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Intelligent transport systems — Public-area mobile robots (PMR) —

Part 1: Overview of paradigm

Systèmes de transport intelligents - Robots mobiles en espace public (RMP) —

Partie 1: Vue d'ensemble du paradigme

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ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

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Foreword

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This document was prepared by Technical Committee ISO/TC 204, *Intelligent transport systems*.

A list of all parts in the ISO 4448 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

0.1 Background

The ISO 4448 series[1)] is focused on robotic road vehicles as they load and unload passengers and goods at the kerb as well as robotic devices operating among unprotected pedestrian bystanders to perform tasks in public spaces such as delivery, inspection, maintenance, surveillance and others.

Mobile robotic vehicles and devices have found uses in factories, farms, mines and warehouses for well over half a century. For applications in constrained spaces, this history stretches back to the 1950s with the use of automated guided vehicles (AGV) that moved along fixed pathways guided by embedded magnets or similar techniques. Over time, this technology matured to use beacons and positioning signals, usually in structured work environments to become what are variously known as industrial mobile robots (IMR) and automated mobile robots (AMR). These technologies have increasing capabilities of moving from fixed, memorized pathways to navigating with increasing flexibility and eventually using indoor-GPS, hi-definition maps and sophisticated algorithms to move safely and deftly among humans in those environments.

In the past decade, this technology has developed sufficiently to operate beyond such relatively structured spaces to provide services directly among humans. Multiple types of mobile robots now operate indoors among air travel passengers, restaurant users and hospital visitors, as well as outdoors in public spaces such as footways, cycleways and parks. Any such mobile robotic device operating among such bystanders is called a public-area mobile robot (PMR).

0.2 Robotic vehicles at the kerb, among non-robotic users

Robotic motor vehicles such as cars and trucks operating in urban areas often need to load or unload passengers and goods at a kerb. Deployment standards are needed to manage this access and queueing process of loading or unloading, often called “pick up and drop off” (PUDO) in the case of human passengers.

The traffic and parking rules that cities have relied on prior to the mid-2020s represent systems already under stress, with their design and governance shortcomings made increasingly evident by the coronavirus pandemic. The data structures related to parking, as clarified and restructured under ISO/TS 5206-1, are insufficient to support PUDO for automated vehicle systems (See Reference [3] for a commonplace description of the PUDO problem).

In the future, cities will need new operating guidelines as kerb lanes and sidewalks are used by automated cars (such as taxis) and automated delivery vehicles that will arrive, stop, wait and either load or unload under sensor, effector and software control. These machines will need to be prioritized, scheduled, queued, bumped and placed in holding patterns regardless of the nature or proximity of human oversight Moreover, these operations need to occur without blocking crosswalks, bicycle lanes, micromobility users, no-stopping areas or transit stops. This needs to be done safely, alongside human-operated vehicles, without inconveniencing pedestrians and other vulnerable road users (VRUs), and with regard to human accessibility challenges.

When cities experience large numbers of automated vehicles that are loading, unloading and performing other tasks at the kerb, they will require orchestration. Systems for this will need to be regional, operating above the level of private owners or commercial fleet operators and overseen by a traffic authority. The ISO 4448 series includes data and procedural documents to support PUDO orchestration for automated cars and trucks.

0.3 Robotic devices operating in public spaces among pedestrian bystanders

Unlike cars and trucks, smaller robotic devices designed to perform various delivery, maintenance, monitoring and other helper tasks can operate on footways, cycleways and roadways including footpaths inside public buildings such as hospitals, malls and airports – collectively termed “pathways.” Some are able to move between the indoors and outdoors, and some are enabled to open doors and use elevators. These devices can have numerous advantages for cities and people who live in cities. The ISO 4448 series refers to these devices as “public-area mobile robots” or PMRs.

1) The other parts of this series are under development.

PMR deployment represents the first time in human history that mobile devices (machines) designed to operate without a proximate human attendant are being used to move among human bystanders that are inattentive, uninvolved, unprotected and untrained relative to the task or activity of the device.

This will have a profound impact on the management of public spaces which until now have been dedicated to pedestrians and unpowered active transportation devices such as wheelchairs, scooters, bicycles or skateboards. Such PMRs can have impacts on safety, accessibility, existing social rights, vulnerable road users (VRUs), adequacy of infrastructure, street and pavement design, road crossing designs, active-user traffic flow, etc.

0.4 Standardization of robotic vehicles at the kerb vs. those operating among bystanders

These two types of robots generally operate on opposite sides of the kerb. While automated road vehicles such as passenger vehicles and trucks operate on the motor vehicle side, PMRs operate on the pedestrian side. Urban infrastructure is organized this way for historical reasons, but is not unambiguous everywhere: in some locations the boundary implied by a kerb is merely assumed and possibly variable.

These two types of automated vehicles are generally subject to different regulations, with the rules designed for road vehicles being generally much more developed, explicit and often more assertively enforced by governments(s). Hence, the ISO 4448 series will focus almost exclusively on PMRs with the critical exception of PUDO (pick-up/drop-off) at the kerb.

Interactions among all such robotic devices, active transportation users and human bystanders is a critical concern of the ISO 4448 series.

0.5 Planned way forward

This document provides an introduction to the ISO 4448 series, which will cover the description, management and operation of automated vehicles at the kerbside, within walkways, in integrated kerbside-pathway (footway) systems and within any public pathway that permits PMRs to move among pedestrians and other VRUs. Operation of such vehicles is inclusive of arriving, stopping, waiting, loading and unloading at the kerbside and arriving, proceeding, stopping, waiting, loading/unloading or any task performed on footways and other pathways.

The purpose of the ISO 4448 series is to:

1. define the operating and behavioural systems needed to organize and expedite the flow of vehicular and robotic ground traffic in cities, specifically with regard to the loading and unloading of goods and passengers at the kerbside;

2. define the allocation and movement of PMRs for short-haul delivery, garbage removal, sweeping, washing, snow removal, repair, food trucks, public works tasks and human transportation in public spaces, among other services conducted on pathways or crosswalks.

For PMRs, standardization addressing numerous behavioural rules that act as “rules of the road” is needed.

The two most important attributes of PMRs are that they operate in publicly accessible spaces shared with inattentive, uninvolved, unprotected and untrained bystanders and that they move without a proximate human operator (a teleoperator beyond line-of-sight is not proximate).

The ISO 4448 series is planned to comprise a set of terminology, guidelines and real-time procedures for the coordination of operations at the kerbside, on pathways and the integrated use of automation on both kerbsides and pathways. The operating and behaviour standards being defined in the ISO 4448 series are intended to enable carefully defined (mapped) and expanding areas of cities to manage any number of vehicles and vehicle varieties operated by any number of operators (public, commercial, and private) for these various activities.

0.6 PMR capabilities, agency and rights

PMRs are machines. They are mobile hardware devices that use the capabilities of sensors and software to move and to perform tasks with varying level of automation. They have no ability to reason or to “decide” anything beyond what their electro-mechanical systems permit whether controlled by code or machine

learning. The only current exception to this is that most of these devices can be under the control of a human teleoperator. In such cases, a PMR that is controlled by a human can be expected to inherit the reasoning capability of its human controller; still, it is the human that is reasoning.

There can be times when the descriptive language used in the ISO 4448 series appears to grant PMRs a degree of agency. They have no agency. Any agency that can be inferred is with fleet operators and teleoperators.

In all cases, a PMR has no "social rights," like a bicycle, although there are a number of circumstances in which a PMR can potentially have the "right-of-way," just as a bicycle with its rider often does. There have been regulations passed in several countries that require a PMR to follow pedestrian rules or for a motor vehicle operator to treat a PMR in a roadway intersection as though it is a pedestrian. These regulations are describing the behaviour of a PMR or how it is to be treated in a traffic circumstance. They do not confer any social rights, as has on occasion been erroneously interpreted in mass media.

It is also critical that the utility and capability of PMRs does not overshadow the social rights and well-being of vulnerable workers. It is frequently stated that robots are needed to address labour shortages. The ISO 4448 series is neutral on such issues, although it is recognized that automation has job impacts. It is not the within the scope of this document to suggest whether new jobs, other jobs, or better jobs will become available, but it is recognized that there will likely be labour impacts.

Intelligent transport systems — Public-area mobile robots (PMR) —

Part 1: Overview of paradigm

1 Scope

This document provides an overview of the ground-based automated mobility systems deployment paradigm. The paradigm covers such kerbsides and pathways as are suitable for co-temporal, collaborative use by various types and combinations of automated and non-automated, wheeled, or ambulatory, motorized and non-motorized, mobility-related vehicles and devices as well as for various levels of automated or remote operation of such vehicles. This includes vehicles and devices that move people as well as goods within proximate distances of human bystanders.

Note Aerial (flying) drones are not part of the scope.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/TS 14812, *Intelligent transport systems — Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/TS 14812 and the following apply.

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

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
ambulatory
relating to or adapted for walking

Note 1 to entry: Implies having and travelling on legs in the case of public-area mobile robots (PMRs).

3.2
block-face
segment of a street and sidewalk facing one or the other side of the street between two consecutive intersections

Note 1 to entry: The length of the block-face is the distance between two consecutive cross-streets.

3.3
bystander
human within a proximate distance of a public-area mobile robot (PMR) that is any of uninvolved, inattentive, unprotected or untrained regarding the task of a PMR or other automated vehicle