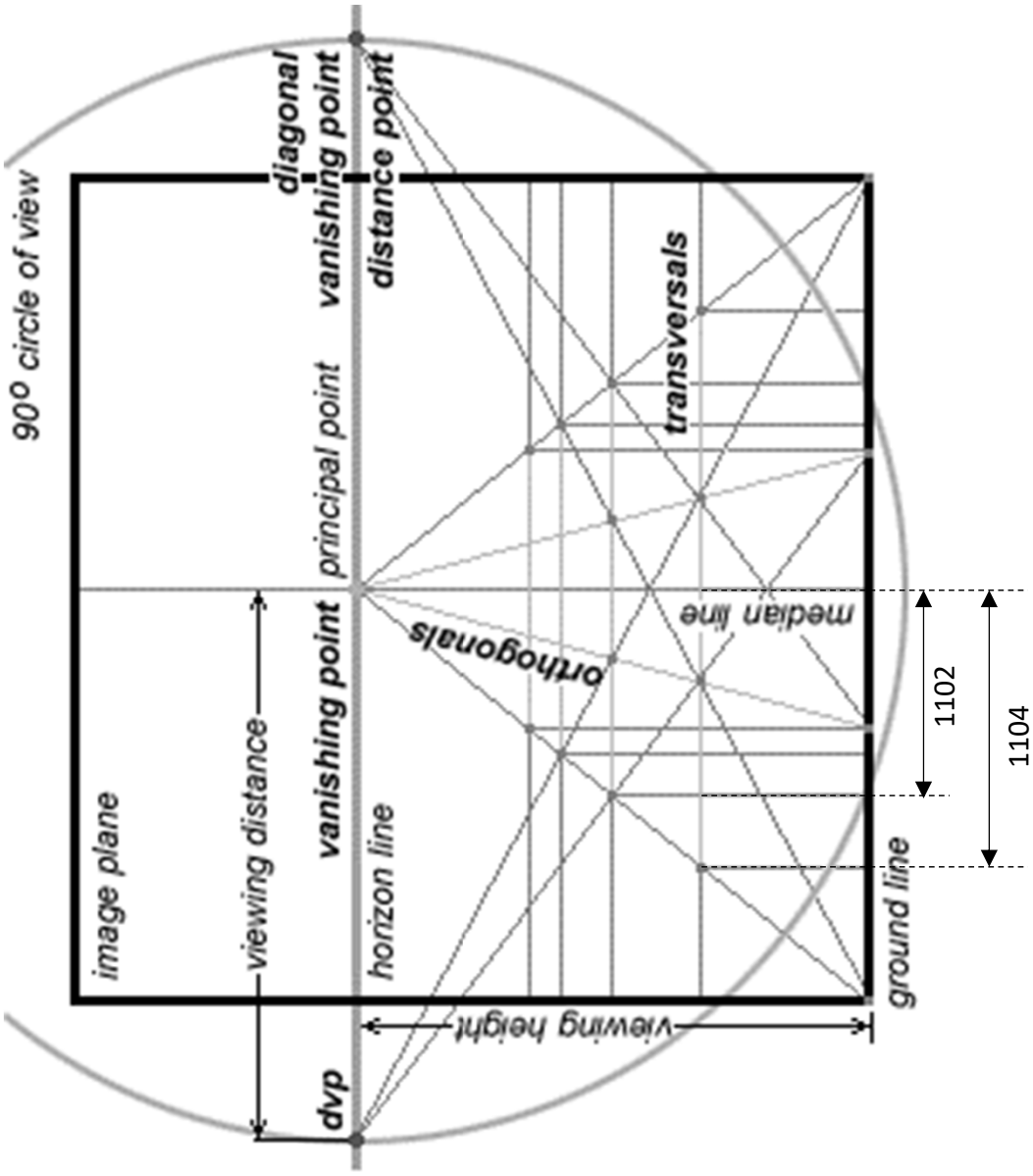

90° circle of view
diagonal vanishing point
distance point
transversals
principal point
median line
orthogonals
vanishing point
image plane
viewing distance
horizon line
viewing height
ground line
dvp
1102
1104

Figure 11

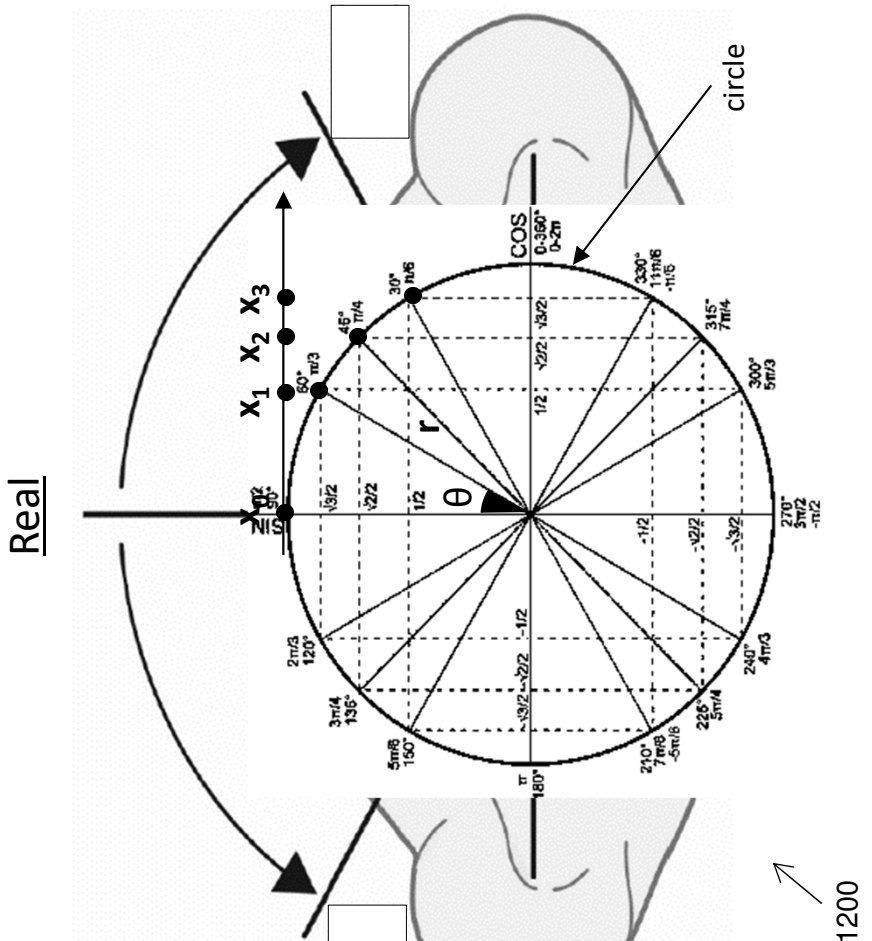


Figure 12A

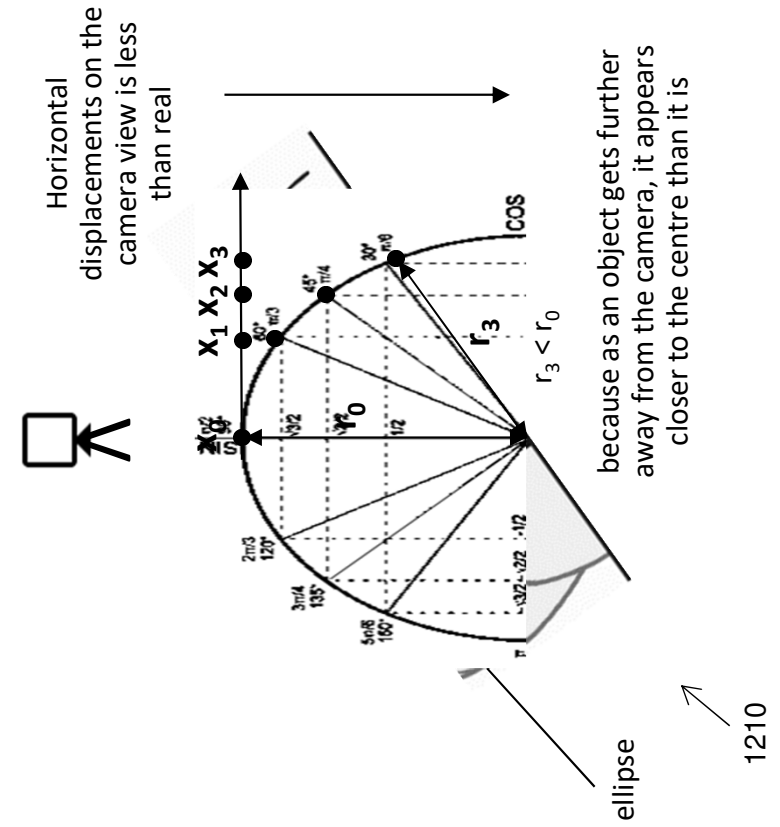
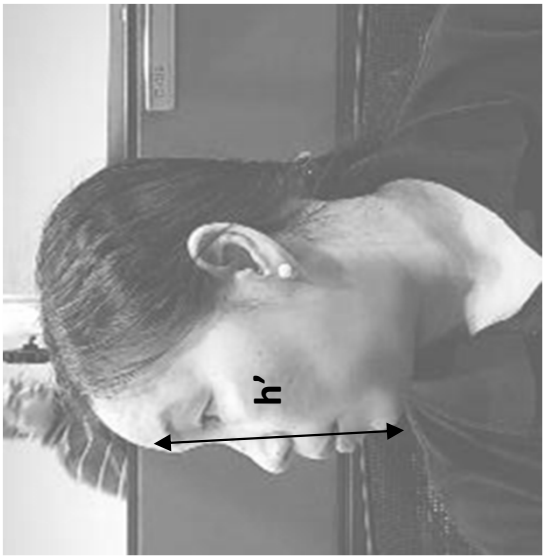


Figure 12B



1310

Figure 13B



1300

Figure 13A

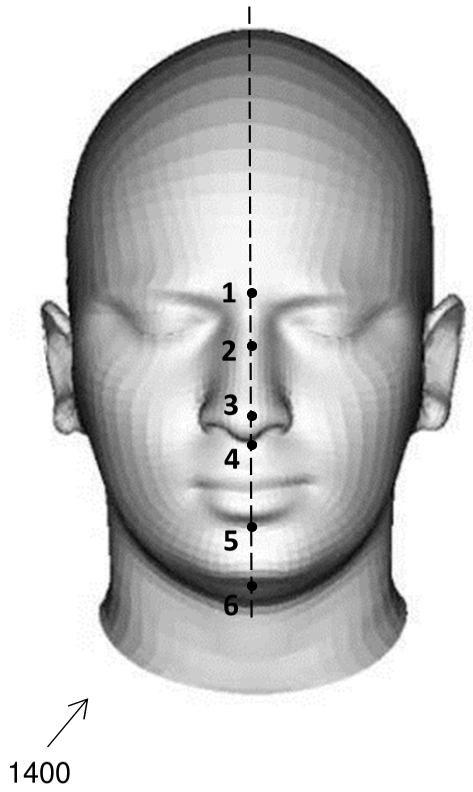


Figure 14A

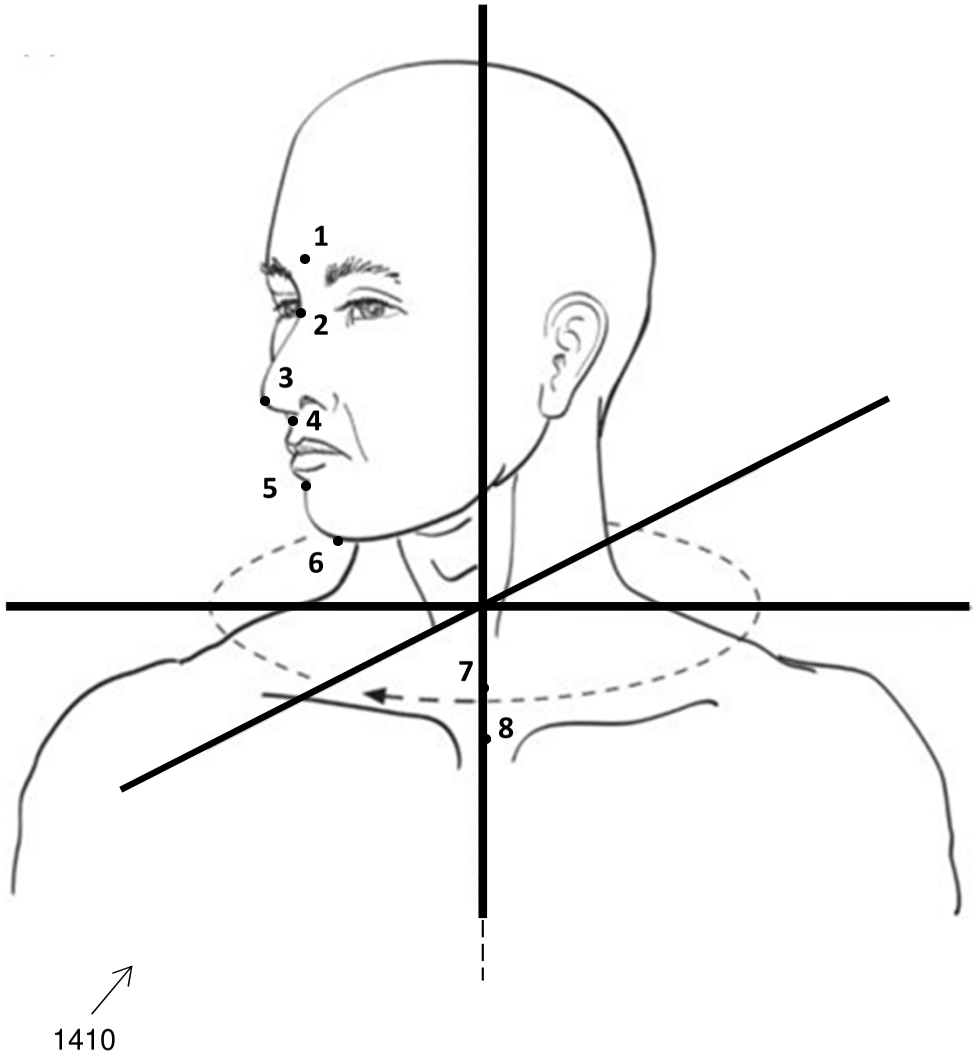


Figure 14B

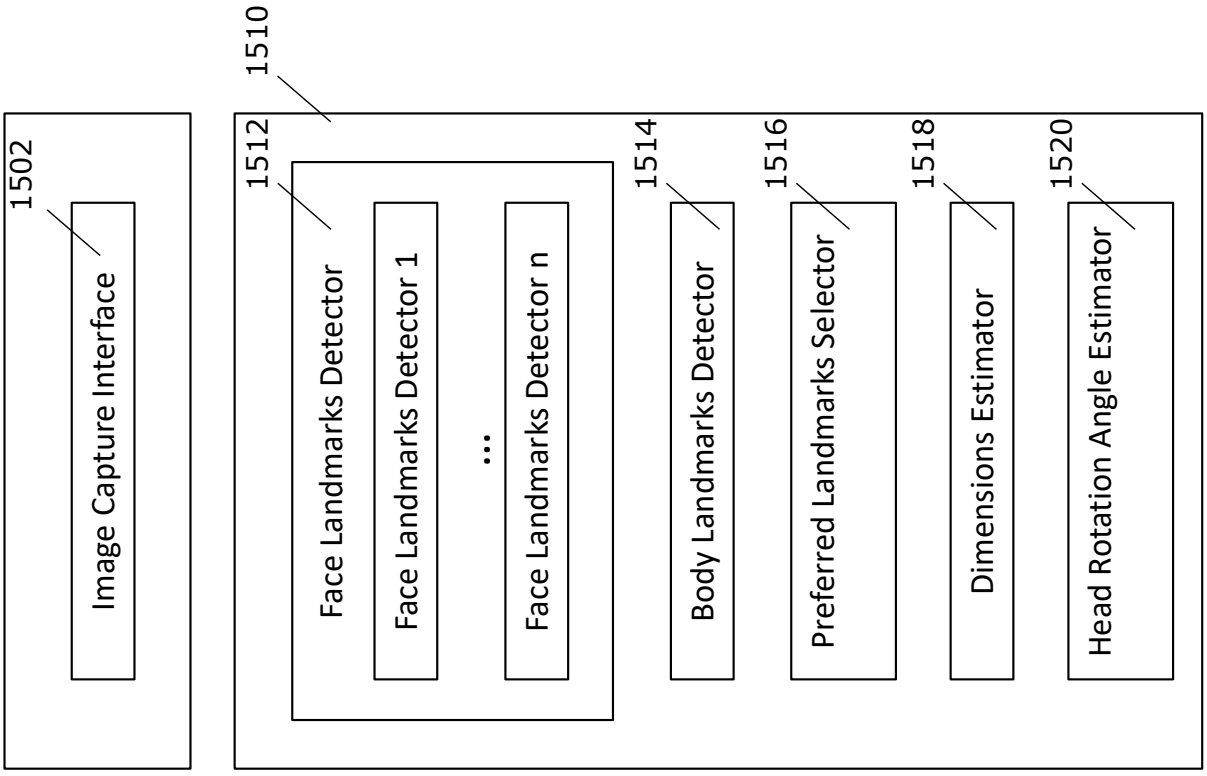

1502
Image Capture Interface
1510
1512
Face Landmarks Detector
Face Landmarks Detector 1
...
Face Landmarks Detector n
1514
Body Landmarks Detector
1516
Preferred Landmarks Selector
1518
Dimensions Estimator
1520
Head Rotation Angle Estimator

Figure 15

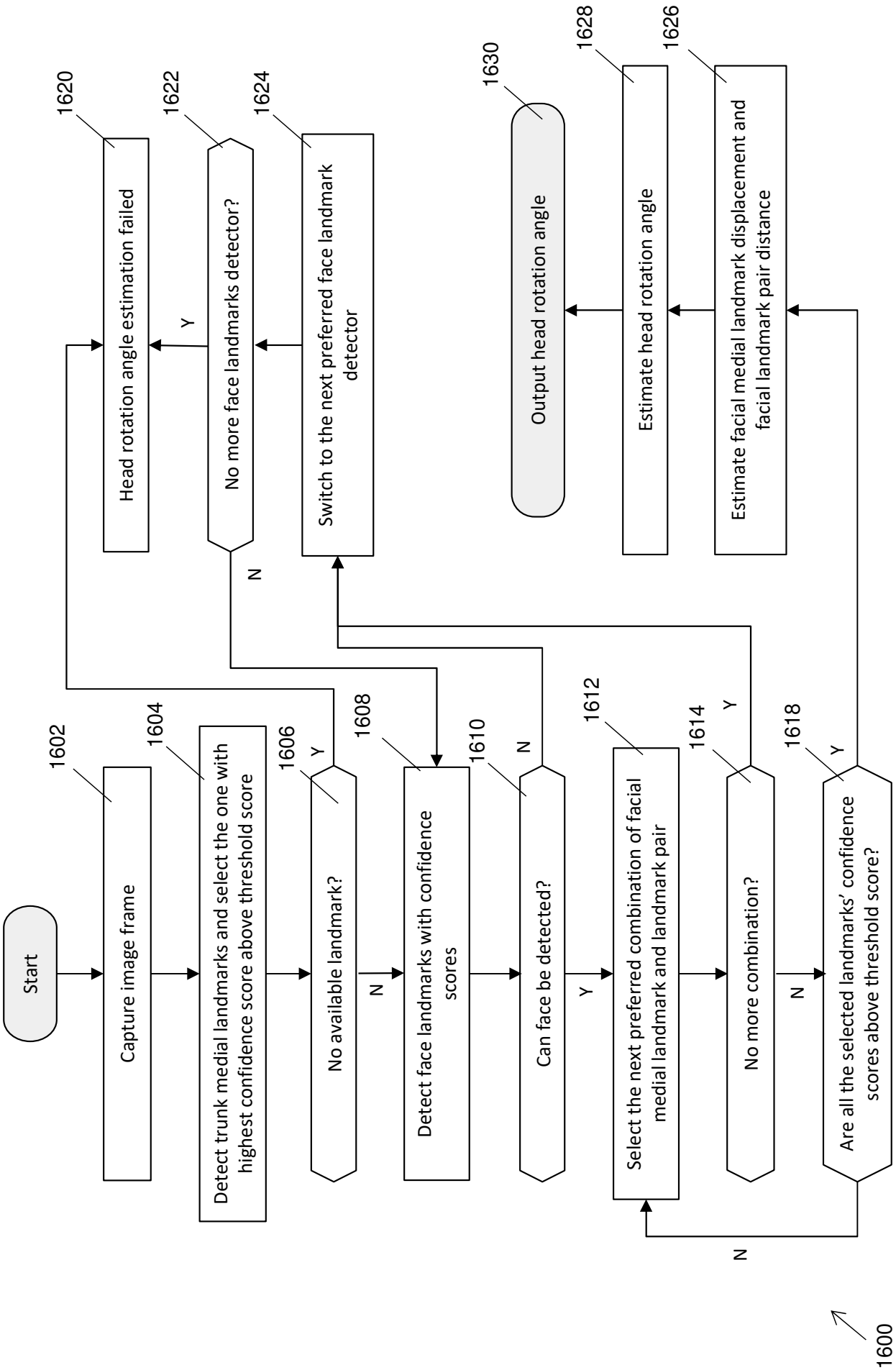
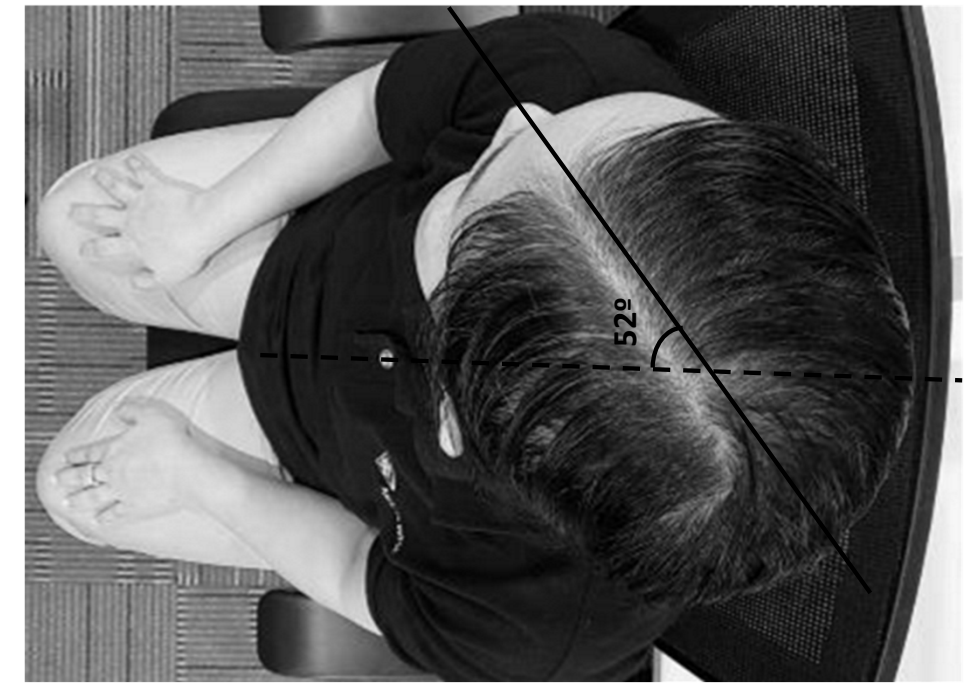
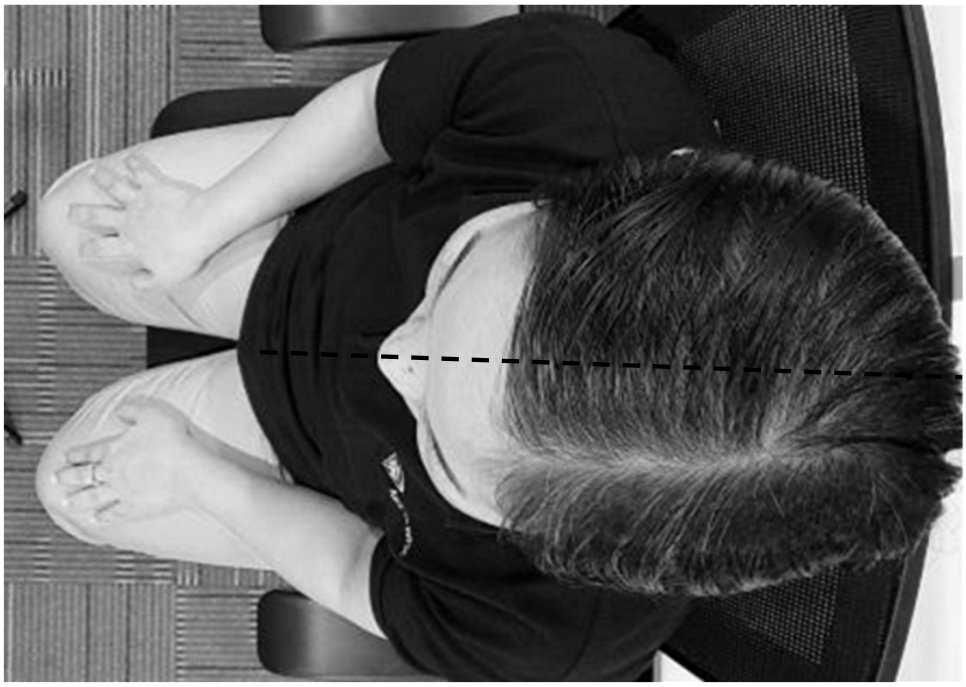

Start
Capture image frame
Detect trunk medial landmarks and select the one with highest confidence score above threshold score
No available landmark?
Detect face landmarks with confidence scores
Can face be detected?
Select the next preferred combination of facial medial landmark and landmark pair
No more combination?
Are all the selected landmarks' confidence scores above threshold score?
Estimate facial medial landmark displacement and facial landmark pair distance
Estimate head rotation angle
Output head rotation angle
Switch to the next preferred face landmark detector
No more face landmarks detector?
Head rotation angle estimation failed
1602
1604
1606
1608
1610
1612
1614
1618
1626
1628
1630
1624
1622
1620
1600
Y
N

Figure 16



1710

Figure 17B



1700

Figure 17A



1800

Figure 18



1910

Figure 19B



1900

Figure 19A



Figure 20



2100

Figure 21A

Frame #					Rotation	
123	0.413086	-13.2847	33.45117	-2.68066	28.21289	4.020996
124	0.70752	-13.1528	33.49951	-2.59277	29.20166	3.405762
125	0.421875	-13.2407	33.46875	-3.03223	29.17969	3.933105
126	0.808594	-13.2231	33.46875	-2.76856	30.27832	3.427734
127	0.404297	-13.2627	33.46436	-3.33984	30.08057	4.042969
128	0.404297	-13.2627	33.46436	-3.33984	30.08057	4.042969
129	1.041504	-13.478	33.36328	-2.3291	31.11328	4.108887
130	0.74707	-13.1045	33.51709	-3.36182	30.95947	3.186035
131	0.597656	-13.1968	33.48633	-3.38379	30.73975	3.713379
132	0.966797	-13.0342	33.54346	-3.36182	31.48682	3.010254
133	0.799805	-13.1792	33.48633	-3.33984	30.82764	3.691406
134	0.799805	-13.1792	33.48633	-3.33984	30.82764	3.691406
135	0.94043	-12.8892	33.59619	-3.73535	31.09131	2.724609

2110

Figure 21B

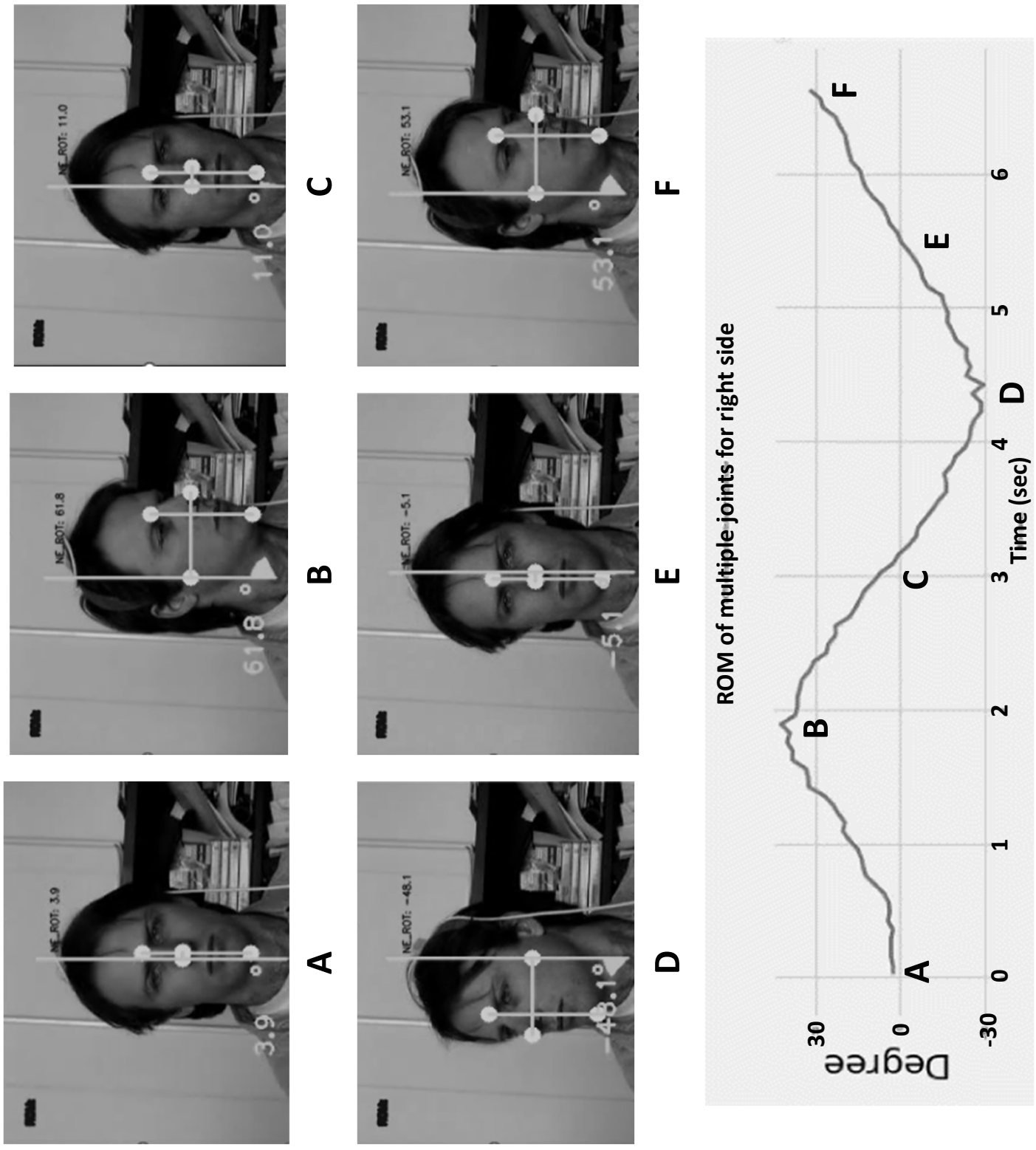
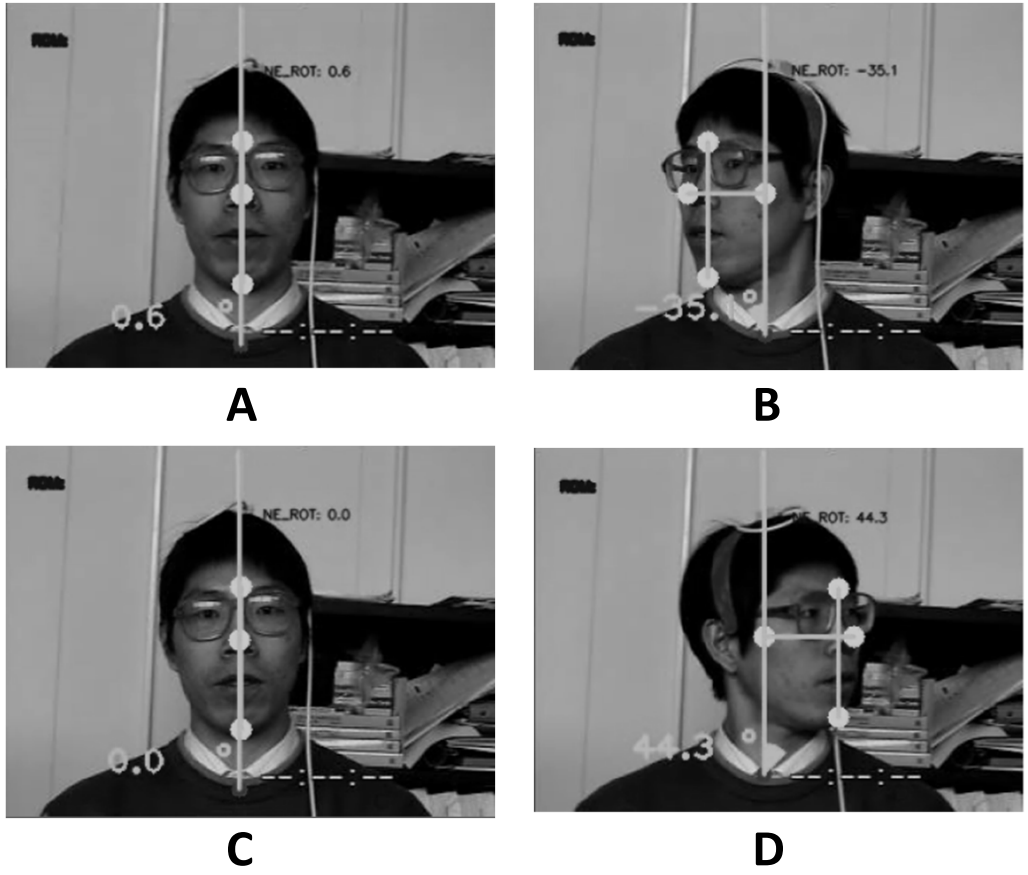

NE_ROT: 3.9
3.9 °
A
NE_ROT: 61.8
61.8 °
B
NE_ROT: 11.0
11.0 °
C
NE_ROT: -48.1
-48.1 °
D
NE_ROT: -5.1
-5.1 °
E
NE_ROT: 53.1
53.1 °
F
ROM of multiple joints for right side
Degree
30
0
-30
0
1
2
3
4
5
6
Time (sec)
A
B
C
D
E
F

Figure 22


NE_ROT: 0.6
0.6 °
NE_ROT: -35.1
-35.1 °
NE_ROT: 0.0
0.0 °
NE_ROT: 44.3
44.3 °
A
B
C
D

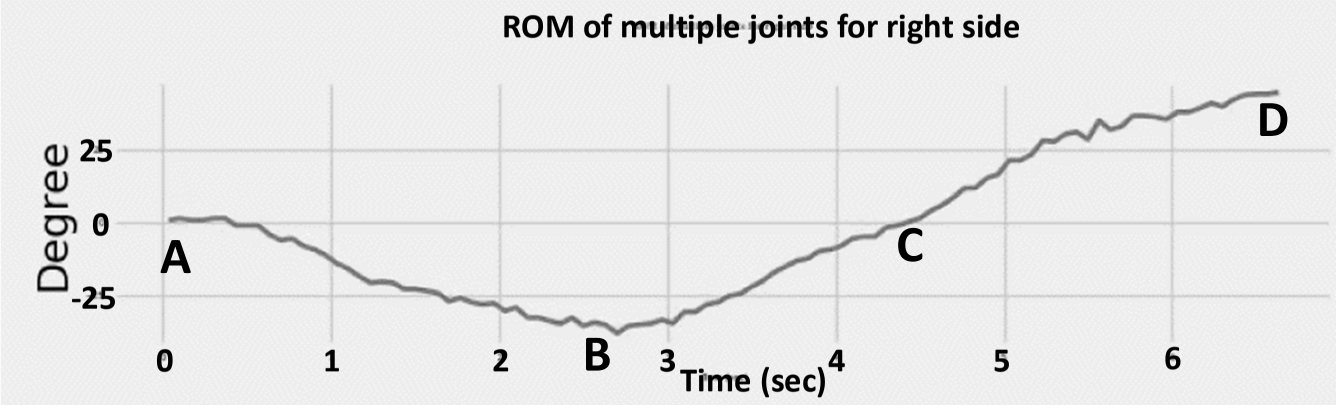
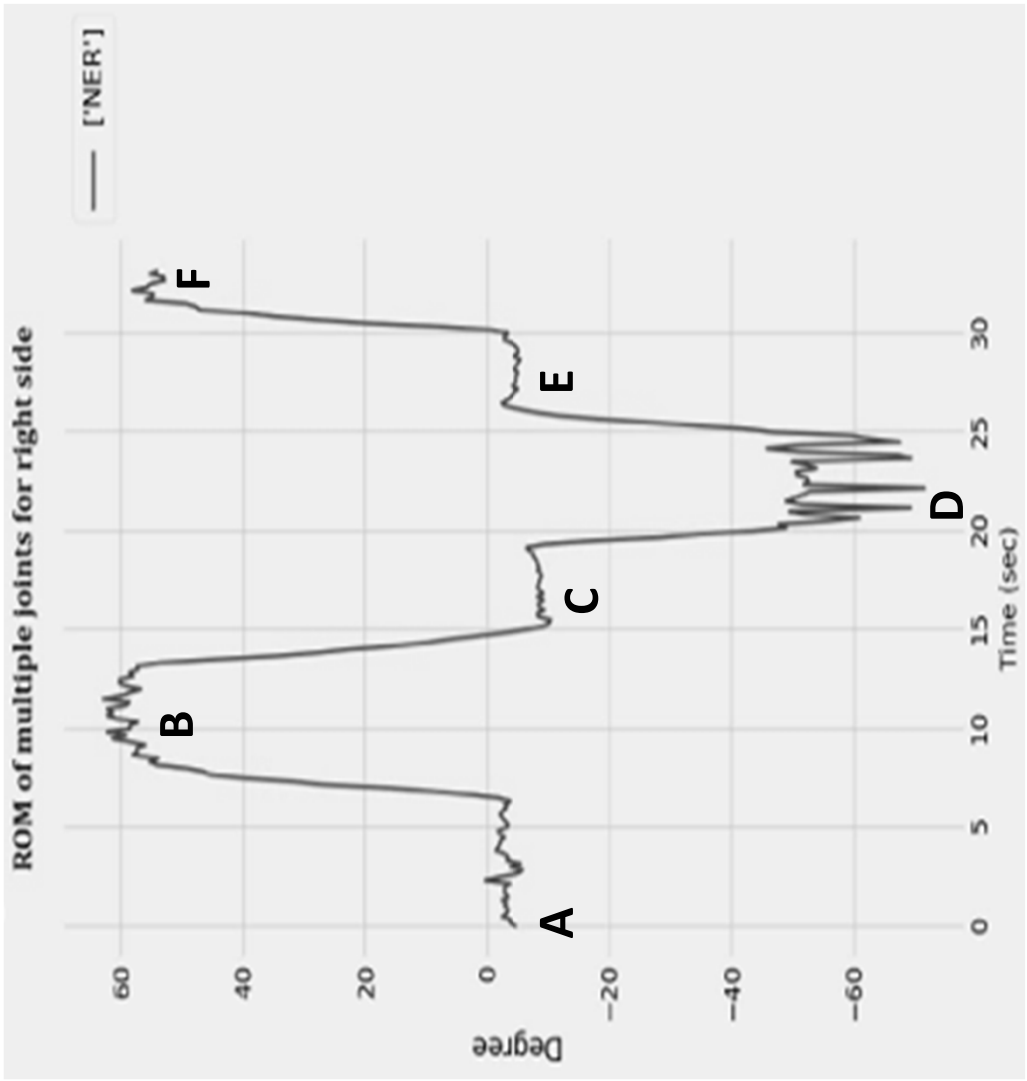

ROM of multiple joints for right side
Degree
25
0
-25
A
B
C
D
0
1
2
3
4
5
6
Time (sec)

Figure 23


ROM of multiple joints for right side
['NER']
Degree
Time (sec)
A
B
C
D
E
F

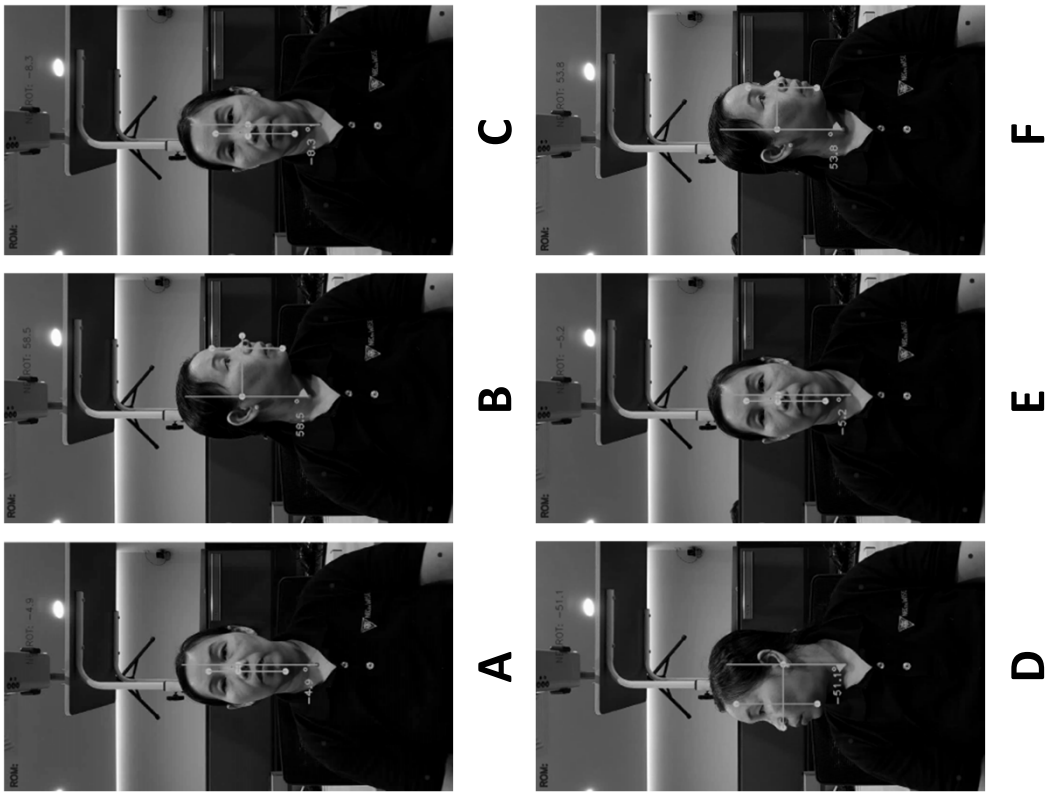
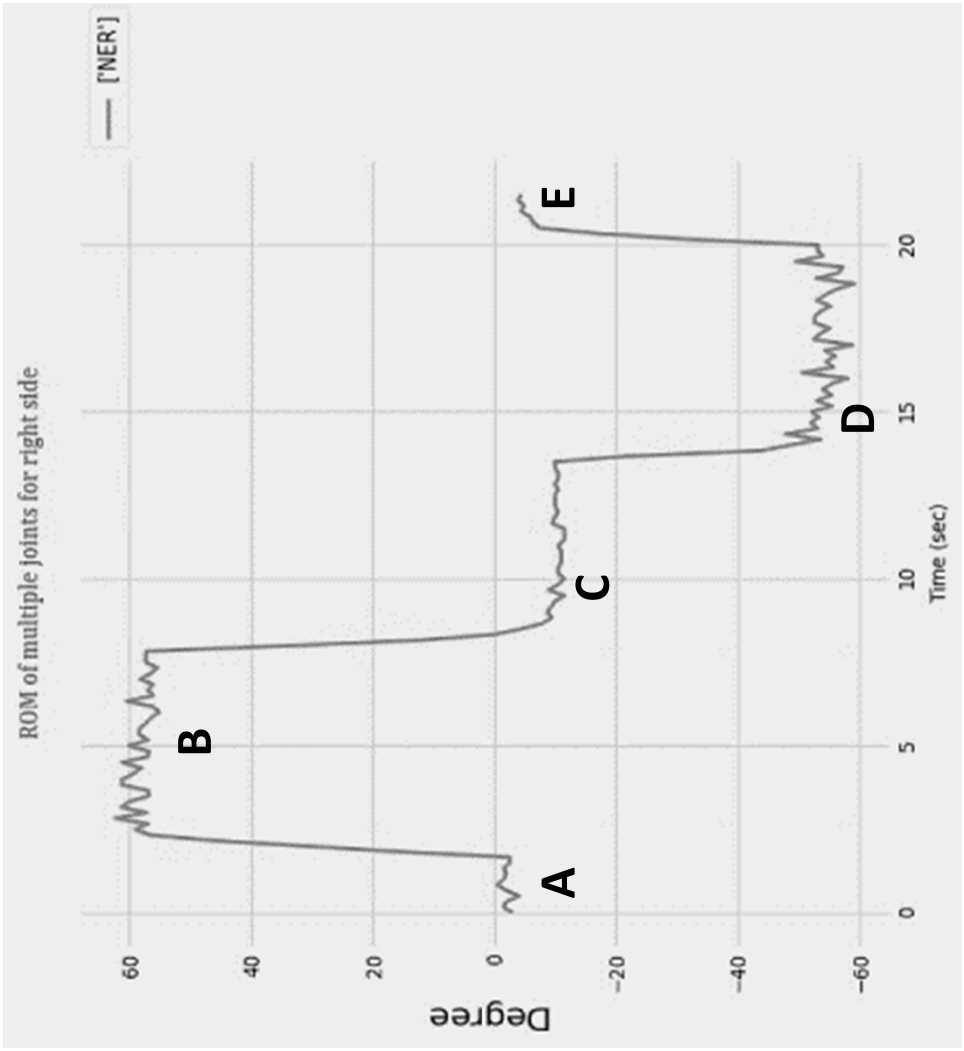

A
B
C
D
E
F

Figure 24


ROM of multiple joints for right side
['NER']
Degree
Time (sec)
60
40
20
0
−20
−40
−60
0
5
10
15
20
A
B
C
D
E

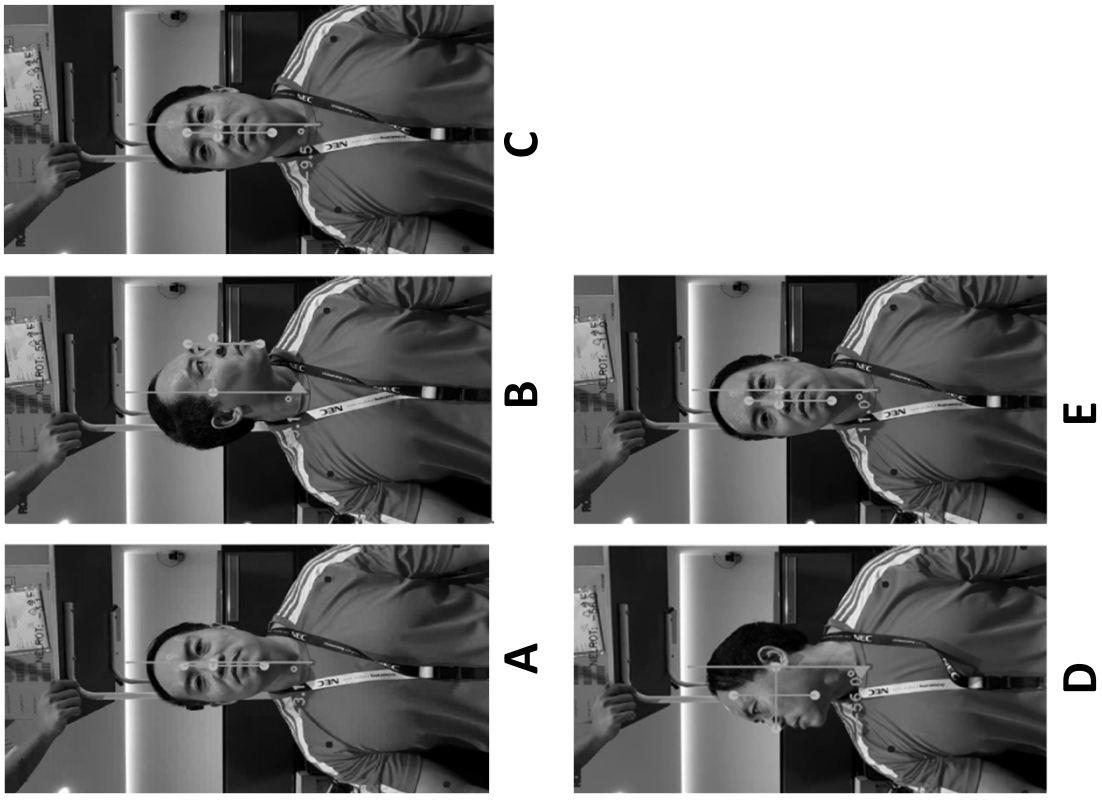

A
B
C
D
E

Figure 25

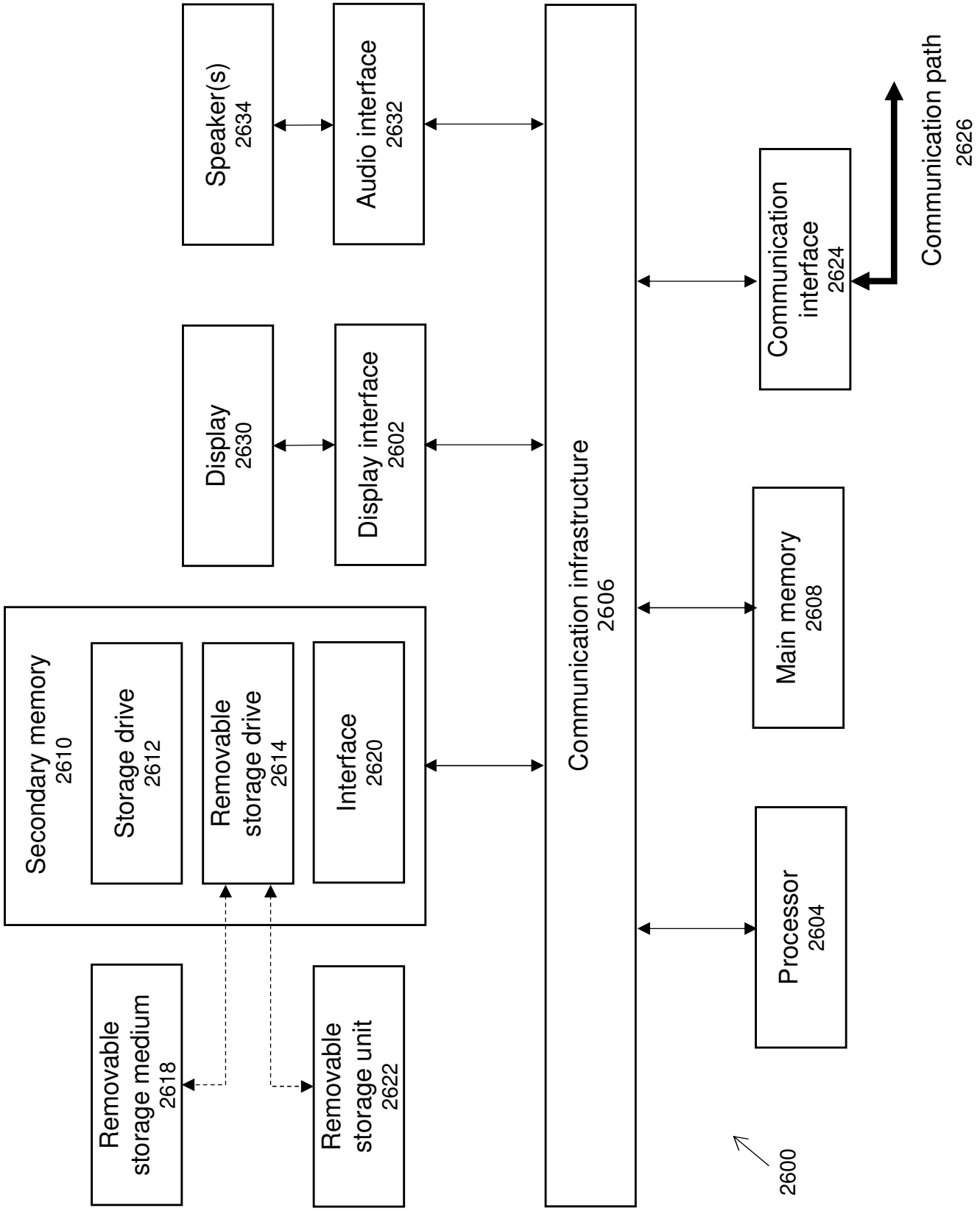

Speaker(s)
2634
Audio interface
2632
Display
2630
Display interface
2602
Secondary memory
2610
Storage drive
2612
Removable
storage drive
2614
Interface
2620
Communication infrastructure
2606
Main memory
2608
Communication
interface
2624
Communication path
2626
Removable
storage medium
2618
Removable
storage unit
2622
Processor
2604
2600

Figure 26