

INTERNATIONAL
STANDARD

ISO
19649

First edition
2017-03

Mobile robots — Vocabulary

Robots mobiles — Vocabulaire



Reference number
ISO 19649:2017(E)

© ISO 2017



COPYRIGHT PROTECTED DOCUMENT

© ISO 2017, Published in Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
Ch. de Blandonnet 8 • CP 401
CH-1214 Vernier, Geneva, Switzerland
Tel. +41 22 749 01 11
Fax +41 22 749 09 47
copyright@iso.org
www.iso.org

Contents

Page

Foreword	iv
Introduction	v
1 Scope	1
2 Normative references	1
3 Terms and definitions	1
3.1 General terms related to mobile robots	1
3.2 Terms related to locomotive structure.....	2
3.3 Terms related to wheeled robots	3
3.4 Terms related to legged robots	3
3.5 Terms related to locomotion.....	4
3.6 Terms related to navigation.....	6
Annex A (informative) Examples	8
Bibliography	10

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 299, *Robotics*.

Introduction

With the increase of mobile robots in both industrial and non-industrial applications, there is a growing need to define terms relating to mobile robots. ISO 8373 defines fundamental terms relating to robotics, but it does not define terms relating to mobile robots fully. This document defines terms for mobile platforms and mobile robots based on the definitions in ISO 8373:2012.

Mobile robots — Vocabulary

1 Scope

This document defines terms relating to mobile robots that travel on a solid surface and that operate in both industrial robot and service robot applications. It defines terms used for describing mobility, locomotion and other topics relating to the navigation of mobile robots.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <http://www.iso.org/obp>
- IEC Electropedia: available at <http://www.electropedia.org/>

3.1 General terms related to mobile robots

3.1.1

mobile robot

robot able to travel under its own control

Note 1 to entry: A mobile robot can be a *mobile platform* (3.1.2) with or without manipulators.

[SOURCE: ISO 8373:2012, 2.13]

3.1.2

mobile platform

assembly of all components of the *mobile robot* (3.1.1) which enables *locomotion* (3.1.10)

Note 1 to entry: A mobile platform can include a chassis which can be used to support a load.

Note 2 to entry: Because of possible confusion with the term “base”, it is advisable not to use the term “mobile base” to describe a mobile platform.

[SOURCE: ISO 8373:2012, 3.18]

3.1.3

mobility

ability of the *mobile platform* (3.1.2) to travel within its environment

Note 1 to entry: Mobility can be used as a measure, e.g. an *omni-directional mobile mechanism* (3.3.6) usually has higher mobility than a *differential drive* (3.3.7) wheeled mechanism.

3.1.4

steering

control of the direction of travel of the *mobile platform* (3.1.2)

3.1.5

configuration

set of all joint values that completely determines the shape of the robot at any time

[SOURCE: ISO 8373:2012, 3.5]

3.1.6

alignment configuration

reference configuration

specified *configuration* (3.1.5) of the *mobile platform* (3.1.2) defined by the manufacturer

EXAMPLE Zero-steering configuration for a wheeled robot, specified stand-still configuration of a legged robot

3.1.7

travel surface

terrain on which the *mobile robot* (3.1.1) travels

[SOURCE: ISO 8373:2012, 7.7]

3.1.8

travel surface contact area

ground contact area

area of one or more wheels, tracks, or legs in contact with the *travel surface* (3.1.7)

3.1.9

support polygon

convex hull of all the *travel surface contact areas* (3.1.8)

3.1.10

locomotion

self-propelled travel of the *mobile platform* (3.1.2)

3.1.11

turret

rotating structure mounted on a *mobile platform* (3.1.2) to give independent orientation to any devices attached on the structure

3.2 Terms related to locomotive structure

3.2.1

suspension

system or structure which absorbs shock or vibration from the *travel surface* (3.1.7)

Note 1 to entry: The purpose of suspension can be to maintain the stability of the *mobile platform* (3.1.2) and to overcome roughness of the travel surface by maintaining contact to the travel surface.

3.2.2

active suspension

suspension (3.2.1) whose damping and/or spring characteristics can be controlled

3.2.3

Zero Moment Point

ZMP

point, on the *support polygon* (3.1.9), with respect to which the moment, resultant from all the forces exerted from the *travel surface* (3.1.7) to the *mobile robot* (3.1.1), has zero components in the horizontal direction

3.3 Terms related to wheeled robots

3.3.1

steer wheel

steered wheel

wheel whose orientation is controlled to change the direction of travel

3.3.2

drive wheel

driving wheel

wheel that propels the *mobile platform* ([3.1.2](#))

3.3.3

idler wheel

follower

trailing wheel

wheel that does not propel the *mobile platform* ([3.1.2](#)) and is not actively steered

3.3.4

swivel castor

castor

assembly including one or more wheels in a housing which rotates freely around a vertical axis that has a horizontal offset from the wheel's axis of rotation

3.3.5

omni-directional wheel

wheel with rollers attached on its outer surface which allows a displacement in any direction, even perpendicular to the wheel itself

EXAMPLE Omniwheels (rollers oriented in 90° angle to the wheel axle), Mecanum wheels (rollers oriented in 45° angle to the wheel axle)

Note 1 to entry: An *omni-directional mobile mechanism* ([3.3.6](#)) is often constructed using three or more omni-directional wheels.

3.3.6

omni-directional mobile mechanism

wheeled mechanism which enables instantaneous travel of the *mobile robot* ([3.1.1](#)) in any direction

[SOURCE: ISO 8373:2012, 3.19.]

3.3.7

differential drive

mechanism and method of motion control in which *drive wheels* ([3.3.2](#)) along an axis are controlled independently, the speeds of the wheels effecting translation and the difference thereof effecting rotation

Note 1 to entry: This term can also apply to tracked robots.

3.4 Terms related to legged robots

3.4.1

gait

pattern of cyclic motion of the leg(s) for legged *locomotion* ([3.1.10](#))

3.4.2

stride length

stride

travel distance of legged robot for one cycle of *gait* ([3.4.1](#))

3.4.3

walking period

gait period

time of one cycle of *gait* ([3.4.1](#))

3.4.4

leg phase

ratio of time delay of the start of *swing state* ([3.4.6](#)) of a leg from that of the reference leg to the *walking period* ([3.4.3](#))

3.4.5

support state

stance state

state of a leg in which the leg is in contact with the *travel surface* ([3.1.7](#))

3.4.6

swing state

recovery state

transfer state

state of a leg in which the leg is not in contact with the *travel surface* ([3.1.7](#))

3.4.7

duty factor

ratio of the duration of the *support state* ([3.4.5](#)) of a leg to the *walking period* ([3.4.3](#))

3.4.8

gait diagram

diagram of cyclic motion of the legs in time for legged *locomotion* ([3.1.10](#))

EXAMPLE A gait diagram for crawl *gait* ([3.4.1](#)) of a quadruped is shown in [Figure A.1](#).

3.5 Terms related to locomotion

3.5.1

travel surface reaction force

ground reaction force

force exerted to the *mobile platform* ([3.1.2](#)) from the *travel surface* ([3.1.7](#)) through the *travel surface contact area* ([3.1.8](#))

3.5.2

travel surface contact pressure

ground contact pressure

pressure exerted to the *mobile platform* ([3.1.2](#)) from the *travel surface* ([3.1.7](#)) with wheels, tracks or legs through the *travel surface contact area* ([3.1.8](#))

3.5.3

overturning moment

minimum moment required to overturn a *mobile robot* ([3.1.1](#)) from a statically stable *pose* ([3.6.1](#))

Note 1 to entry: This moment is dependent on surface conditions, e.g. slope.

3.5.4

traction

maximum frictional force that can be produced between *travel surface* ([3.1.7](#)) and *mobile robot* ([3.1.1](#)) wheels, tracks or legs

3.5.5**mobile platform coordinate system**

coordinate system referenced to one of the components of a *mobile platform* (3.1.2)

Note 1 to entry: ISO 9787:2013, 5.5, specifies a mobile platform coordinate system, $O_p - X_p - Y_p - Z_p$. The origin of the mobile platform coordinate system, O_p , is the mobile platform origin. The $+X_p$ axis is normally taken in the forward direction of the mobile platform. The $+Z_p$ axis is normally taken in the upward direction of the mobile platform. See [Figure A.2](#)

[SOURCE: ISO 8373:2012, 4.7.6, modified – Original Note 1 to entry has been deleted and new Note 1 to entry has been added.]

3.5.6**steer angle**

angular displacement of the axle of a *steer wheel* (3.3.1) about the $+Z_p$ axis

Note 1 to entry: Steer angle is usually zero when the wheel axle is aligned with Y_p direction of the *mobile platform* (3.1.2).

Note 2 to entry: See *mobile platform coordinate system* (3.5.5).

3.5.7**forward travel**

movement of the *mobile platform* (3.1.2) along its $+X_p$ axis

Note 1 to entry: See *mobile platform coordinate system* (3.5.5).

3.5.8**reverse travel****backward travel**

movement of the *mobile platform* (3.1.2) along its $-X_p$ axis

Note 1 to entry: See *mobile platform coordinate system* (3.5.5).

3.5.9**traverse****lateral travel**

movement of the *mobile platform* (3.1.2) along its Y_p axis

Note 1 to entry: See *mobile platform coordinate system* (3.5.5).

3.5.10**diagonal travel**

movement of the *mobile platform* (3.1.2) as a combination of *forward travel* (3.5.7)/*reverse travel* (3.5.8) and *traverse* (3.5.9)

3.5.11**omni-directional travel**

movement of the *mobile platform* (3.1.2) whose direction of travel can be changed instantaneously and arbitrarily by means of an *omni-directional mobile mechanism* (3.3.6)

3.5.12**turning**

movement of the *mobile platform* (3.1.2) causing a change of the orientation of the *mobile platform coordinate system* (3.5.5)

Note 1 to entry: Turning is typically accompanied by the change of the direction of travel of the mobile platform.

Note 2 to entry: [Table A.1](#) provides a comparison of turning, *pivoting* (3.5.13) and *spinning* (3.5.14).

3.5.13

pivoting

pivot turning

rotating with translation during which one wheel, track or leg contact point stays in one place on the *travel surface* (3.1.7) to be used for the centre of *turning* (3.5.12)

Note 1 to entry: [Table A.1](#) provides a comparison of turning, pivoting and *spinning* (3.5.14).

3.5.14

spinning

spin turning

in-place rotation, or rotation about the *mobile platform* (3.1.2) origin without translation

Note 1 to entry: [Table A.1](#) provides a comparison of *turning* (3.5.12), *pivoting* (3.5.13) and spinning.

3.5.15

turning radius

radius of curvature of the path of the *mobile platform* (3.1.2) origin

3.5.16

turning width

minimum width of the rectangular passage within which the *mobile platform* (3.1.2) can complete a specific type of *turning* (3.5.12)

3.5.17

cornering force

force exerted on the *mobile robot* (3.1.1) by centrifugal force when travelling

3.5.18

balance control

balance management

process of maintaining the static and dynamic stability of the *mobile robot* (3.1.1)

3.6 Terms related to navigation

3.6.1

pose

combination of position and orientation in space

Note 1 to entry: Pose for the manipulator normally refers to the position and orientation of the end effector or the mechanical interface.

Note 2 to entry: Pose for a *mobile robot* (3.1.1) can include the set of poses of the *mobile platform* (3.1.2) and of any manipulator attached to the mobile platform, with respect to the world coordinate system.

[SOURCE: ISO 8373:2012, 4.5]

3.6.2

simultaneous localization and mapping

SLAM

constructing and refining the environment map while using features of the partly constructed map for recognizing the *pose* (3.6.1) of the *mobile robot* (3.1.1) travelling within its environment

3.6.3

guidance

provision of external information to enable the *mobile robot* (3.1.1) to navigate

3.6.4

path planning

planning an ordered set of *poses* (3.6.1) to travel

3.6.5**trajectory planning**

path planning ([3.6.4](#)) with time as parameter

3.6.6**collision**

dynamic contact resulting in momentum exchange

3.6.7**obstacle avoidance**

preventing interference, such as approaching, contacting or *collision* ([3.6.6](#)), with obstacles by detecting them with external state sensors and adjusting *trajectory planning* ([3.6.5](#))

3.6.8**collision avoidance**

preventing *collision* ([3.6.6](#)) using external state sensors and reacting accordingly

3.6.9**docking**

process of reaching and/or connecting a station, facility or other *mobile platform* ([3.1.2](#)) in order to perform an intended task

Note 1 to entry: Examples of intended tasks include charging, exchanging data and transferring payload.

3.6.10**inertial navigation system****INS**

system that processes data from inertial sensors to calculate the *pose* ([3.6.1](#)) and velocity of *mobile platform* ([3.1.2](#))

Note 1 to entry: INS usually calculates the pose and velocity employing an inertial measurement unit (IMU) which is composed of a gyroscope and an accelerometer, and additionally a compass.

3.6.11**dead reckoning**

method of obtaining the *pose* ([3.6.1](#)) of a *mobile robot* ([3.1.1](#)) using only internal measurements from a known initial pose

[SOURCE: ISO 8373:2012, 7.8.]

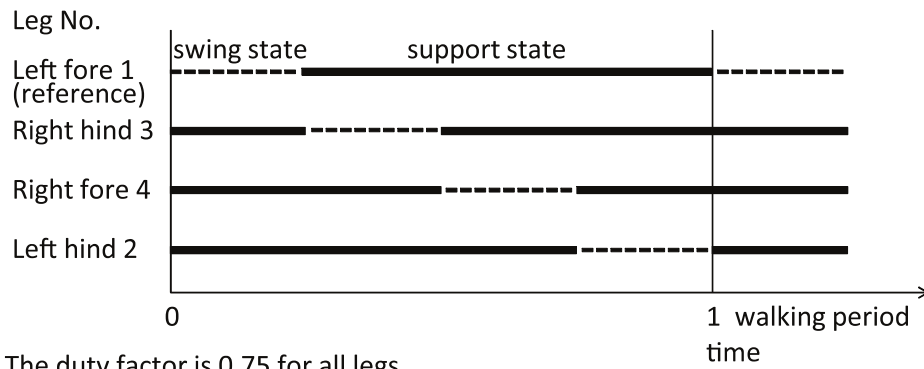
3.6.12**odometry**

measurement method employing the incremental distance data from internal state sensors to estimate the changes in position over time

Note 1 to entry: When not only incremental distance data but also direction information from a compass or *inertial navigation system* ([3.6.10](#)) is employed, *dead reckoning* ([3.6.11](#)) is a proper term rather than odometry.

Annex A (informative)

Examples



The duty factor is 0.75 for all legs.

The leg phases of legs 2, 3, and 4 are 0.75, 0.25, and 0.5, respectively.

Figure A.1 — Gait diagram of a typical crawl gait

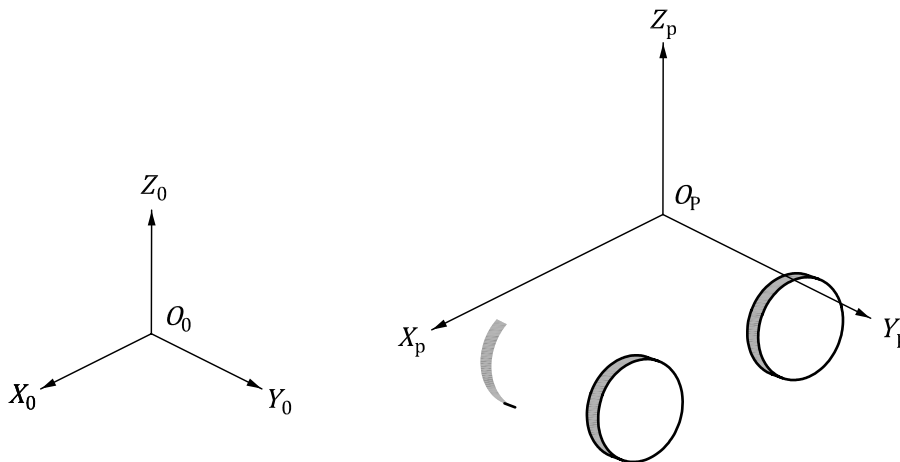










Figure A.2 — Example of mobile platform coordinate system

Table A.1 — Comparison of turning, pivoting and spinning

	Turning	Turning	Pivoting	Spinning
Differential drive				
Omni-directional drive				
Description	Rotating with translation	Turning	Special turning where one of the contact points with the surface acts as a centre of rotation	Rotating without translation

Bibliography

- [1] ISO 8373:2012, *Robots and robotic devices — Vocabulary*
- [2] ISO 9283, *Manipulating industrial robots — Performance criteria and related test methods*
- [3] ISO 9787:2013, *Robots and robotic devices — Coordinate systems and motion nomenclatures*
- [4] ISO 9946, *Manipulating industrial robots — Presentation of characteristics*
- [5] ISO 13482, *Robots and robotic devices — Safety requirements for personal care robots*

