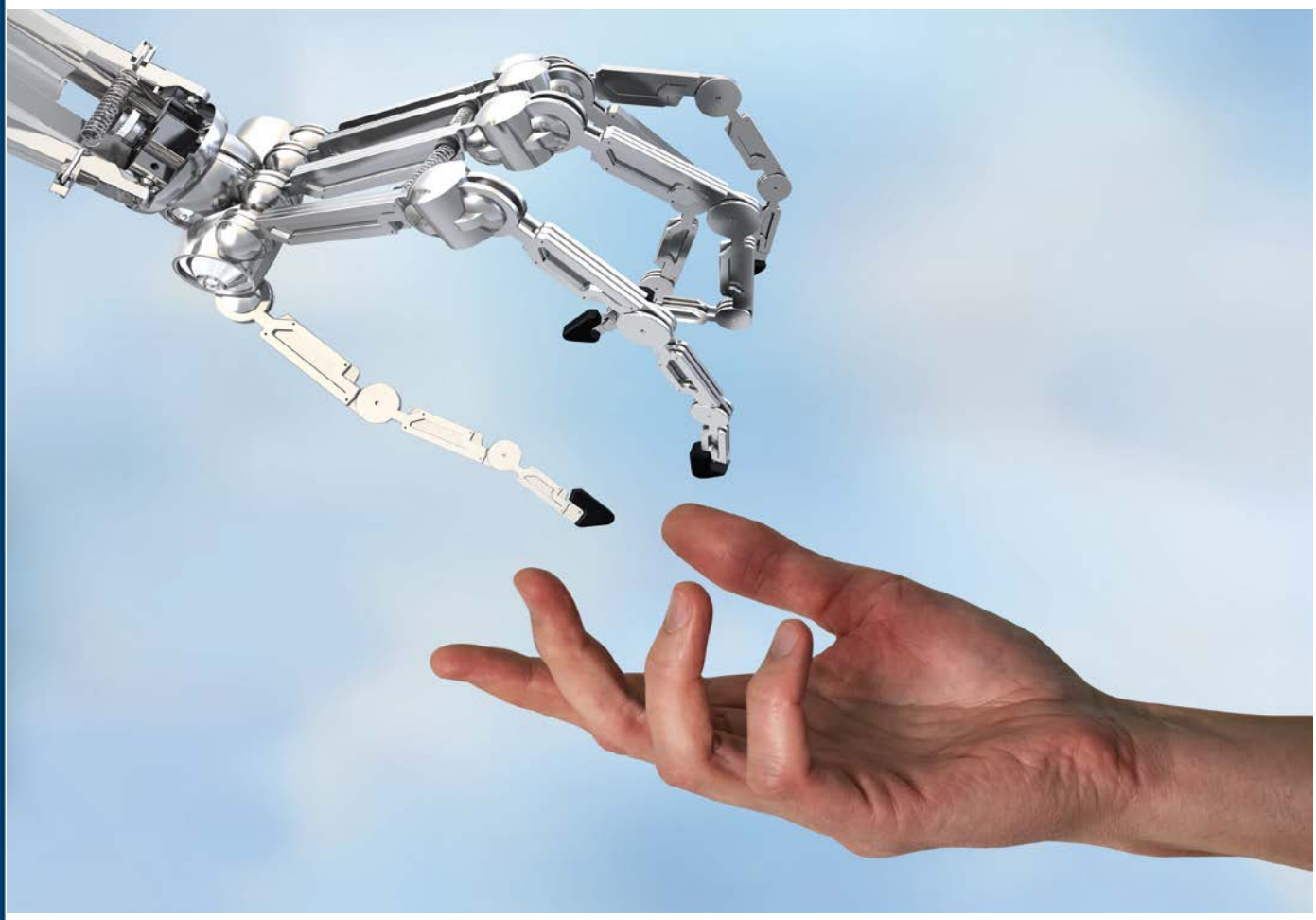
OMRON
AUTOMATION & SAFETY

Collaborative Robots

Hand Guiding



Safe Applications

- Description
- Definitions
- Guidelines
- Design

"Human error is not a potential, it is a given."

Description

In a hand guiding application, the robot allows a limited amount of its motion control to be released, allowing the operator to manually move the robot to various positions. This application has been primarily used to teach programs, especially when new parts are added frequently. It may be done with traditional and collaborative robots, with some difference in safety requirements.

Information can be found in the Industrial Robots and Robot Systems – Safety Requirements standard, ANSI RIA R15.06-2012, which is harmonized with ISO 10218-1:2011 and ISO 10218-2:2011.

Detailed collaborative safety requirements will be available in the ISO/TS 15066 Technical Specification, which is expected to be available in late 2015 or early 2016.

Definitions

Collaborative Workspace

It is the space within the operating space where the robot system and a human can perform tasks concurrently.

End-Effector

This is a device attached to the end of the robot's/collaborative robot's arm (mechanical interface). It allows a task to be done.

This may also be referred to as end-of-arm tools.

Safety-Rated Monitored Stop

The robot/collaborative robot stops before the operator enters the collaborative workspace.

With a traditional robot this may be achieved with a safety-rated control system that complies with the requirements in ANSI/RIA 15.06-2012.

With a collaborative robot this may be achieved through inherently-safe design.

Safety-Rated Space Limiting

A limit is placed on the robot's range of motion by a software- or firmware-based system having a sufficient safety-rated performance.

Guidelines for all Systems

These guidelines are applicable for traditional and collaborative robot systems. Detailed information can be found in the ISO/TS 15066 technical specification.

- The operator is responsible for the robot's motion during the hand-guiding process. This includes being aware of surrounding equipment and prevent being crushed between the robot and auxiliary equipment, walls, columns, barriers, etc.
- If the operator's safety is dependent on limiting the robot's range of motion, the application can use the robot's safety-rated soft axis and space limiting functions or other external safety-rated system.
- The robot system must utilize safety-rated reduced speed control and the safety-rated monitored speed controls, as specified in ANSI/RIA R15.06.
- The motion direction must be intuitive to the operator. For example, if an operator is using a joystick type device and presses left, the robot should move in the left direction.
- Transition to and from a hand guiding application should
    a. be a deliberative and controlled behavior
    b. not lead to unexpected motions or behaviors
    c. not create additional hazards
- The robot is not allowed to be moving when the operator enters the collaborative workspace.
- The collaborative workspace is defined as any area where the robot can move. In many cases this will be the same as the robot's defined workspace (including the end-effector and part).
- If an operator enters the collaborative workspace while the robot is moving, the robot shall generate a protective stop. The operator must reset the system before the hand guiding can be started.
- The operator must activate the force guiding feature before the robot can enter hand guiding mode.
- The robot shall not resume normal operation until the operator(s) has left the safeguarded space. Additional means requiring operator verification, such as the operator pressing a restart button, may be used.
- If operator safety is dependent on the movement or location of the robot, the robot shall have a way to knowing its position.

Note: Each application is unique and may include topics not listed.

Design

A system that is functional and easy to use increases the operator's ability to teach new programs quickly. Some design consideration may include;

- Place mechanisms giving the operator motion control close to the robot's end-of-arm and end-effector (tooling).
- The distance between the operator and the portion where the operator manually moves the robot should be a comfortable level for the operator to reach and easy to maneuver.
- Ensure the robot does not have an uncontrolled singularity point that can spin the robot's arm out of the operator's control. If a singularity point exists, methods such as reduce speed through the point, warning signals, or stopping the robot may be used.
- Determine if additional limited speeds are needed. When designing these, make the switch to lower speeds easy and intuitive for the operator to use.
- Clearly define areas where the operator may be located during the programming.
- Verify the operator is able to clearly see within the entire operation area.
- Signals, such as indicator lights, may be used to alert others when the robot is hand-guiding mode.

Traditional Robot Guidelines

Traditional robots typically have higher payload, faster speeds, and most safety-related features are monitored and controlled by an external system. These guidelines may also be applied with collaborative robot applications.

- Movement of the robot is only allowed when an enabling device/switch is activated.
- Additional safety-rated controls, such as enabling devices, are needed for each person if multiple operators are within the operating space.
- Emergency stop is required.
- The emergency stop and enabling switch should be located on the guiding device and the location should be so they do not cause additional hazards.

Collaborative Robot Guidelines

Most collaborative robots are inherently safe by their design. This may include features such as force amplification, virtual safety zones, and tracking technologies. This guideline may not be applicable for traditional robot applications unless specified by the risk assessment.

- Power and force collaborative robots do not need to use an enabling device as long as the power and force capability cannot be deactivated.
- The transient contact chart in the annex of ISO/TR 15066 should be used to determine robot's maximum speed.

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