A feasibility and comparison study of Autonomous Robotic Vehicles for the FMCG manufacturing sector

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Abstract:

As we are approaching the fourth industrial revolution of Industry 4.0, many companies including Original Equipment Manufacturers (OEM) and Fast-Moving Consumer Goods (FMCG) companies are currently conducting feasibility studies and researching the potentials of autonomous robots and vehicles in future mass-production processes. Compared to their Automated Guided Vehicle (AGV) predecessors, they are deemed to be far more economical to install and integrated into brownfield sites with more ease.

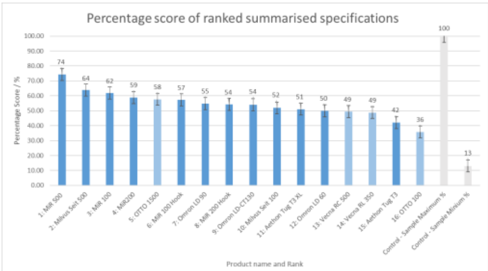
This work presents a specification based comparison study of market leaders that evaluates the specifications given for 16 ARV technologies available globally and within the UK. From this comparison study a feasibility study of two similarly specified ARVs could be conducted, most notably the Omron LD-CT130 AIV.

If Industry 4.0 is fully exploited, it has the opportunity to cause an increased efficiency and reduce overall costs within a company, and making processes lean. Failure to embrace ARV technology will result in the potential loss of jobs. There is of course resentment for change from modern Luddites. However, the 4th Industrial Revolution is inevitable and should be embraced.

Wartzman (2015) suggested two approaches working hand in hand in for Industry 4.0: preparing for a future career, and encouraging continuous learning within industry with organisations retraining employees. Moreover, industries should train and educate themselves and employees regarding how to accommodate ARV technologies in order to retain jobs in the future.

Specification based comparison Study of 16 ARV technologies

(Fig.1. Products to be compared)



(Fig.2. Ranked percentages of products)

Of the 16 ARV technologies most available globally, the specifications narrowed down to be ranked and compared where Cost, Payload Capacity and Area, Speed and Battery Life.

Over the course of 12 months gathering information about the ARV technology available, the specifications each product has, and who the suppliers are enabled the majority of specifications to be collected. However, as shown in table 1 there were some unknown variables.

Therefore, the specifications would be ranked from best to worst, and given a percentage of the score from the final rank. For example, 2nd place out of 10 = 20%. The missing information would be given a nominal percentage to counteract the missing percentages. The worse the score, the lower the rank and therefore percentage. To begin with, the nominal percentage was 50%. This soon changed to 25% as unknown specifications were performing better than known specifications. The percentages were then totalled up for each ARV, which could then be compared.

As can be seen from figure 2, the best combined specifications were with the MiR 500. Since this study finished, a MiR 1000 (Kgs) has been released with the same footprint area. The downsides of the increased payload capacities is that the footprint of the vehicle increases. Many brownfield sites are restricted by narrow corridors so will have to put up with smaller vehicles that can carry less.

Product Name	Name given to Unit type	Approximate Price* (£)	Payload capability (Kg)	Payload area Size L x W (mm)	Battery Life (Hours)	Battery Charge Time (Hours)	Speed (m/s)
AIV LD-CT 130	Load Unit with removable cart	45,000	130	592 × 846 (Cart Size)	15	3.5	0.9
AIV LD - 60	Load Unit	40,000	60	699 × 500	13	3.5	1.8
AIV LD - 90	Load Unit	40,000	90	699 × 500	12	3.5	1.35
MiR 100	Load Unit	34,800	100	800 x 600	10	3	1.5
MiR 200	Load Unit	38,800	200	800 x 600	10	3	1.1
MiR 100 Hook	Tow Unit	48,300	300	N/A	8	3	1.5
MiR 200 Hook	Tow Unit	52,300	500	N/A	8	3	1.1
MiR 500 (Brand New)	Load Unit	50,000 (indroductory offer)	500	Euro Pallet – 1200 x 800	8	1	2
Aethon Tug T3	Load and Tow Unit	57,980	453	965 x 570	10	?	0.76
Aethon Tug T3 XL	Load and Tow Unit	Unknown	635	1220 x 675.65	10	?	0.76
OTTO 100	Load Unit	Unknown	100	750 x 550	8	?	2
OTTO 1500	Load Unit	Unknown	1500	1190x 1810	8	?	2
Milvus Seit 100	Load Unit	22,234	100	890 x 650	8	?	1.5
Milvus Seit 500	Load and Tow Unit	35,259	500	1577 x 920	8	?	1.5
Vecna RC 500	Load Unit	Unknown	500	1171 x 567	8	?	2
Vecna RL350	Load and lift Unit	Unknown	350	1171 x 567	9	?	2

Approximate price only includes quoted prices and not the full installation price. Most prices include the unit price, software and training. Excluding VAT.

(Table 1:Products listed out with specifications)

Name of Category	Description of product
Forklift (F)	An ARV that has forklift tines fitted.
Tow (T)	An ARV that is suited for towing materials such as bins or wheeled pallets.
Load Unit Platform (LUP)	An ARV with a flat surface – a completely blank canvas on which a payload structure or cart system can be set up.

(Table 2: Proposed Nomenclatures)

Whilst conducting this study, a naming system for the type of robot was devised because there is no standardisation of ARV technology as there is with AGV technology. The naming system is based on the AGV naming system and also the payload structure available. AGVs have Tugs, Forklifts and Unit loaders. Table 2 shows the proposed names. This will help when conducting future comparison studies of this technology.

Implementation Feasibility Study

A key part of determining the feasibility of ARV technology was by demonstrating that they could successfully transport products from A to B with limited human interaction.

By utilising the existing cart design on the Omron AIV, a cassette design was developed that can be retrofitted onto most ARVs enabling the pick up and drop off of materials with limited human interaction.

(Fig.5. Omron AIV with Designed payload structure)

By demonstrating that materials can be successfully transported from A to B using an innovative payload structure in a snacks factory setting, future ARV technology research can be broadened to consider other OEM and FMCG use cases and fully enable industry 4.0

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ARVs in varying manufacturing Environments

In order to asses the feasibility of the Omron AIV for the snack factory environment specified, it was compared to similar competitors.

From the comparison study of specifications, a similar specification of ARV could be found to be compared against the Omron LD-CT 130 (AIV). The MiR 200 and 200 Hook (Figure 7), were used for side by side in primary research. The characteristics of a product cannot be determined until primary research is conducted and any weaknesses are presented.

From a physical comparison, it was found the MiR as it is very square and has a low centre of gravity compared to the AIV so faired better on uneven surfaces.

Furthermore, due to the MiR 200's encased sensors they did not get caught. The AIV on the other hand was found not to be suited to industrial environments where collisions and narrow corridors are present. Excessive vibrations from uneven factory floors caused a sensor arm to crack (figure 8).

The MiR200 has enclosed sensors and nothing that can get caught so is more suited to factory environments. Upon the receipt of new arms it was noted that the quality was of a much greater standard (figure 9).The improved arms may suit industrial environments more than previous arms and therefore should be re-assessed in future tests.

(Fig.6. Omron AIV)

(Fig.7. MiR 200)

(Fig.8.Broken sensor arm)

(Fig.9. New and old arms)

References:

Wartzman, R., 2015. Replaced by robots? A relevant approach to workplace change. [Online] Available at: http://blog.pqsystems.com/2015/12/07/replaced-by-robots-a-relevant-approach-to-workplace-change/
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