COMPGX04: ROBOT VISION AND NAVIGATION
Workshop 3: Multisensor Navigation
ANSWERS

Task 1: Car Dead Reckoning

The position and velocity solution is as follows:

Time (s)	Latitude (°)	Longitude (°)	Velocity (m/s) North	East
0	50.424958	-3.595797	-0.30	10.22
0.5	50.424956	-3.595725	-0.47	10.21
1	50.424956	-3.595654	0.29	10.22
1.5	50.424957	-3.595582	0.02	10.10
2	50.424956	-3.595510	-0.19	10.30
2.5	50.424955	-3.595439	-0.27	10.10
3	50.424955	-3.595367	0.19	10.26
3.5	50.424954	-3.595295	-0.52	10.13
4	50.424953	-3.595224	-0.11	10.14
4.5	50.424953	-3.595152	0.01	10.22
5	50.424954	-3.595081	0.64	10.08
10	50.424958	-3.594367	0.30	10.26
15	50.424952	-3.593488	-0.10	14.78
20	50.424949	-3.592250	-0.05	19.62
25	50.424964	-3.590818	1.52	19.80
30	50.424950	-3.589383	-1.63	19.80
35	50.424937	-3.588112	0.20	15.42
40	50.424925	-3.587197	-0.47	10.85
45	50.424475	-3.587060	-13.98	0.40
50	50.423760	-3.587073	-19.42	0.19
55	50.422861	-3.587057	-21.48	1.29
60	50.421944	-3.587049	-21.94	1.77
65	50.421038	-3.586886	-21.04	7.00
70	50.420235	-3.586197	-19.12	10.67
75	50.419442	-3.585476	-19.19	11.02
80	50.418624	-3.584715	-21.90	12.57
85	50.417623	-3.583797	-26.18	15.00
90	50.416454	-3.582730	-27.93	15.33
95	50.415267	-3.581647	-27.74	16.21
100	50.414030	-3.580740	-31.47	5.48
105	50.412658	-3.580668	-31.48	-1.57
110	50.411283	-3.580660	-31.15	1.64
115	50.409957	-3.580670	-26.90	0.12
120	50.408968	-3.580659	-18.54	0.03
125	50.408357	-3.580658	-9.70	0.22
130	50.408162	-3.580512	-0.53	4.06
135	50.408161	-3.580388	-0.33	-0.18

Time (s)	Latitude (°)	Longitude (°)	Velocity (m/s) North	East
140	50.408161	-3.580388	-0.36	0.22
145	50.408161	-3.580389	-0.36	0.06
150	50.408161	-3.580389	-0.36	-0.02
155	50.408161	-3.580389	-0.37	0.30
160	50.408161	-3.580388	-0.38	0.70
165	50.408161	-3.580389	-0.38	0.66
170	50.408161	-3.580389	-0.38	0.42
175	50.408161	-3.580390	-0.39	0.82

Task 2: Car DR/GNSS Integration

The position and velocity solution is as follows:

Time (s)	Latitude (°)	Longitude (°)	Velocity (m/s) North	East
0	50.424958	-3.595797	-0.05	10.03
0.5	50.424948	-3.595737	0.01	10.01
1	50.424943	-3.595669	0.00	10.00
1.5	50.424940	-3.595599	-0.03	10.02
2	50.424939	-3.595528	-0.02	10.01
2.5	50.424939	-3.595458	0.00	10.03
3	50.424939	-3.595388	-0.02	10.01
3.5	50.424939	-3.595318	-0.01	10.01
4	50.424938	-3.595249	-0.01	10.01
4.5	50.424938	-3.595179	0.02	10.00
5	50.424938	-3.595109	-0.01	10.01
10	50.424937	-3.594408	-0.04	10.00
15	50.424938	-3.593530	0.05	15.00
20	50.424938	-3.592299	0.02	20.01
25	50.424938	-3.590892	-0.01	20.02
30	50.424938	-3.589484	-0.03	20.01
35	50.424937	-3.588252	0.00	14.99
40	50.424937	-3.587373	0.00	10.01
45	50.424493	-3.587225	-13.37	0.00
50	50.423781	-3.587226	-18.31	0.00
55	50.422894	-3.587226	-19.99	-0.01
60	50.421995	-3.587226	-20.00	0.00
65	50.421107	-3.587072	-18.91	6.52
70	50.420313	-3.586415	-17.35	10.00
75	50.419535	-3.585710	-17.34	10.00
80	50.418719	-3.584974	-19.97	11.53
85	50.417724	-3.584075	-24.33	14.05
90	50.416570	-3.583033	-26.02	15.02
95	50.415402	-3.581979	-26.01	15.01
100	50.414183	-3.581101	-29.29	6.53

Time (s)	Latitude (°)	Longitude (°)	Velocity (m/s) North	East
105	50.412840	-3.580999	-30.02	-0.02
110	50.411492	-3.580999	-30.01	0.03
115	50.410202	-3.580999	-25.38	0.01
120	50.409248	-3.580998	-17.03	0.02
125	50.408670	-3.580998	-8.67	0.01
130	50.408487	-3.580855	-0.02	3.87
135	50.408487	-3.580749	-0.02	-0.01
140	50.408487	-3.580749	0.01	0.00
145	50.408487	-3.580749	0.01	0.00
150	50.408487	-3.580749	0.00	0.01
155	50.408487	-3.580750	0.01	0.01
160	50.408488	-3.580750	0.02	0.00
165	50.408488	-3.580750	-0.03	-0.02
170	50.408488	-3.580750	-0.01	0.00
175	50.408488	-3.580751	0.02	-0.01

Task 3: UAV INS/GNSS Integration

The position, velocity and attitude solution is as follows:

Time (s)	Latitude (°)	Longitude (°)	Height (m)	Velocity (m/s) North	East	Down	Attitude (°) Roll	Pitch	Heading
0	-2.575939	-67.417578	997.6	-0.01	199.97	0.07	0.28	-0.06	91.00
1	-2.575941	-67.415785	997.9	0.00	200.02	0.01	0.09	-0.19	90.99
2	-2.575943	-67.413988	998.1	0.01	200.03	-0.01	0.06	-0.09	90.99
3	-2.575945	-67.412191	998.0	0.00	200.02	0.00	0.09	-0.01	90.98
4	-2.575946	-67.410394	997.9	0.01	200.00	0.00	0.08	0.04	90.98
5	-2.575947	-67.408597	997.9	0.00	199.99	0.00	0.08	0.05	90.98
6	-2.575947	-67.406799	997.9	0.01	199.99	0.00	0.08	0.04	90.97
7	-2.575947	-67.405002	997.9	0.00	200.00	-0.01	0.08	0.05	90.97
8	-2.575947	-67.403204	997.9	0.00	200.00	-0.01	0.08	0.05	90.97
9	-2.575948	-67.401407	997.9	0.00	200.00	-0.01	0.09	0.05	90.98
10	-2.575948	-67.399609	997.9	0.00	200.00	0.00	0.08	0.06	90.98
20	-2.575949	-67.381628	998.2	0.02	199.99	-0.02	0.07	0.06	90.95
30	-2.577029	-67.363693	998.5	-24.16	198.55	-0.02	14.11	0.06	96.94
40	-2.580308	-67.346023	998.6	-48.28	194.08	-0.02	14.12	0.04	103.94
50	-2.585736	-67.328884	998.9	-71.65	186.71	-0.03	14.12	-0.03	111.09
60	-2.593231	-67.312535	998.7	-93.97	176.61	0.01	14.10	0.01	118.05
70	-2.602682	-67.297219	998.9	-114.83	163.76	-0.02	14.08	0.05	125.06
80	-2.613945	-67.283166	998.8	-133.99	148.48	0.00	14.09	0.07	132.06
90	-2.626594	-67.270317	998.7	-141.41	141.43	0.01	0.05	0.09	134.98
100	-2.639381	-67.257601	998.8	-141.40	141.43	-0.02	0.04	0.09	135.02
110	-2.652168	-67.244884	998.8	-141.42	141.41	-0.02	0.03	0.08	135.04
120	-2.664704	-67.231930	998.8	-131.40	150.79	0.00	-14.03	0.08	131.14
130	-2.675720	-67.217682	998.9	-111.95	165.74	0.00	-14.03	0.07	124.12

Time	Latitude	Longitude	Height	Velocity (m/s)			Attitude (°)		
(s)	(°)	(°)	(m)	North	East	Down	Roll	Pitch	Heading
140	-2.684901	-67.202200	999.0	-90.85	178.16	-0.02	-14.05	0.06	117.11
150	-2.692108	-67.185720	998.9	-68.38	187.92	-0.02	-14.06	0.04	110.06
160	-2.697235	-67.168488	998.6	-44.88	194.87	-0.01	-14.09	0.02	103.01
170	-2.700202	-67.150760	998.6	-20.71	198.93	-0.01	-14.11	0.00	95.99
180	-2.700994	-67.132805	998.6	0.00	200.03	0.02	-0.05	0.05	90.19