Available online at www.sciencedirect.com

ScienceDirect

Procedia CIRP 44 (2016) 175 – 180

www.elsevier.com/locate/procedia

6th CIRP Conference on Assembly Technologies and Systems (CATS)

Evaluating Cobots For Final Assembly

Åsa Fast-Berglund[a]*, Filip Palmkvist[b], Per Nyqvist[a], Sven Ekered[a] and Magnus Åkerman[a]

[a]*Chalmers University of Technology,Hörsalsvägen 7a, 412 96 Gothenburg, Sweden*
[b]*CEJN AB, Batterivägen 4 SE-541 34 SKÖVDE*

* Corresponding author. Tel.:+46317723686; fax: +467721000. *E-mail address:* asa.fasth@chalmers.se

Abstract

Collaborative robots becomes more and more common in lab environment and soon also in industry. In order to create resource- and volume flexibility, dynamic and smart automation could be seen as an answer. This paper has investigated the collaborative robots UR3 and UR5 for O-ring assembly and final assembly, compared to the current state which is performed manually. The methodology Dynamo++ was used for measurement and analysis in terms of LoA (cognitive and physical), cycle-time and quality. Furthermore, automation strategy, safety and easiness of programming was investigated. Results show that collaborative robots have great potential in the middle product volume area. A lot of time, layout space and money could be saved with these solutions. However, standards and safety has to be investigated further in order to reach its fully potential.
© 2016 The Authors. Published by Elsevier B.V. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).
Peer-review under responsibility of the organizing committee of the 6th CIRP Conference on Assembly Technologies and Systems (CATS)
Keywords: UR3;UR5, Collaborative Robots, Final assembly; LoA; Levels of Automation, Co-bots

1. Introduction

Physical automation is still not common in final assembly systems. Case studies in over twenty cases measuring over 2000 tasks in Swedish industry shows that over 90% of the task are performed by humans [1-3]. This depends on varies aspects. Product Volume and Product variants might be the most common way of determine when or when not to automate [4], Return of investments and ramp-up time are two other aspects. It is hard to motivate an investment of a robot cell if the volume is too small, so middle volume products are still assembled by humans. Collaborative robots or ``cobots'' are intended for direct interaction with a human worker, handling a shared payload and the benefits may be expected in ergonomics, in productivity and in the interface of computers and information systems to those many activities which continue to make good use of uniquely human skills [5]. But this idea is not new. Twenty years ago, the first cobot was presented [6], this cobot was the simplest one with one joint and two control moves. Robots and especially cobots have had a tremendous evolution the last ten years. The technology should be easy for the user to understand intuitive to use, they are conducive to learning and respond reliably. This means that flexible solutions in all four areas (cyber-physical, hardware-software) are necessary. Collaborative manufacturing has emerged as the norm of manufacturing in a distributed environment [7]. There are different solutions; light-weight robots (such as universal robots), cameras, gestures etc. [8, 9]. Among many other factors, flexibility, timeliness, and adaptability are identified in this research as the major characteristics to bring dynamism to collaborative manufacturing [7]. Therefore, companies must obtain deeper knowledge about new production solutions and be willing to evaluate them with reference to their own production in order to create a long-term sustainable system [10]. An enabler to achieve flexible and changeable systems is the ability to upgrade or downgrade the level of automation [11]. Most system design tools focused solely on the physical system [12] towards a more flexible assembly [13] but all resources contributed to flexibility. However, it is common that designers automate every subsystem which leads to an economic benefit for that subsystem but leaves the operator to manage the rest [14]. Taken the perspective and history from the third paradigm it is clear that this debate is still going on, but in this paradigm with a more advanced technology. Still the important questions of automation strategies, standards of

2212-8271 © 2016 The Authors. Published by Elsevier B.V. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).
Peer-review under responsibility of the organizing committee of the 6th CIRP Conference on Assembly Technologies and Systems (CATS)
doi:10.1016/j.procir.2016.02.114

systems and the flexibility of humans remains. At shop-floor user level the shop-floor decision support system need to have capability to be individualized [15]. The aim of this paper is to evaluate collaborative robot solutions in terms of strategy, safety, easiness of programming and cycle time. This will be done within an industrial case study.

2. Automation strategies

When top management initiates automation, often with the aim to reduce manufacturing cost, the decision on automation tends to be the only concern, i.e. automation is the manufacturing strategy [15]. The common strategy among industry has been to automate high volume products with low product variant, but in order to stay competitive companies have to come up with solutions to also automate small or middle volume products. Several development trends towards highly automated production and shop floor workplaces were seen during the 1980's and early 1990's. At that time the predominant task allocation strategy was "left-over allocation". Since the late 1990's trends are changing, much due to obvious shortcomings of automation to fulfil cost and flexibility expectations. Instead of having big robot cells that are static the trend is towards collaborative robots, small and flexible units. Flexibility and changeability of assembly processes require a close linkage between the worker and the automated assembly system [16]. Both humans and robots have crucial advantages regarding industrial assembly processes [17]. While robots ace at repetitive and monotonous assembly steps, humans are still the most flexible resource within the system [1]. The ability to handle unexpected and unplanned tasks are also prior to the humans [18]. Combining these advantages by means of direct human-robot cooperation seems to be interesting for producing companies but has not been realized in industry yet [17].Traditionally levels of automations is often divided into three different levels i.e. manual, semi-automatic and automatic. In order to get a more detailed measure of the manual part of the assembly tasks, levels of automation should be divided into seven levels [19]. Furthermore, cognitive automations should also be considered in every task [1]. A matrix defining and measuring both physical and cognitive automation has been developed and validated for over ten years in over ten Swedish companies, illustrated in figure 1. This matrix is used to determine the current and future state of the automation strategies within the case study.

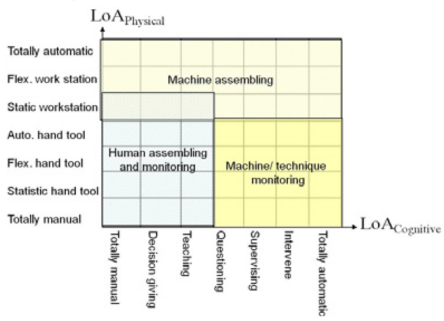

Fig. 1. LoA matrix [20]

3. Standards regarding collaborative robots

There are several drawbacks that prevent collaborative robots from being widely introduced to production environments [21]. Even if the technical challenges of designing and deploying such systems have been overcome, the operators' safety will always be the primary factor for achieving an acceptance. The existing applications separate the human from the robots' working areas in order for the operators´ safety to be ensured. There are numerous of standards regarding robots. ISO 10218-1, ISO 10218-2 are more general standards regarding robot-cell design. The first part of this ISO standard is regarding the robot itself, and the second part is regarding robot system and integration. New ways of determine the safety in a collaborative environment needs to be developed, it could for example be connected to the persons skill-level or what activities that the human and robot will perform side-by-side [22]. These kind of standards exist to ensure and evaluate the safety working with collaborative robots. There is a new published standard, ISO/TS 15066:2016 (Robots and robotic devices - Collaborative Robots), that specifies safety requirements for collaborative industrial robot systems and the work environment. It also supplements the requirements and guidance on collaborative industrial robot operation given in ISO 10218 1 and ISO 10218 2. In practice there could be different solutions within standard requirements but with a resulting difference in the safety level. For example, multiple small robots could be more appropriate than a large and heavy robot. It is a fact that the kinetic energy of a small/lighter robot is less than the large and heavy one when both robots are moving with the same speed, and therefore less harmful to a human if a collision occurs. Also, fenceless separation monitoring requires a lot of clearance between the human and the robot in order for the supervision system to be effective [21]. Although not directly related to safety, there is another robot standard that could be mentioned - ISO 9283 was developed in 1998. This standard consists of performance criteria and related test methods when manipulating industrial robots. In our case we are using an UR 5 and an UR 3 which are not tested in accordance with ISO 9283 by the manufacturer. But an UR 10 robot has been tested with interesting results by a third part [23].Standards will be necessary to be developed before the collaborative robots will be fully accepted within industry. More cases and early demos will hopefully lead the way towards these standards. In the case study in this paper three UR robots are used (one UR 5 and two UR3, illustrated in figure 2). These robots are approved within ISO 15066 and therefore considered safely to explore within the lab and within industry as a second step.

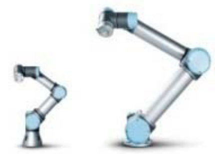

Fig. 2. UR 3 and UR 5 from Universal robots [24]

Download English Version:

https://daneshyari.com/en/article/1698590

Download Persian Version:

https://daneshyari.com/article/1698590

Daneshyari.com