Colaborative Robots in Industry 4.0 and Security Around Them

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Abstract: *Industry 4.0 and collaborative robots (Cobots) are more and more discussed topics. There is wide range of opinions on Collaborative robots and the fact that industry 4.0 is about "taking humans out" of industrial processes in favor of automation. Despite that Collaborative robots definitely still have their use in specific areas where human factor is still needed and sometimes even unnecessary.*

Keywords: *Industrial Robots, Collaborative robots, Hazards around robots*

1 Introduction

1.1 Definitions of Industrial Robots and Collaborative Robots

1.1.1 Robot

Robot is programmed actuated mechanism with a degree of autonomy to perform locomotion, manipulation or positioning. A robot includes control system. Examples of mechanical structure of robots are manipulator, mobile platform and wearable robot.[2]

1.1.2 Industrial Robot

Automatically controlled, reprogrammable multipurpose manipulator, programmable in three or more axes, which can be either fixed in place or fixed to mobile platform for use in automation applications in an industrial environment.[2]

1.1.3 Human-robot collaboration

Collaboration is defined as: operation by purposely designed robots and person working within the same space.[2]

1.1.4 Cobot

COBOTS, which is short for COllaborative roBOTS, are industrial robots specifically designed to work with human coworker in the same workspace, this brings a lot of difficulties and challenges to the design and implementation of these workplaces.

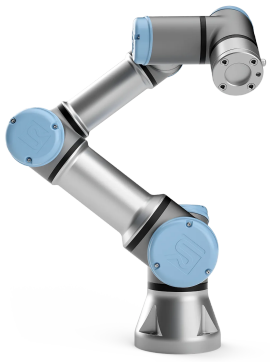

Figure 1: Cobot UR3 made by Universal Robots[6]

2 Uses of Collaborative Robots

Industrial robots have wide variety of variants and each as many uses. Collaborative robots can be technically used in every scenario as any other non-collaborative robot, that being said collaborative robots have some specific areas where classic robots don't make too much sense. These applications can be anywhere from agriculture and medical industry to pharmaceutical applications.[5] In Food and Agriculture production is non-stop, implementing robots can lead to less human labor, less waste and faster production. In addition collaborative robots can work in hot, cold or otherwise unpleasant conditions.

Figure 2: Copenhagen University Hospital is using UR5 cobots to optimize its blood testing processes.[5]

3 Common problems when implementing cobots

As is with every heavy machinery, robots too can be dangerous if not operated correctly. As a result of this fact there are categories of injuries and common sources of these injuries defined by Occupational Safety and Health Administration (OSHA).

3.1 technical and safety limitations

Due to the kind of work that are cobots meant to do, and the fact that they are supposed to work in the same workspace as human workers, they can't have too fast movement, else they are risking fast and dangerous collision with workers that may result in serious injuries. Cobots also have relatively low payload capacity compared to *"normal"* industrial robots of same size, again, due to safety reasons, so they don't have too much power to injure people around them.[3]

Categories of hazards associated with robots[1]

In the list below are 8 groups of robot application hazards grouped into the following major types:

1. Impact, Collision, or other "Struck-by/Caught-between" hazards

   Caused by unpredicted or unexpected movement of robot, end-effector or peripheral equipment.

2. Crushing and Trapping Hazards

   Worker's limb or other body part being trapped within or between robot or its equipment.

3. Struck-by Projectiles

   Breakdown of workpiece, end-effector or peripheral equipment may result in unpredictable flying objects, posing danger to other machines and people.

4. Electrical Hazards

   Robots power system can present arc flashes, shocks, fire and/or other electrical hazards.

5. Hydraulic Hazards

Ruptured hydraulic lines can create high-pressure cutting streams or hazardous whipping hoses. Leaks can cause fires or exposure if the fluids are toxic or otherwise hazardous. Ruptured or leaking hydraulic lines can also cause pressure losses that can lead to struck-by or crushing hazards.

6. Pneumatic Hazards

   Ruptured pneumatic lines can crate injury hazards from whipping hoses.

7. Slipping, Tripping and Falling Hazards

   Spills or leaks can result in slipping hazards. Equipment, power cables and hoses can present tripping and falling hazards.

8. Environmental Hazards

   Exposure to chemicals, heat, hot surfaces, dust, overhead hazards, equipment orientation hazards, radiation or other potentially hazardous light, sparks, and noise.

Common Sources of Robot Hazards[1]

OSHA organization defines 8 common sources of hazards.

1. Human Errors of Integration and/or Programming

   A common misunderstanding with the robot is "direction of movement". For example *"left"* for worker could be *"right"* for the robot, due to different perspectives, e.g. robot mounted overhead. Existing programming, interfacing peripheral equipment or live input/output processing can cause dangerous and unpredicted action or movement. Another most common problem is over familiarity with the application so that worker places themselves in hazardous positions while working around the robot.

2. Control Errors

   Faults within the control system of the robot application, errors in software, electromagnetic interference, and/or radio frequency interference are control errors or faults. Current robot systems are designed to minimize faults and to tolerate interference, but due to environmental effects these can still happen.

3. Unauthorized Access

   Entry into the restricted space is hazardous because the worker involved may not be familiar with the hazards, the safeguards in place, or their activation status.

4. Mechanical Failures

   Operating programs do not account for cumulative mechanical part failure, resulting in potentially faulty or unexpected operation occurring.

5. Time Pressure

   Often employers and sometimes the workers themselves can impose pressure to resume operations as soon as possible. When workers feel rushed to resume operations as quickly as possible, critical safety functions can be overlooked, maintenance steps can be missed, shutdown and/or startup steps can be neglected, the position of other workers can be unnoticed, and other critical steps could be overlooked resulting in hazards and injuries.

6. Environmental Sources

   Exposure to water, heat, dust, combustible or flammable atmospheres, and/or other environmental sources in the area can adversely affect robot operation or result in failure of the robot application.

7. Power System Failures or Malfunctions

   Pneumatic, hydraulic, or electrical power sources that have malfunctioning control or transmission elements in the robot power system can disrupt electrical signals to the control and/or power source lines. Fire risks are increased by electrical overloads or by use of flammable hydraulic oil. Electric shock and release of stored energy from accumulating devices can also be hazardous to workers.

8. Improper Assembly and Installation

   The design requirements, and layout of equipment, utilities, and facilities of a robot application, if inadequately done per applicable safety codes and standards, can lead to hazards and injuries.

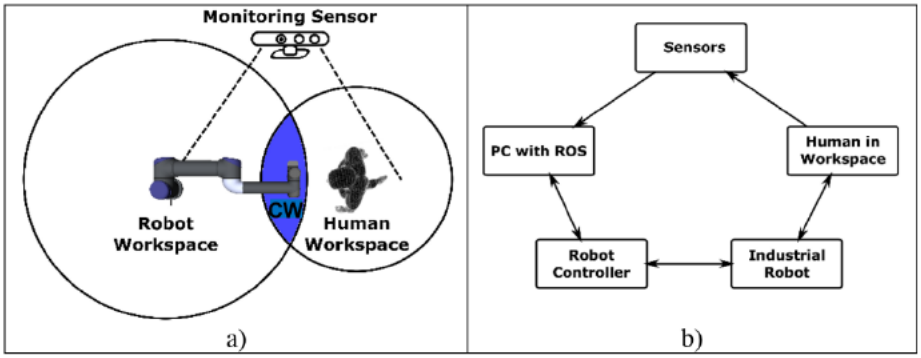

Figure 3: Schematic of Collaborative Workspace between Human and Robot[4]

3.2 Authors subjective views on collaborative robots

While collaborative robots have big potential to increase productivity and effectiveness in some applications they are definitely not the best and only way to do thing. For cobot to be safe to work around they have to be relatively small, slow and weak compared to their "normal" counterparts. But even these normal industrial robots can be in a way collaborative with the use of right peripherals. Nowadays cobots feel more like toys than industrial machines. From my point of view, collaborative robot can be any kind of robot with enough and well chosen sensoric systems, e.g. acceleration sensors, machine vision cameras, light gates and/or other proximity sensors, in addition their program could be written in a way that they can avoid or adjust to real-time position of their human coworker.

References

[1] Osha technical manual (otm) section iv: Chapter 4.
[2] Iso 8373:2021(en) robotics - vocabulary. 2021.
[3] 4 common challenges in implementing cobots, 2024 ©.
[4] (a) collaborative workspace (cw) between human and robot monitored by multiple sensors. (b) interaction diagram showing aspects of the concept used for a safe human robot collaboration., © 2008-2024.
[5] Cobot applications, © 2024.
[6] Ur3e, © 2024.