Save Victims under Siege with Automatic Trucks

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An Innovative Fully-Automatic Motion Control System For Trucks to Provide Immediate Assistance to Victims under Siege and Armed Conflicts

Introduction

- While the number of humanitarian aid workers in conflict areas should be minimized for human safety concerns, fully-automatic trucks could be used to replace the majority of humanitarian aid workers in armed conflict regions in order to provide immediate assistance to victims safely with higher efficiency.
- According to Aid Worker Security Database (AWSD), South Sudan was recently the most violent context for aid workers, reflecting the fracturing conflict and an atmosphere of impunity for armed actors.
- From 2006 until 2016, 1765 major attacks against aid operations occurred in which 1129 aid workers were killed, 1158 wounded, and 968 kidnapped. Noting that 2013 was the most dramatic year with the maximum number of incidents and aid worker victims.

Major attacks on aid workers 2006-2016 According to (AWSD)

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Number of incidents	107	123	165	155	130	152	170	265	191	148	159
Total aid worker victims	240	220	278	296	254	309	277	475	330	287	289
Total killed	87	88	128	109	72	86	70	156	122	109	102
Total injured	87	87	91	94	84	126	115	178	88	110	98
Total kidnapped*	66	45	59	93	98	97	92	141	120	68	89
International victims	26	34	51	75	46	29	49	58	32	28	43
National victims	214	186	227	221	208	280	228	417	298	259	246
UN staff	61	39	65	102	44	91	58	110	67	44	71
International NGO staff	110	132	157	129	148	141	86	137	149	176	157
LNGO and RCS staff	55	35	46	55	47	77	107	206	98	61	46
ICRC staff	10	4	5	9	10	5	3	14	16	3	12

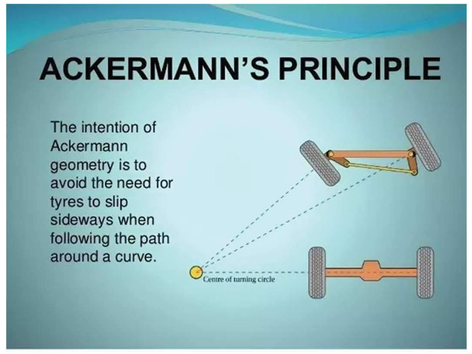
* Victim survived, or unknown outcome (kidnappings where victims were killed are counted in the 'killed' totals)

Key for organisation type

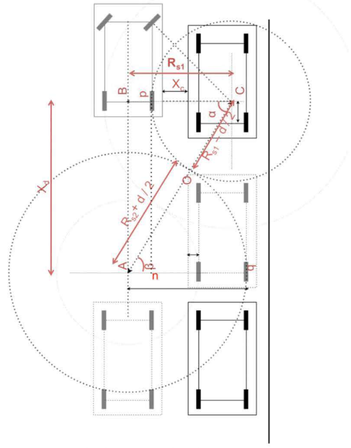
- **UN:** United Nations
- **INGO:** International non-governmental organisation
- **LNGO and NRCS:** Local non-governmental organisation or National Red Cross / Red Crescent Society
- **ICRC:** International Committee of the Red Cross
- **IFRC:** International Federation of Red Cross and Red Crescent Societies

Engineering problem addressed

- The process of designing a fully-automatic control system for any type of vehicles depend on creating the trajectory for every possible movement especially the backward one.
- The auto-parking project is the first checkpoint to design such automatic systems, as you have to achieve all possible movements during parking.
- Regular cars follow Ackerman steering principle for backward movement as well as for automatic parking methodologies.



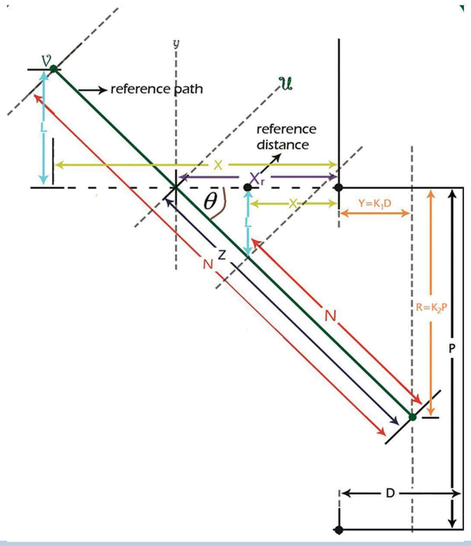
Applying the same methodologies and algorithms of parking for regular cars would force a low steering angle (LSA) vehicle to perform a lot of maneuvers until it can successfully fit into a parking slot. So for instance if a commercial car can complete a successful automated parking maneuver in about six moves, a (LSA) vehicle will not be able to achieve such number or even close in a relative situation. So practically, High Duty Trucks which are classified as (LSA) vehicles can not follow Ackerman steering geometry for automatic parking.



Path planning and parking trajectory of Ackerman steering geometry

The Innovative Solution For Trucks

- This innovative system main principle is to convert Ackerman curvy trajectories(especially the backward) into linear paths.
- After detecting the suitable parking slot the truck moves (forward or backward) linearly (distance L) to a point on the reference path where it shifts its own axis from (x,y) to (u,v) by angle (θ), then it moves backward linearly (distance N) to the target point.
- This motion control system is governed by five main mathematical equations for all possible scenarios. By following them, the truck can reach successfully the target point with minimum number of maneuvers.



The developed system equations

$$Xr = \frac{R}{\tan(\theta)} - Y \quad (1)$$

For Case1: (X≤Xr)

$$L = \frac{(Xr - X)}{tan(\theta)} \quad (2)$$

$$N = Z - \sqrt{(Xr - X)^2 + L^2} \quad (3)$$

For Case2: (X≥Xr)

$$L = \frac{(X - Xr)}{tan(\theta)} \quad (4)$$

$$N = Z + \sqrt{(X - Xr)^2 + L^2} \quad (5)$$

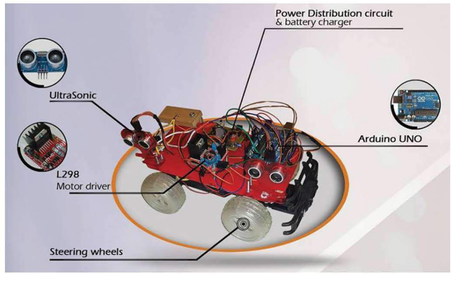
D,P	Parking slot dimensions
K1,K2 θ	Parameters chosen by the system 0<K1 < 1 0<K2 < 1
Xr	Reference distance
X	actual distance (Sensor reading)
L	Linear Distance to a point on the reference path
N	Backward distance to the target point

Contributions to humanitarian sector

- The fully- automatic system for trucks will provide useful humanitarian services with minimum risk on aid workers. Such a system for existing LSA vehicles can simultaneously meet safety targets, improve system availability with reasonable costs.
- Automatic trucks can be the key of survival for victims under siege by supplying them with water, food, and medications. Also, shelters construction in remote and conflicts areas can be much easier with automatic cranes and trucks.
- The number of aid workers in an evacuation operation, which is considered as the most hazardous operation, can be minimized by replacing the majority of workers with automatic vehicles.

Special application for small robots

- The developed motion control system can be applied to 4-wheel LSA robots with mechanical restriction in steering angle (or the front design in general).
- These tiny ground robots are hard to be detected and have much lower possibility to be targeted ,so they can be used in the most dangerous active war zones to provide wide range of humanitarian assistance.



References

- Aid worker security report 2017: Behind the attacks - A look at the perpetrators of violence against aid workers.
- Ankit Gupta, Rohan Divekar, "Autonomous Parallel Parking Methodology for Ackerman Configured Vehicles.", ACEEE International Journal on Communication, Vol 1, No. 2, July 2010.