REP: 155
Title: Conventions, Topics, Interfaces for Perception in Human-Robot Interaction
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Contents

Abstract

This REP provides a set of conventions and common interfaces for Human-Robot Interaction (HRI) scenarios, with a focus on the perception of humans and social signals. It aims at enabling interoperability and reusability of core functionality between the many HRI-related software tools, from skeleton tracking, to face recognition, to natural language processing.

Besides, these interfaces are designed to be relevant for a broad range of HRI situations, from crowd simulation, to kineastetic teaching, to social interaction.

Specifically, this REP covers:

- human modeling, as a combination of a permanent identity (person) and transient parts that are intermittently detected (eg face, skeleton, voice);
- topic naming conventions under the `/humans/` topic namespace;
- human kinematic modeling (based on dynamically generated URDF models), as well as 3D TF frame conventions (naming, orientation);
- representation of group interactions (groups, mutual gaze)

Rationale

ROS is widely used in the context of human-robot interactions (HRI). However, to date, no single effort (e.g. [1] [2]) has been successful at coming up with broadly accepted interfaces and pipelines for that domain, as found in other parts of the ROS ecosystem (for manipulation or 2D navigation for instance). As a result, many different implementations of common tasks (skeleton tracking, face recognition, speech processing, etc) cohabit, and while they achieve similar goals, they are not generally compatible, hampering the code reusability, experiment replicability, and general sharing of knowledge.

In order to address this issue, this REP aims at structuring the whole "ROS for HRI" space by creating an adequate set of ROS messages and services to describe the software interactions relevant to the HRI domain, as well as a set of conventions (eg topics structure, tf frames) to expose human-related information.

The REP aims at modeling these interfaces based on existing, state-of-the-art algorithms relevant to HRI perception, while considering the broad range of

application scenario in HRI.

It is hoped that such an effort will allow easier collaboration between projects and allow a reduction in duplicate efforts to implement the same functionality.

Overview

This REP specifies multiple aspects of human-robot interaction, with a primary focus on human perception/social signal recognition.

It is split into 4 sections:

1. human representation, as a combination of a permanent identity (*person*) and transient parts that are intermittently detected (e.g. *face*, *skeleton*, *voice*);
2. topic naming conventions under the `/humans/` topic namespace;
3. kinematic model of the human and 3D tf frame conventions (naming, orientation, compatible with REP-120 [3] where possible)
4. representation of group interactions (groups, mutual gaze)

By following the naming conventions and leveraging the interfaces defined in this REP, both tools and libraries can be designed to be reusable between different frameworks and experiments.

> **Note**
>
> Importantly, the REP does not mandate specific tools or algorithms to perform human perception/social signal recognition per se. It only specify naming conventions and interfaces between these nodes.

The use of capitalized words such as MUST, SHOULD, MAY must be understood as specified in the IETF RFC2119 'Key words for use in RFCs to Indicate Requirement Levels' [6].

Human Representation

To accommodate existing tools and techniques used to detect and recognise humans, the representation of a person is built on a combination of 4 unique identifiers (UUIDs): a **person identifier**, a **face identifier**, a **body identifier** and a **voice identifier**. Future revisions of this REP might add additional identifiers.

These four identifiers are not mutually exclusive, and depending on the requirements of the application, the available sensing capabilities, and the position/behaviour of the humans, only some might be available for a given person, at a given time.

Person Identifier

The **person identifier** MUST be a unique ID (typically, a UUID) permanently associated with a unique person. This person ID is normally assigned by a node able to perform person identification (face recognition node, voice recognition node, sound source localisation + name, identification based on physical features like height/age/gender, person identification based on pre-defined features like the colour of the clothes, etc.) This ID is meant to be **persistent** so that the robot can recognize people across encounters/sessions. Nodes providing person IDs MAY serialise these IDs to a permanent storage, for them to persist across robot reboots.

When meaningful (see section Person frame), a TF frame MUST be associated to the person ID and named `person_<personID>`. Due to the importance of the head in human-robot interaction, the `person_<personID>` frame is expected to be placed as close as possible to the head of the human. If neither the face nor the skeleton are tracked, the `person_<personID>` frame might be located to the last known position of the human, or removed altogether if no meaningful estimate of the human location is available. See section Person frame for details regarding the `person_<personID>` frame.

At any given time, the list of known persons is published under the `/humans/persons/tracked` topic as `hri_msgs/IdsList` messages.

Merging Person Identifiers

In certain cases, two person IDs must be merged (for instance, the robot detects that a voice and a face that were thought to belong to different people are indeed the same person).

In such a case, one of the person IDs is marked as an *alias* of the other person, by publishing the ID of the other person on a special subtopic named `alias`. See section Topics structure for details.

> **Note**
>
> The reverse operation (splitting a person into two) can be realised by simply publishing a second person ID.

Anonymous persons

While person IDs are generally expected to be permanent, one exception exists for persons that the robot has detected but not yet identified.

For instance, the robot hears a voice, and therefore knows that a person is around, but no voice identification nodes is available -- or the voice identification has not yet recognised the voice: in such a case, an *anonymous person* might be created, ie a person who has not yet been assigned a permanent ID.

Anonymous persons are treated like regular persons. They however publish a latched `true` boolean on their `/anonymous` subtopic, and their ID is not guaranteed to be permanent (it can in fact change/be removed at any point).

Face Identifier

The **face identifier** MUST be a unique ID that identifies a detected face. This ID is typically generated by the face detector/head pose estimator upon face detection.

Importantly, **this ID is not persistent**: once a face is lost (for instance, the person goes out of frame), its ID is not valid nor meaningful anymore. To cater for a broad range of applications (where re-identification might not be always necessary), there is no expectation that the face detector will attempt to recognise the face and re-assign the same face ID if the person reappears.

> **Note**
>
> A face detector/face tracker MAY reuse the same face ID if it is confident that the face is indeed the same.

There is a one-to-one relationship between this face ID and the estimated 6D pose of the head. If the node published a head pose estimated, the ROS TF frame MUST be named `face_<faceID>` (see section Face and Gaze Frames for the face frame conventions).

At any given time, the list of tracked faces SHOULD be published under the `/humans/faces/tracked` topic as `hri_msgs/IdsList` messages.

Body Identifier

Similarly to the face identifier, the **body identifier** MUST be a unique ID, associated to a person's skeleton. It is normally created by a skeleton tracker upon detection of a skeleton.

Like the face ID, **the body ID is not persistent**, and is valid only as long as the specific skeleton is tracked by skeleton tracker which initially detected it.

The corresponding TF frame is `body_<bodyID>`, and TF frames associated with each of the body parts of the person, MUST suffixed with the same ID (see section Body frames).

At any given time, the list of tracked bodies SHOULD be published under the `/humans/bodies/tracked` topic as `hri_msgs/IdsList` messages.

Voice Identifier

Likewise, a speech separation node MUST assign a unique, non-persistent, ID for each detected voice. Tracked voices SHOULD be published under the `/humans/voices/tracked` topic as `hri_msgs/IdsList` messages.

Identifier Matching

Associations between IDs (for instance to denote that a given voice belongs to a given person, or a given face to a given body) are expressed by publishing `hri_msgs/IdsMatch` messages on the `/humans/candidate_matches` topic. The `hri_msgs/IdsMatch` message MAY include a confidence level.

A typical implementation will have several specialised nodes publishing candidate matches on `/humans/candidate_matches` (e.g. a face recognition node providing matches between faces and persons; a voice recognition node providing matches between voices and persons) and one 'person manager' node collecting the candidates, and publishing the most likely associations between a person ID and its face/body/voice IDs under the `/humans/persons/` namespace.

Special case for anonymous persons

A node that wants to advertise that a person exists, but is not identified yet ("anonymous person") SHOULD publish a `hri_msgs/IdsMatch` message on the `/humans/candidate_matches` topic with only one specified id. For instance, a simple face *detector* (ie, not performing face identification) can published a message like:

```
{face_id: 'ff424', body_id: '', voice_id: '', person_id: '' confidence: 0.0, }
```

to indicate that the face `ff424` has been detected, and thus, a corresponding person must exist. That person will be published as `anonymous`, and that message will have lower precedence than another message that associates that face to a recognised person. Note that in that case, the confidence MUST be ignored.

Identifier Syntax

Identifiers can be arbitrary, as long as they are unique. It is also recommended to keep them short to avoid clutter.

Note that using people's names as identifier is possible, but not generally recommended as collisions are likely.

Common Parameters

- `/humans/faces/width` (default: 128): width in pixels of the cropped faces published under `/humans/faces/XYZ/cropped`, `/humans/faces/XYZ/aligned` and `/humans/faces/XYZ/frontalized`
- `/humans/faces/height` (default: 128): height in pixels of the cropped faces published under `/humans/faces/XYZ/cropped`, `/humans/faces/XYZ/aligned` and `/humans/faces/XYZ/frontalized`
- `/human_description_<bodyID>`: URDF models of detected humans. See Section Kinematic Model of the Human for details.
- `/human/match_threshold` (`float`, default: 0.5): the minimum level of likelihood to consider a face/body/voice to belong to a given person.
- `/humans/reference_frame` (`string`, default: *map*): persons' TF frames must be published with respect to *reference_frame*. Typically, faces/bodies/voices frames are published wrt to their respective sensors frame. *reference_frame* is usually a 'static' frame (eg *map*), so that if the person moves out of view of the robot (and therefore, its position can not be updated anymore), it 'stays' where it was last seen.

Topics Structure

A system implementing this REP MUST follow the following conventions for all HRI-related topics:

1. all topics are grouped under the global namespace `/humans/`
2. five sub-namespaces are available:
    - `/humans/faces`
    - `/humans/bodies`
    - `/humans/voices`
    - `/humans/persons`
    - `/humans/interactions`
3. the first four (`/faces`, `/bodies`, `/voices`, `/persons`) expose one sub-namespace per face, body, voice, person detected, named after the corresponding ID (for instance, `/humans/faces/bd34a/`). In addition, they expose a topic `/tracked` (of type `hri_msgs/IdsList`) where the list of currently tracked faces/bodies/voices/persons is published;
4. matches between faces/bodies/voices/persons are published on the `/humans/candidate_matches` topic, as explained in Section Identifier

matching;
5. the `/humans/interactions` topic exposes group- level signals, including gazing patterns and social groups.

> **Note**
>
> the `hri_msgs` messages are defined in the hri_msgs repository.

> **Note**
>
> The slightly unconvential structure of topics (with one namespace per face, body, person, etc.) enables modular pipelines.
>
> For instance, a face detector might publish cropped images of detected faces under `/humans/faces/face_1/cropped`, `/humans/faces/face_2/cropped`, etc.
>
> Then, depending on the application, an additional facial expression recognizer might be needed as well. For each detected face, that node would subscribe to the corresponding */cropped* topic and publish its results under `/humans/faces/face_1/expression`, `/humans/faces/face_2/expression`, etc., augmenting the available information about each face in a modular way.
>
> Such modularity would not be easily possible if we had chosen to publish instead a generic `Face` message, as a single node would have had first to fuse all possible information about faces.
>
> See the Illustrative Example below for a complete example.

> **Note**
>
> libhri can be used to hide away the complexity of tracking new persons/faces/bodies/voices. It automatically handles subscribing/unsubcribing to the right topics when new persons/faces/bodies/voices are detected.

Faces

The list of currently detected faces (list of face IDs) is published under `/humans/faces/tracked` (as a `hri_msgs/IdsList` message).

For each detected face, a namespace `/humans/faces/<faceID>/` is created (eg `/humans/faces/bf3d/`).

The following subtopics MAY then be available, depending on available detectors:

Name	Message type	Required	Description
`/roi`	`sensor_msgs/RegionOfInterest`	x	Region of the face in the source image
`/cropped`	`sensor_msgs/Image`	x	Cropped face image, if necessary scaled, centered and 0-padded to match the `/humans/faces/width` and `/humans/faces/height` ROS parameters
`/aligned`	`sensor_msgs/Image`		Aligned (eg, the two eyes are horizontally aligned) version of the cropped face, with same resolution as `/cropped`
`/frontalized`	`sensor_msgs/Image`		Frontalized version of the cropped face, with same resolution as `/cropped`
`/landmarks`	`hri_msgs/FacialLandmarks`		2D facial landmarks extracted from the face
`/facs`	`hri_msgs/FacialActionUnits`		The presence and intensity of facial action units found in the face
`/expression`	`hri_msgs/Expression`		The expression recognised from the face
`/softbiometrics`	`hri_msgs/SoftBiometrics`		Detected age and gender of the person

Bodies

The list of currently detected bodies (list of body IDs) is published under `/humans/bodies/tracked` (as a `hri_msgs/IdsList` message).

For each detected body, a namespace `/humans/bodies/<bodyID>/` is created. The following subtopics MAY then be available, depending on available detectors:

Name	Message type	Required	Description
`/roi`	`sensor_msgs/RegionOfInterest`	x	Region of the whole body body in the source image
`/cropped`	`sensor_msgs/Image`	x	Cropped body image
`/skeleton2d`	`hri_msgs/Skeleton2D`		The 2D points of the the detected skeleton
`/joint_states`	`sensor_msgs/JointState`		The joint state of the human body, following the Kinematic Model of the Human

Name	Message type	Required	Description
`/posture`	`hri_msgs/BodyPosture`		Recognised body posture (eg standing, sitting)
`/gesture`	`hri_msgs/Gesture`		Recognised symbolic gesture (eg waving)

3D body poses SHOULD be exposed via TF frames. This is discussed in Section Kinematic Model and Coordinate Frames.

Voices

The list of currently detected voices (list of voice IDs) is published under `/humans/voices/tracked` (as a `hri_msgs/IdsList` message).

For each detected voice, a namespace `/humans/voices/<voiceID>/` is created.

The following subtopics MAY then be available, depending on available detectors:

Name	Message type	Required	Description
`/audio`	`audio_msgs/AudioData`	x	Separated audio stream for this voice
`/features`	`hri_msgs/AudioFeatures`		INTERSPEECH'09 Emotion challenge [4] low-level audio features
`/is_speaking`	`std_msgs/Bool`		Whether or not speech is recognised from this voice
`/speech`	`hri_msgs/LiveSpeech`		The live stream of speech recognized via an ASR engine

Persons

The list of currently tracked persons (list of person IDs) is published under `/humans/persons/tracked` (as a `hri_msgs/IdsList` message).

The list of known persons (either actively tracked, or known but not tracked anymore) is published under `/humans/persons/known` (as a `hri_msgs/IdsList` message).

For each detected person, a namespace `/humans/persons/<personID>/` is created.

The following subtopics MAY then be available, depending on available detectors, and whether or not the person has yet been matched to a face/body/voice:

Name	Message type	Required	Description
`/anonymous`	`std_msgs/Bool` (latched)	x	If true, the person is *anonymous*, ie has not yet been identified, and has not been issued a permanent ID
`/face_id`	`std_msgs/String` (latched)		Face matched to that person (if any)
`/body_id`	`std_msgs/String` (latched)		Body matched to that person (if any)
`/voice_id`	`std_msgs/String` (latched)		Voice matched to that person (if any)
`/alias`	`std_msgs/String` (latched)		If this person has been merged with another, this topic contains the person ID of the new person
`/engagement_status`	`hri_msgs/EngagementLevel`		Engagement status of the person with the robot
`/location_confidence`	`std_msgs/Float32`		Location confidence; 1 means *person currently seen*, 0 means *person location unknown*. See Person Frame
`/name`	`std_msgs/String`		Name, if known
`/native_language`	`std_msgs/String`		IETF language codes like EN_gb, if known

Interactions

Finally, the namespace `/humans/interactions` exposes topics where group-level interactions are published when detected.

Name	Message type	Description
`/groups`	`hri_msgs/Group`	Estimated social groups
`/gazing`	`hri_msgs/Gaze`	Estimated gazing behaviours

See section Group-level Interactions for details.

Illustrative Example

You run a node `your_face_detector_node`. This node detects two faces, and publishes the corresponding regions of interest and cropped faces. The node effectively advertises and publishes onto the following topics:

```
> rostopic list
/humans/faces/23bd5/roi     # sensor_msgs/RegionOfInterest
/humans/faces/23bd5/cropped # sensor_msgs/Image
/humans/faces/b092e/roi     # sensor_msgs/RegionOfInterest
/humans/faces/b092e/cropped # sensor_msgs/Image
```

> **Note**
>
> The IDs (in this example, `23bd5` and `b092e`) are arbitrary, as long as they are unique. However, for practical reasons, it is recommended to keep them reasonably short.

You start an additional node to recognise expressions: `your_expression_classifier_node`. The node subscribes to the `/humans/faces/<faceID>/cropped` topics and publishes expressions for each faces under the same namespace:

```
> rostopic list
/humans/faces/23bd5/roi
/humans/faces/23bd5/cropped
/humans/faces/23bd5/expression # hri_msgs/Expression
/humans/faces/b092e/roi
/humans/faces/b092e/cropped
/humans/faces/b092e/expression # hri_msgs/Expression
```

You then launch `your_body_tracker_node`. It detects one body:

```
> rostopic list
/humans/faces/23bd5/...
/humans/faces/b092e/...
/humans/bodies/67dd1/roi     # sensor_msgs/RegionOfInterest
/humans/bodies/67dd1/cropped # sensor_msgs/Image
```

In addition, you start a 2D/3D pose estimator `your_skeleton_estimator_node`. The 2D skeleton can be published under the same body namespace, and the 3D skeleton is published as a joint state. The joint state can then be converted into TF frames using eg a URDF model of the human, alongside a `robot_state_publisher`:

```
> rostopic list
/humans/faces/23bd5/...
/humans/faces/b092e/...
/humans/bodies/67dd1/roi
/humans/bodies/67dd1/cropped
/humans/bodies/67dd1/skeleton2d # hri_msgs/Skeleton2D
/humans/bodies/67dd1/joint_states # sensor_msgs/JointState


> xacro ws/human_description/urdf/human-tpl.xacro id:=67dd1 height:=1.7 > body-67dd1.urdf
> rosparam set human_description_67dd1 -t body-67dd1.urdf
> rosrun robot_state_publisher robot_state_publisher joint_states:=/humans/bodies/67dd1/joint_states
robot_description:=human_description_67dd1
```

> **Note**
>
> In this example, we manually generate the URDF model of the human, load it to the ROS parameter server, and start a `robot_state_publisher`. In practice, this should be done programmatically everytime a new body is detected.

So far, faces and bodies are detected, but they are not yet 'unified' as a person.

First, we need a stable way to associate a face to a person. This would typically require a node for facial recognition. Such a node would subscribe to each of the detected faces' `/cropped` subtopics, and publish *candidate matches* on the `/humans/candidate_matches` topic, using a `hri_msgs/IdsMatch` message. For instance:

```
> rostopic echo /humans/candidate_matches
face_id: "23bd5"
body_id: ''
voice_id: ''
person_id: "76c0c"
confidence: 0.73
---
```

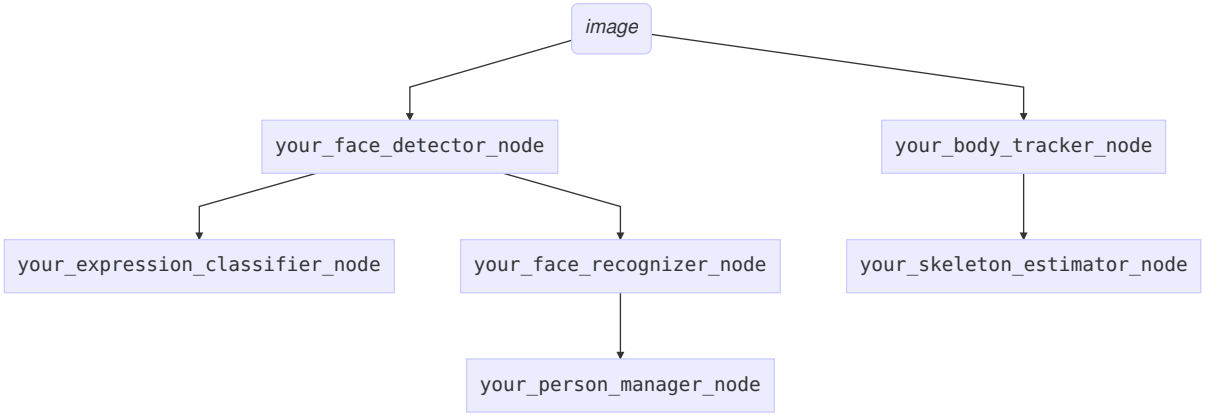
In that example, the person ID `76c0c` is created and assigned by the face recognition node itself.

Finally, you would need a `your_person_manager_node` to publish the `/humans/persons/76c0c/` subtopics based on the candidate matches:

```
> rostopic list
/humans/faces/23bd5/...
/humans/faces/b092e/...
/humans/bodies/67dd1/...
/humans/persons/76c0c/face_id
```

In this simple example, only the `/face_id` subtopic would be advertised (with a latched message pointing to the face ID `23bd5`). In practice, additional information could be gathered by the `your_person_manager_node` to expose eg soft biometrics, engagement, etc. Similarly, the association between the person and its body would have to be performed by a dedicated node.

Overall, six independent nodes are combined to implement this pipeline:



This possible pipeline is only for illustration purposes: depending on each specific pipeline implementations, some of these nodes might be merged or on the contrary, further divided into smaller nodes. For instance, one might choose to integrate together the face recogniser node and the person manager.

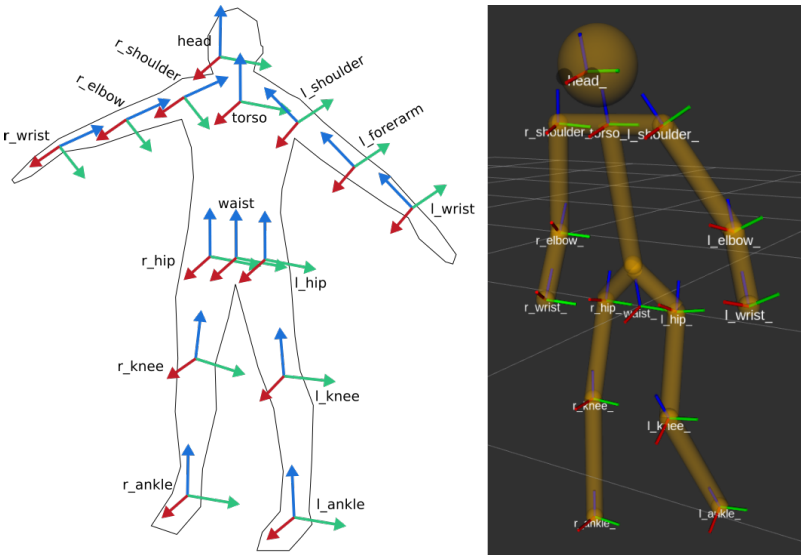
Note as well that, in order to build a complete perception pipeline for HRI, additional nodes would be needed, for instance for voice processing.

Kinematic Model and Coordinate Frames

Where meaningful, the coordinate frames used for humans follow the conventions set out in REP-120 [3].

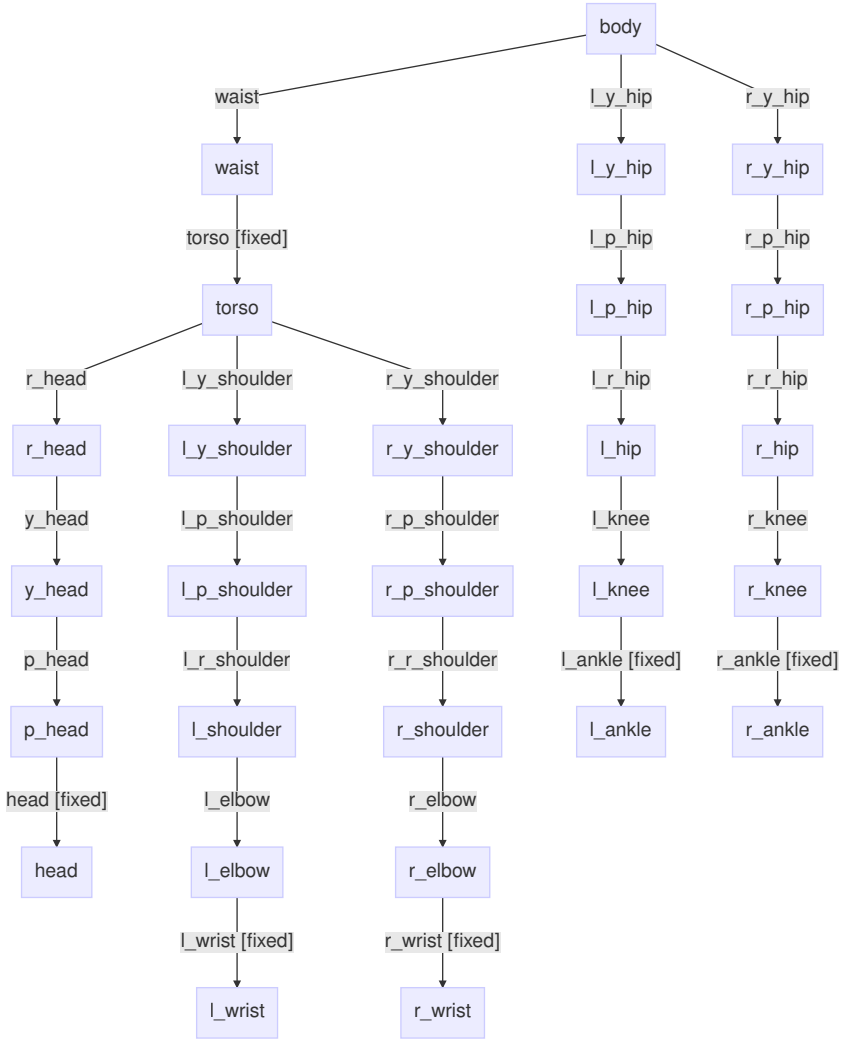
These conventions also follow the REP-103 [5].

Kinematic Model of the Human



The main 15 links defined on the human body are presented in the above diagram. Frames orientations and naming are based on REP-103 and REP-120. Right: render of the reference URDF model of the human body in *rviz*.

The following diagram presents all the link (boxes) and joints (arrows) in the recommended human kinematic model.



In practice, each of these links and joints must be suffixed with the corresponding `<bodyID>`, as several skeletons might be present at the same time.

A parametric URDF model of humans is available in the `human_description` package. It SHOULD be used to instantiate at run-time new human URDF model, adjusted for the e.g. height of the detected persons. The person's joint state (published under `/humans/bodies/<bodyID>/joint_states`) can then be used with eg a *robot_state_publisher node <http://wiki.ros.org/robot_state_publisher>* to publish the body's TF frames.

When generated, the URDF models of the humans should be loaded on the ROS parameter server under `/human_description_<bodyID>`.

> **Note**
>
> the human_description ROS package contains a launch script `visualize.launch` that can be used to quickly experiment with the kinematic model of humans.

Face and Gaze Frames

- Head pose estimation nodes MUST publish the head 6D pose as a TF frame named `face_<faceID>` where `<faceID>` stands for the unique face identifier.
- the parent of this frame is the sensor frame used to estimate the face pose.
- The origin of the frame must be the sellion (defined as the deepest midline point of the angle formed between the nose and forehead. It can generally be approximated to the mid point of line connecting the two eyes).
- The x axis is expected to point forward (ie, out of the face), the z axis is expected to point toward the scalp (ie, up when the person is standing vertically).
- Any other facial landmark published as a TF frame must be parented to the head TF frame. It should be suffixed with the same `_<faceID>`.

In addition, the person's gaze direction MUST be published as a `gaze_<faceID>` frame, collocated with the `face_<faceID>` frame, and with its z axis aligned with the estimated gaze vector, x right, and y down ('optical frame' convention).

If gaze is not estimated beyond general head orientation, the `gaze_<faceID>`'s z axis will be colinear with the `face_<faceID>`'s x axis.

Finally, nodes performing attention estimation MAY publish a frame `focus_<faceID>` representing the estimated focus of attention of the person.

Body Frames

- The body frame is named `body_<bodyID>` where `<bodyID>` stands for the unique skeleton identifier.
- The origin of the frame is located at the mid point of the line connecting the hips.

- the parent of this frame is the sensor frame used to estimate the body pose.
- The x axis is expected to point forward (ie, out of the body), the z axis is expected to point toward the head (ie, up when the person is standing vertically).
- The other skeleton points published as TF frames must be parented to the root `body_<bodyID>` frame, and all be suffixed with the same `_<bodyID>`. Section Kinematic Model of the Human lists the recommended names of body links and body joints.
- if the skeleton tracker provide an estimate of the head pose, it might publish a frame named `head_<bodyID>`. *It is the joint responsibility of the face tracker and skeleton tracker to ensure that* `face_<faceID>` *and* `head_<bodyID>` *are consistent with each other.*

Voice Frame

- Sound source localisation algorithms can broadcast estimated TF frames for detected voices. These frames should be named `voice_<voiceID>`.
- The orientation of the frame is meaningless, and should be ignored.

Person Frame

The `person_<personID>` frame has a slightly more complex semantic and must be interpreted in conjunction with the person's `location_confidence` value (see Persons topics).

We can distinguish three cases:

1. The human is currently being tracked (ie `personID` is set, and at least one of `faceID` or `bodyID` is set). In this case, `location_confidence` MUST be set to 1 and:
    - when a face ID is also defined, the `person_<personID>` frame must be collocated with the `face_<faceID>` frame.
    - when a body ID is defined (ie the skeleton is being tracked), the `person_<personID>` frame must be collocated with the skeleton frame the closest to the head.
    - if both the face and body IDs are defined, the `person_<personID>` frame must be collocated with the `face_<faceID>` frame.
2. The human is not seen, but has been previously seen. In this case, `location_confidence` MUST be set to a value `< 1` and a `person_<personID>` TF frame MUST be published **as long as** `location_confidence > 0`. Simple implementations might choose to set `location_confidence = 0.5` as soon as the person is not actively seen anymore, continuously broadcast the last known location. More advanced implementations might slowly decrease `location_confidence` over time to represent the fact that the human might have walked away, for instance.
3. The human is known, but has never been seen before. In this case, `location_confidence` MUST be set to `0`, and no TF frame should be broadcast.

Group-level Interactions

Representation of Groups

When detected, group-level interactions are published on the `/humans/interactions/groups`, using the `hri_msgs/Group.msg` message type.

Each group is defined by a unique group ID, and a list of person IDs. (groups can only be defined between persons).

Representation of gazing behaviours

Social gazing (eg, gazing between people) is represented as `hri_msgs/Gaze.msg` messages, published on the `/humans/interactions/gazing` topic.

Each `Gaze.msg` messages contain a *sender* and a *receiver* that MUST be known persons. Note that the relationship is not symmetrical: "A gazes at B" does not imply "B gazes at A". As such, *mutual gaze* will lead to two messages being published.

If one or the other of the sender and receiver IDs are not set, the robot is assumed to respectively originate or be the target of the gaze.

Nodes publishing gazing information are expected to continuously publish gaze messages, until the person is not gazing at the target anymore.

References

[1] `people` package, last commit in 2015 (https://github.com/wg-perception/people)

[2] `cob_people_perception` package, mainly developed between 2012 and 2014 (https://github.com/ipa320/cob_people_perception)

[3] *(1, 2)* REP 120, Coordinate Frames for Humanoid Robots (https://ros.org/reps/pep-0120.html)

[4] *The INTERSPEECH 2009 emotion challenge*, Schuller, Steidl and Batliner, Tenth Annual Conference of the International Speech Communication Association, 2009

[5] REP 103, Standard Units of Measure and Coordinate Conventions (http://www.ros.org/reps/rep-0103.html)

[6] RFC2119, Key words for use in RFCs to Indicate Requirement Levels (https://datatracker.ietf.org/doc/html/rfc2119)

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