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Assignment 6

Trade Study

System: Package Delivery Drone

Subsystem or Component Chosen: Proximity Sensor

Scope: The purpose of this trade study is to evaluate the use of different proximity sensors within the flight processing subsystem of our Package Delivery Drone. The proximity sensors are utilized for obstacle detection and flight path adjustment.

Process Used: The trade study outlined herein will evaluate alternative proximity sensors using the Nth Root Pairwise Comparison Methodology to assign weight to our selection criteria. This will be a technical trade study that does not factor in cost.

Criterion: Criterion for this trade study are derived from proximity sensor system requirements outlined below. They are weight, range detection, current consumption, max operating temperature, and proximity measurement period. Weight is judged with a preference for a lighter sensor systems; range detection is judged with a preference for sensor systems which can measure further distances; current consumption is judged with a preference for a lower nominal amount to save on battery power; max operating temperature is judged with a preference for higher temperature ratings to potentially eliminate the need for additional cooling in the system design; and shorter proximity measurement periods are preferred to allow for safer navigation at high speeds.

- *The Drone shall utilize proximity sensors with a unit weight less than 120g (T) 5g (O).*
- *The Drone shall utilize proximity sensors with a nominal power consumption of 2W(T) 0.075W(O).*
- *The Drone shall utilize proximity sensors with a maximum operating temperature at 40℃ (T) 85℃ (O).*
- *The Drone shall utilize proximity sensors with a measurement range of at least 100cm (T) 600cm (O).*
- *The Drone shall utilize proximity sensors with a measurement period of at most 45ms (T) 10ms (O)*

Criterion Weights:

		Measurement Range	Power Consumption	Weight	Measurement Period	Max Operating Temperature			
		A	B	C	D	E	Row Value Products	Nth Root of Value Products	Normalized Weighting Factors
Measurement Range	A	1.00	3.00	3.00	5.00	5.00	225.000	2.954	0.445
Power Consumption	B	0.33	1.00	2.00	4.00	5.00	13.333	1.679	0.253
Weight	C	0.33	0.50	1.00	3.00	4.00	2.000	1.149	0.173
Measurement Period	D	0.20	0.25	0.33	1.00	2.00	0.033	0.506	0.076
Max Operating Temperature	E	0.20	0.20	0.25	0.50	1.00	0.005	0.347	0.052

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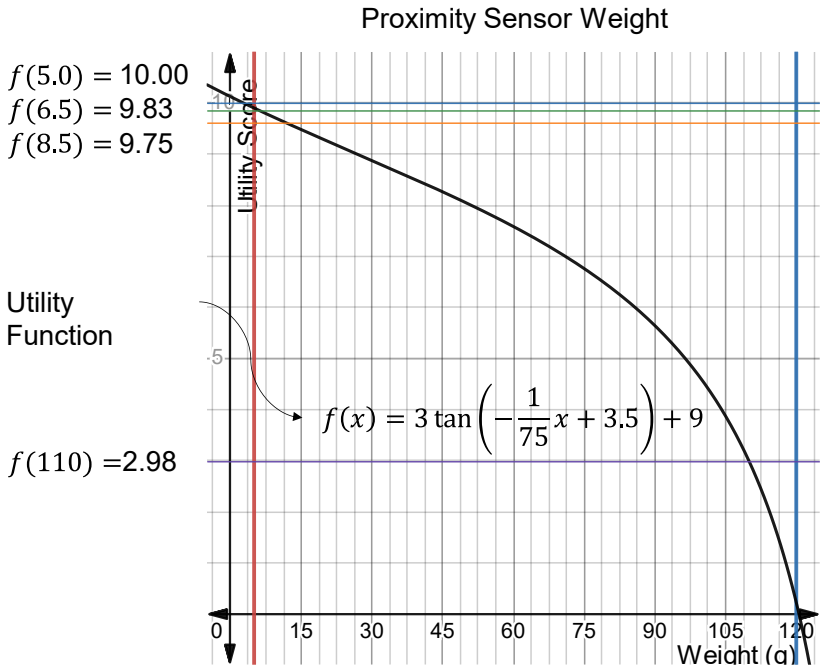
Alternatives:

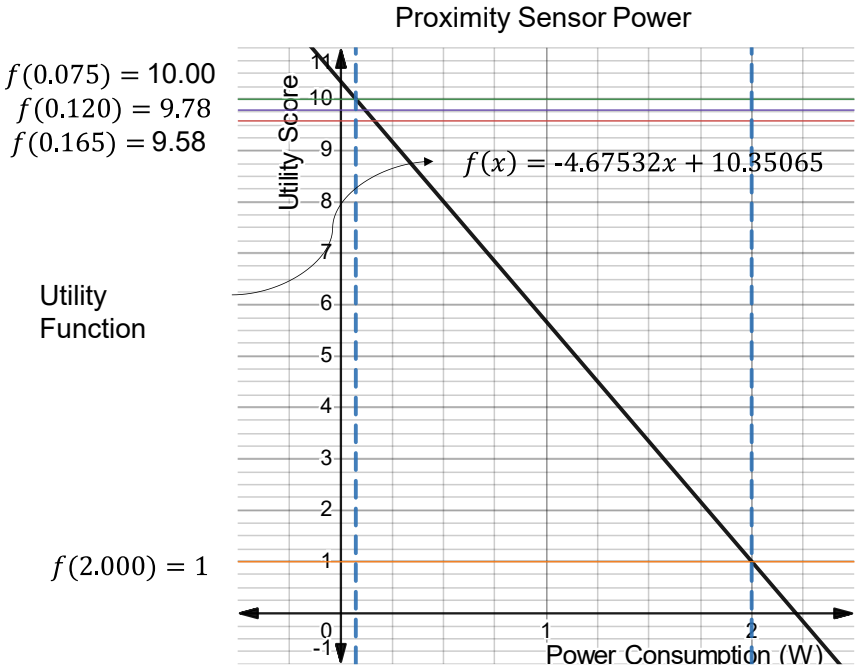
	Measurement Range	Power Consumption	Weight	Measurement Period	Max Operating Temperature
Sharp GP2Y0A02YK0F	150cm	0.165W	5g	38ms	60°C
AMS TMF8801	250cm	0.120W	6.5g	33ms	70°C
ElecFreaks HC-SR04	400cm	0.075W	8.5g	25ms	40°C
Leddar Vu8 VU08-75H0001	18500cm	2W	110.3g	10ms	85°C

Utility Functions:

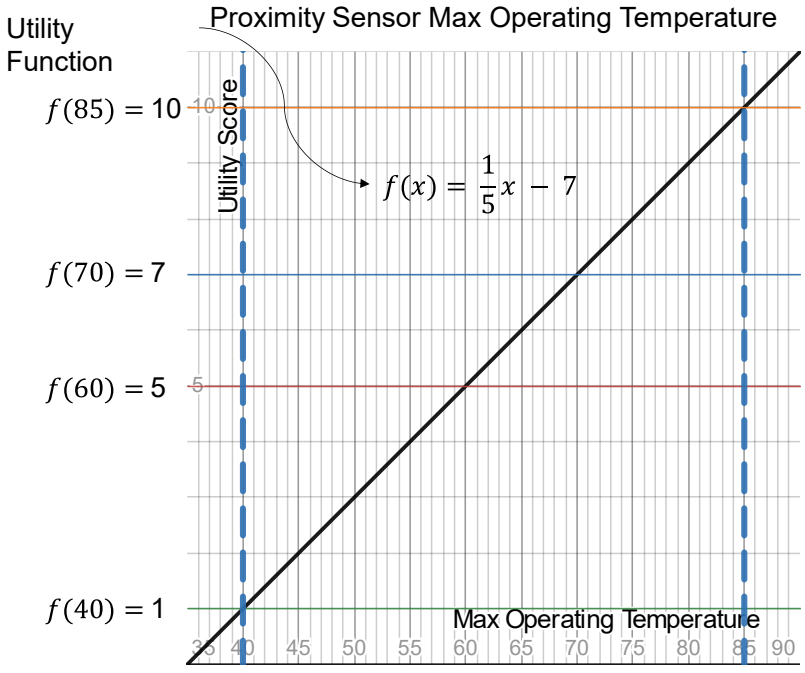
Requirement: *The Drone shall utilize proximity sensors with a unit weight less than 120g (T) 5g (O).*



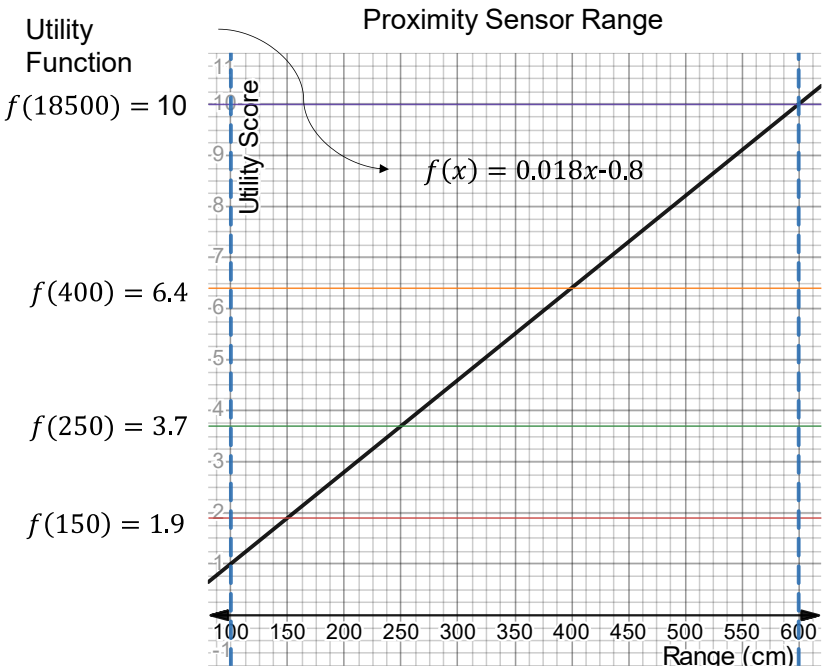
Requirement: *The Drone shall utilize proximity sensors with a nominal power consumption of 2W(T) 0.075W(O).*



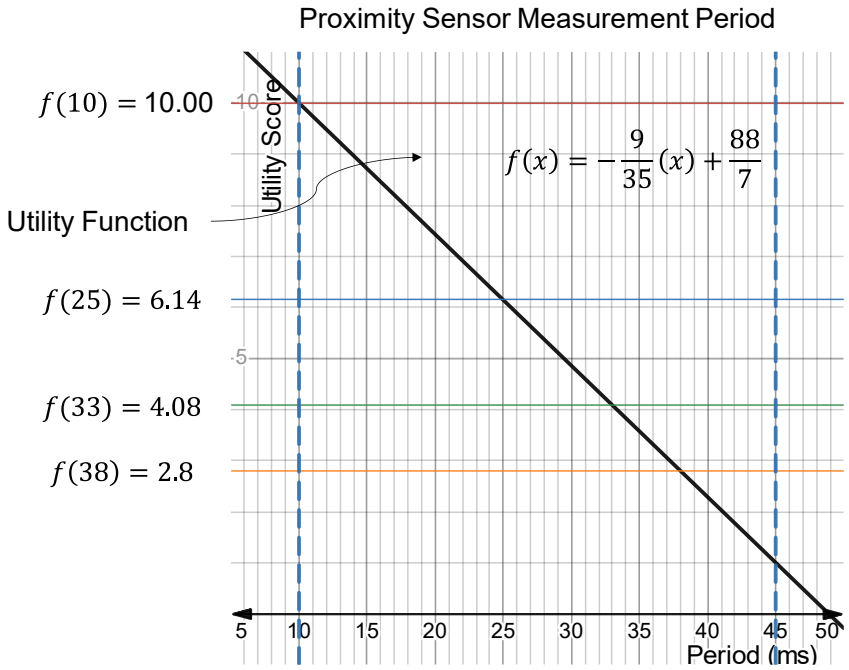
Requirement: *The Drone shall utilize proximity sensors with a maximum operating temperature at 40°C (T) 85°C (O).*



Requirement: *The Drone shall utilize proximity sensors with a measurement range of at least 100cm (T) 600cm (O).*



Requirement: *The Drone shall utilize proximity sensors with a measurement period of at most 45ms (T) 10ms (O)*



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Summary Table:

Technical Winner

			Alternatives							
			Sharp GP2Y0A02YK0F		AMS TMF8801		ElecFreaks HC-SR04		Leddar Vu8 VU08-75H0001	
Criteria		Weights	Utility Score	Weighted Score	Utility Score	Weighted Score	Utility Score	Weighted Score	Utility Score	Weighted Score
Measurement Range	A	0.445	1.9	0.85	3.7	1.65	6.4	2.85	10	4.45
Power Consumption	B	0.253	9.58	2.42	9.78	2.47	10	2.53	1	0.25
Weight	C	0.173	10	1.73	9.83	1.70	9.75	1.69	2.98	0.52
Measurement Period	D	0.076	2.8	0.21	4.08	0.31	6.14	0.47	10	0.76
Max Operating Temperature	E	0.052	5	0.26	7	0.37	1	0.05	10	0.52
			Sum Total	5.48	Sum Total	6.50	Sum Total	7.59	Sum Total	6.51

Adding Cost as Independent Variable

			Alternatives							
			Sharp GP2Y0A02YK0F		AMS TMF8801		ElecFreaks HC-SR04		Leddar Vu8 VU08-75H0001	
Criteria		Weights	Utility Score	Weighted Score	Utility Score	Weighted Score	Utility Score	Weighted Score	Utility Score	Weighted Score
Measurement Range	A	0.445	1.9	0.85	3.7	1.65	6.4	2.85	10	4.45
Power Consumption	B	0.253	9.58	2.42	9.78	2.47	10	2.53	1	0.25
Weight	C	0.173	10	1.73	9.83	1.70	9.75	1.69	2.98	0.52
Measurement Period	D	0.076	2.8	0.21	4.08	0.31	6.14	0.47	10	0.76
Max Operating Temperature	E	0.052	5	0.26	7	0.37	1	0.05	10	0.52
			Sum Total	5.48	Sum Total	6.50	Sum Total	7.588973643	Sum Total	6.51
			Unit Cost	$ 16.95	Unit Cost	$ 7.00	Unit Cost	$ 10.99	Unit Cost	$ 985.00
			CAIV	32.31	CAIV	92.87	CAIV	69.053	CAIV	0.66

Sensitivity Analysis:

Sensitivity analysis shows that when the measurement range is not factored in, alternative 2 is the best choice. Additionally, when Power consumption and weight are not factored in, alternative 4 is the best choice. However, with measurement period and max operating temperature not factored in, alternative 3 stands as the clear winner. Overall, alternative 3 wins more than any other choice when sensitivity analysis is run. Therefore, it is safe to say that alternative 3 is the most well-rounded technical selection for our sensor requirements.

			Alternatives							
			Sharp GP2Y0A02YK0F		AMS TMF8801		ElecFreaks HC-SR04		Leddar Vu8 VU08-75H0001	
Criteria		Weights	Utility Score	Weighted Score	Utility Score	Weighted Score	Utility Score	Weighted Score	Utility Score	Weighted Score
Measurement Range	A	0.000	1.9	0.00	3.7	0.00	6.4	0.00	10	0.00
Power Consumption	B	0.253	9.58	2.42	9.78	2.47	10	2.53	1	0.25
Weight	C	0.173	10	1.73	9.83	1.70	9.75	1.69	2.98	0.52
Measurement Period	D	0.076	2.8	0.21	4.08	0.31	6.14	0.47	10	0.76
Max Operating Temperature	E	0.052	5	0.26	7	0.37	1	0.05	10	0.52
			Sum Total	4.63	Sum Total	4.85	Sum Total	4.74	Sum Total	2.05

			Alternatives							
			Sharp GP2Y0A02YK0F		AMS TMF8801		ElecFreaks HC-SR04		Leddar Vu8 VU08-75H0001	
Criteria		Weights	Utility Score	Weighted Score	Utility Score	Weighted Score	Utility Score	Weighted Score	Utility Score	Weighted Score
Measurement Range	A	0.445	1.9	0.85	3.7	1.65	6.4	2.85	10	4.45
Power Consumption	B	0.000	9.58	0.00	9.78	0.00	10	0.00	1	0.00
Weight	C	0.173	10	1.73	9.83	1.70	9.75	1.69	2.98	0.52
Measurement Period	D	0.076	2.8	0.21	4.08	0.31	6.14	0.47	10	0.76
Max Operating Temperature	E	0.052	5	0.26	7	0.37	1	0.05	10	0.52
			Sum Total	3.05	Sum Total	4.03	Sum Total	5.06	Sum Total	6.25

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			Alternatives							
			Sharp GP2Y0A02YK0F		AMS TMF8801		ElecFreaks HC-SR04		Leddar Vu8 VU08-75H0001	
Criteria		Weights	Utility Score	Weighted Score	Utility Score	Weighted Score	Utility Score	Weighted Score	Utility Score	Weighted Score
Measurement Range	A	0.445	1.9	0.85	3.7	1.65	6.4	2.85	10	4.45
Power Consumption	B	0.253	9.58	2.42	9.78	2.47	10	2.53	1	0.25
Weight	C	0.000	10	0.00	9.83	0.00	9.75	0.00	2.98	0.00
Measurement Period	D	0.076	2.8	0.21	4.08	0.31	6.14	0.47	10	0.76
Max Operating Temperature	E	0.052	5	0.26	7	0.37	1	0.05	10	0.52
			Sum Total	3.74	Sum Total	4.80	Sum Total	5.90	Sum Total	5.99

			Alternatives							
			Sharp GP2Y0A02YK0F		AMS TMF8801		ElecFreaks HC-SR04		Leddar Vu8 VU08-75H0001	
Criteria		Weights	Utility Score	Weighted Score	Utility Score	Weighted Score	Utility Score	Weighted Score	Utility Score	Weighted Score
Measurement Range	A	0.445	1.9	0.85	3.7	1.65	6.4	2.85	10	4.45
Power Consumption	B	0.253	9.58	2.42	9.78	2.47	10	2.53	1	0.25
Weight	C	0.173	10	1.73	9.83	1.70	9.75	1.69	2.98	0.52
Measurement Period	D	0.000	2.8	0.00	4.08	0.00	6.14	0.00	10	0.00
Max Operating Temperature	E	0.052	5	0.26	7	0.37	1	0.05	10	0.52
			Sum Total	5.26	Sum Total	6.19	Sum Total	7.12	Sum Total	5.74

			Alternatives							
			Sharp GP2Y0A02YK0F		AMS TMF8801		ElecFreaks HC-SR04		Leddar Vu8 VU08-75H0001	
Criteria		Weights	Utility Score	Weighted Score	Utility Score	Weighted Score	Utility Score	Weighted Score	Utility Score	Weighted Score
Measurement Range	A	0.445	1.9	0.85	3.7	1.65	6.4	2.85	10	4.45
Power Consumption	B	0.253	9.58	2.42	9.78	2.47	10	2.53	1	0.25
Weight	C	0.173	10	1.73	9.83	1.70	9.75	1.69	2.98	0.52
Measurement Period	D	0.076	2.8	0.21	4.08	0.31	6.14	0.47	10	0.76
Max Operating Temperature	E	0.000	5	0.00	7	0.00	1	0.00	10	0.00
			Sum Total	5.22	Sum Total	6.14	Sum Total	7.54	Sum Total	5.98

Conclusion / Recommendation:

From a technical perspective alternative 3, ElecFreaks HC-SR04 , offers the best solution for our Drone system. It is the clear winner, even when measurement period and max operating temperature are taken out as criterions in sensitivity analysis for the trade study. Additionally notable were alternative 2 and 4. Alternative 2 is especially strong when considering cost as an independent variable. Alternative 4 is also a strong technical selection that may be considered under special applications, especially when power consumption and weight do not factor into the trade study for the system. However, alternative 4 is very expensive and that will likely remove it as a viable option from a program managers perspective.