WBM::ClassDiagram

WBMBase

+fixed_link: string
+wf_R_b: matrix
+wf_p_b: vector
+g_wf: vector
+ndof: integer
+frict_coeff: struct
+joint_limits: struct {readOnly}
+robot_model: wbmBaseRobotModel {readOnly}
+DF_ROBOT_MODEL: string {readOnly}
+MAX_NUM_JOINTS: integer {readOnly}

+WBMBase(out obj: WBMBase, robot_model: wbmBaseRobotModel)
+copy(out newObj: WBMBase, obj)
+delete()
+initModel(obj)
+initModel(obj, urdf_model_name: string)
+initModelURDF(obj, urdf_file_name: string)
+setWorldFrame(obj, wf_R_b: matrix, wf_p_b: vector)
+setWorldFrame(obj, wf_R_b: matrix, wf_p_b: vector, g_wf: vector)
+setInitWorldFrame(obj)
+setInitWorldFrame(obj, wf_R_b: matrix, wf_p_b: vector)
+setInitWorldFrame(obj, wf_R_b: matrix, wf_p_b: vector, g_wf: vector)
+getWorldFrameFromFixLnk(out wf_p_b: vector, out wf_R_b: matrix, obj, urdf_fixed_link: string)
+getWorldFrameFromFixLnk(out wf_p_b: vector, out wf_R_b: matrix, obj, urdf_fixed_link: string, q_j: vector)
+getWorldFrameFromDfltFixLnk(out wf_p_b: vector, out wf_R_b: matrix, obj)
+getWorldFrameFromDfltFixLnk(out wf_p_b: vector, out wf_R_b: matrix, obj, q_j: vector)
+setState(q_j: vector, dq_j: vector, v_b: vector)
+getState(out vqT_b: vector, out q_j: vector, out v_b: vector, out dq_j: vector)
+getFloatingBaseState(out stFltb: wbmFltgBaseState)
+transformationMatrix(out wf_H_lnk: matrix, obj)
+transformationMatrix(out wf_H_lnk: matrix, obj, urdf_link_name: string)
+transformationMatrix(out wf_H_lnk: matrix, obj, wf_R_b: matrix, wf_p_b: vector, q_j: vector)
+transformationMatrix(out wf_H_lnk: matrix, obj, wf_R_b: matrix, wf_p_b: vector, q_j: vector, urdf_link_name: string)
+massMatrix(out M: matrix)
+massMatrix(out M: matrix, wf_R_b: matrix, wf_p_b: vector, q_j: vector)
+getJointLimits(out jl_lower: vector, out jl_upper: vector)
+isJointLimit(out resv: vector, obj, q_j: vector)
+inverseDynamics(out tau_j: vector, ob, dq_j: vector, ddq_j: vector)
+inverseDynamics(out tau_j: vector, obj, dq_j: vector, ddq_j: vector, dv_b: vector)
+inverseDynamics(out tau_j: vector, obj, wf_R_b: matrix, wf_p_b: vector, q_j: vector, dq_j: vector, v_b: vector, ddq_j: vector)
+inverseDynamics(out tau_j: vector, obj, wf_R_b: matrix, wf_p_b: vector, q_j: vector, dq_j: vector, v_b: vector, ddq_j: vector, dv_b: vector)
+jacobian(out J: matrix, obj)
+jacobian(out J: matrix, obj, urdf_link_name: string)
+jacobian(out J: matrix, obj, wf_R_b: matrix, wf_p_b: vector, q_j: vector)
+jacobian(out J: matrix, obj, wf_R_b: matrix, wf_p_b: vector, q_j: vector, urdf_link_name: string)
+dJdq(out dJ: vector, obj)
+dJdq(out dJ: vector, obj, urdf_link_name: string)
+dJdq(out dJ: vector, obj, wf_R_b: matrix, wf_p_b: vector, q_j: vector, dq_j: vector, v_b: vector)
+dJdq(out dJ: vector, obj, wf_R_b: matrix, wf_p_b: vector, q_j: vector, dq_j: vector, v_b: vector, urdf_link_name: string)
+centroidalMomentum(out h_c: vector)
+centroidalMomentum(out h_c: vector, wf_R_b: matrix, wf_p_b: vector, q_j: vector, dq_j: vector, v_b: vector)
+forwardKinematics(out wf_vqT_lnk: vector, obj)
+forwardKinematics(out wf_vqT_lnk: vector, obj, urdf_link_name: string)
+forwardKinematics(out wf_vqT_lnk: vector, obj, wf_R_b: matrix, wf_p_b: vector, q_j: vector)
+forwardKinematics(out wf_vqT_lnk: vector, obj, wf_R_b: matrix, wf_p_b: vector, q_j: vector, urdf_link_name: string)
+generalizedBiasForces(out C_qv: vector)
+generalizedBiasForces(out C_qv: vector, wf_R_b: matrix, wf_p_b: vector, q_j: vector, dq_j: vector, v_b: vector)
+generalizedForces(out tau: vector, f_c: vector, Jc_t: matrix)
+generalizedForces(out tau: vector, wf_R_b: matrix, wf_p_b: vector, q_j: vector, dq_j: vector, v_b: vector, f_c: vector, Jc_t: matrix)
+coriolisCentrifugalForces(out tau_c: vector)
+coriolisCentrifugalForces(out tau_c: vector, wf_R_b: matrix, wf_p_b: vector, q_j: vector, dq_j: vector, v_b: vector)
+gravityForces(out tau_g: vector)
+gravityForces(out tau_g: vector, wf_R_b: matrix, wf_p_b: vector, q_j: vector)
+frictionForces(out tau_fr: vector, obj)
+frictionForces(out tau_fr: vector, obj, dq_j: vector)
+wholeBodyDynamics(out M: matrix, out C_qv: vector, out h_c: vector, obj)
+wholeBodyDynamics(out M: matrix, out C_qv: vector, out h_c: vector, obj, wf_R_b: matrix, wf_p_b: vector, q_j: vector, dq_j: vector, v_b: vector)
+set.fixed_link(obj, lnk_name: string)
+get.fixed_link(out lnk_name: string, obj)
+set.wf_R_b(obj, new_rotm: matrix)
+get.wf_R_b(out wf_R_b: matrix, obj)
+set.wf_p_b(obj, new_pos: vector)
+get.wf_p_b(out wf_p_b: vector, obj)
+set.g_wf(obj, g: vector)
+get.g_wf(out g_wf: vector, obj)
+set.ndof(obj, ndof: integer)
+get.ndof(out ndof: integer, obj)
+set.frict_coeff(obj, frict_coeff: struct)
+get.frict_coeff(out frict_coeff: struct, obj)
+get.joint_limits(out jl: struct, obj)
+get.robot_model(out robot_model: wbmBaseRobotModel, obj)
+dispModel(obj, prec: integer)
-initWBM(obj, robot_model: wbmBaseRobotModel)
-computeNewWorld2Base(obj, urdf_link_name: string): vector
-computeNewWorld2Base(out nw_p_b: vector, out nw_R_b: matrix, obj, urdf_link_name: string, q_j: vector)

«interface»
handle
+delete()

«dataType»
wbmRobotDrawProp
+joints.marker: char
+joints.marker_sz: double
+joints.color
+links.line_width: double
+links.color
+com.marker: char
+com.marker_sz: double
+com.color
+shape.line_width: double
+shape.edge_color
+shape.face_color
+shape.face_alpha: double

«use»

«utility»
wbmColor

1
+draw_prop
Draw properties for the body components of the simulated robot.

«dataType»
wbmBaseRobotModel
+ndof: integer
+urdf_robot_name: string
+urdf_fixed_link: string
+wf_R_b: matrix
+wf_p_b: vector
+g_wf: vector
+frict_coeff.v: vector
+frict_coeff.c: vector
+jlim.lwr: vector
+jlim.upr: vector

Base model parameters of a floating base robot.
1
#mwbm_model
1
+model

«dataType»
wbmSimBody
+shape_geom: struct
+shape_size_sf: matrix
+shape_faces: matrix
+foot_geom: struct
+foot_joints: vector
+foot_base_sz
+foot_shape_ds: matrix
+joint_lnk_names: string[1..*] {readOnly}
+joint_pair_idx: matrix {readOnly}
+nJoints: integer {readOnly}
+nLinks: integer {readOnly}
+nFeets: integer {readOnly}
-mshape_geom.size_sf: matrix
-mshape_geom.faces: matrix
-mfoot_geom.joints: vector
-mfoot_geom.base_sz.width: double
-mfoot_geom.base_sz.height: double
-mfoot_geom.shape_ds: double

+wbmSimBody(out obj: wbmSimBody, joint_lnk_names: string[1..*], joint_pair_idx: matrix, draw_prop: wbmDrawProp)
+set.shape_geom(obj, shape_geom: struct)
+get.shape_geom(out shape_geom: struct, obj)
+set.shape_size_sf(obj, size_sf: matrix)
+get.shape_size_sf(out shape_size_sf: matrix, obj)
+set.shape_faces(obj, shape_faces: matrix)
+get.shape_faces(out shape_faces: matrix, obj)
+set.foot_geom(obj, foot_geom: struct)
+get.foot_geom(out foot_geom: struct, obj)
+set.foot_joints(obj, foot_jnts: vector)
+get.foot_joints(out foot_jnts: vector, obj)
+set.foot_base_sz(obj, base_sz: struct)
+set.foot_base_sz(obj, base_sz: vector)
+get.foot_base_sz(out foot_base_sz: struct, obj)
+set.foot_shape_ds(obj, foot_ds: matrix)
+get.foot_shape_ds(out foot_shape_ds: matrix, obj)

«use»

Base model and configuration parameters of a floating base robot. This data type is useful e.g. for interfaces.

«dataType»
wbmBaseRobotParams
+wf2fixLnk: logical

«use»

«use»

«utility»
wbmErrorMsg
+DIM_MISMATCH: string {readOnly}
+EMPTY_ARRAY: string {readOnly}
+EMPTY_DATA_TYPE: string {readOnly}
+EMPTY_STRING: string {readOnly}
+EMPTY_VECTOR: string {readOnly}
+FILE_NOT_EXIST: string {readOnly}
+IDX_OUT_OF_BOUNDS: string {readOnly}
+MAX_JOINT_LIMIT: string {readOnly}
+MAX_NUM_LIMIT: string {readOnly}
+NAME_NOT_EXIST: string {readOnly}
+NOT_HOMOG_MAT: string {readOnly}
+STRING_MISMATCH: string {readOnly}
+UNKNOWN_AXIS_SEQ: string {readOnly}
+UNKNOWN_EXC: string {readOnly}
+SINGULAR_MAT: string {readOnly}
+UNKNOWN_JNT_TYPE: string {readOnly}
+UNKNOWN_LNK_NAME: string {readOnly}
+VALUE_IS_INIT: string {readOnly}
+VALUE_LTE_ZERO: string {readOnly}
+WRONG_ARG: string {readOnly}
+WRONG_ARR_SIZE: string {readOnly}
+WRONG_DATA_TYPE: string {readOnly}
+WRONG_MAT_DIM: string {readOnly}
+WRONG_VEC_DIM: string {readOnly}
+WRONG_VEC_SIZE: string {readOnly}

«dataType»
wbmSimEnvironment
+background_color_opt: string
+ground_shape: matrix
+ground_color
+ground_edge_color
+origin_pt_color
+origin_pt_size: double

1
+robot_body
Geometry data to define the structure and the shape of the simulated robot.
Environment settings for the simulation.
+environment

«dataType»
absSimConfig
+DF_MAIN_POS: vector {readOnly}
+DF_AXES_POS: matrix {readOnly}
+DF_AXES_COLORS: matrix {readOnly}
+DF_AXIS_LIMITS: vector {readOnly}
+DF_GROUND_SHAPE: matrix {readOnly}
+DF_GROUND_COLOR: vector {readOnly}
+hMainFigure: matlab.ui.Figure
+main_title: string
+main_pos: vector
+hAxes: vector
+axes_pos: matrix
+axes_colors: matrix
+axis_limits: vector
+plot_objs: cell

«use»

Since every robot is different, you can specify the configuration parameters of your robot in your own data type.

Robot.YourRobotName_ModelType

«dataType»
yourSpecificRobotConfig

«dataType»
wbmStateParams
+x_b: matrix
+qt_b: matrix
+q_j: matrix
+dx_b: matrix
+omega_b: matrix
+dq_j: matrix

«use»
State parameters of the current state of the robot.
1
+init_state_params

«dataType»
wbmFltgBaseState
+wf_R_b: matrix
+wf_p_b: vector
+v_b: vector

«use»
State parameters of the robot floating base. This data type is useful e.g. for interfaces.

+config

«dataType»
wbmHumanoidConfig
+jpos_head: vector
+jpos_torso: vector
+jpos_left_arm: vector
+jpos_left_hand: vector
+jpos_left_leg: vector
+jpos_left_feet: vector
+jpos_right_arm: vector
+jpos_right_hand: vector
+jpos_right_leg: vector
+jpos_right_feet: vector

General configuration structure of a humanoid robot.

«dataType»
wbmBaseRobotConfig
+nCstrs: integer
+cstr_link_names: cell
+nPlds: integer
+nTools: integer
+stvLen: integer

Initial condition of a floating base robot.
1
#mwbm_config

«dataType»
wbmPayloadLink
+urdf_link_name: string
+pt_mass: double
+lnk_p_pl: vector

0..*
+payload_links

Payload at a specified link, e.g. hands, with a point mass at a specifiied position in the frame of the reference link.

«dataType»
wbmToolLink
+urdf_link_name: string
+ee_vqT_tt: vector

0..*
+tool_links

Tool at a spezified end-effector link, i.e. hand/finger, with an orientation and translation relative to the link frame.

+body
Configuration data to define the body components of the robot.
0..1

WBM

+stvChiInit: vector {readOnly}
+stvLen: integer {readOnly}
+vqTInit: vector {readOnly}
+stvqT: vector {readOnly}
+robot_body: wbmBody {readOnly}
+robot_config: wbmBaseRobotConfig {readOnly}
+robot_params: wbmBaseRobotParams {readOnly}
+init_state: wbmStateParams
+DF_STIFFNESS: double {readOnly}
+MAX_NUM_TOOLS: integer {readOnly}
#wf2fixLnk: logical

+WBM(out obj: WBM, robot_model: wbmBaseRobotModel, robot_config: wbmBaseRobotConfig)
+WBM(out obj: WBM, robot_model: wbmBaseRobotModel, robot_config: wbmBaseRobotConfig, wf2fixLnk: logical)
+copy(out newObj: WBM, obj)
+delete(obj)
+setWorldFrameAtFixLnk(obj, urdf_fixed_link: string)
+setWorldFrameAtFixLnk(obj, urdf_fixed_link: string, q_j: vector, dq_j: vector, v_b: vector)
+setWorldFrameAtFixLnk(obj, urdf_fixed_link: string, q_j: vector, dq_j: vector, v_b: vector, g_wf: vector)
+updateWorldFrameFromFixLnk(obj)
+updateWorldFrameFromFixLnk(obj, q_j: vector, dq_j: vector, v_b: vector)
+updateWorldFrameFromFixLnk(obj, q_j: vector, dq_j: vector, v_b: vector, g_wf: vector)
+updateInitVQTransformation(obj)
+fkinVQTransformation(out wf_vqT_lnk: vector, obj, urdf_link_name: string, q_j: vector, vqT: vector, g_wf: vector)
+jointAccelerations(out ddq_j: vector, out acc_data: struct, obj, dq_j: vector, tau: vector)
+jointAccelerations(out ddq_j: vector, out acc_data: struct, obj, wf_R_b: matrix, wf_p_b: vector, q_j: vector, dq_j: vector, v_b, vector, tau: vector)
+jointAccelerationsExt(out ddq_j: vector, out acc_data: struct, obj, dq_j: vector, v_b: vector, tau: vector, foot_conf: struct)
+jointAccelerationsExt(out ddq_j: vector, out acc_data: struct, obj, M: matrix, C_qv: vector, dq_j: vector, nu: vector, tau: vector, Jc: matrix, dJcdq: vector, foot_conf: struct)
+jointAccelerationsExt(out ddq_j: vector, out acc_data: struct, obj, wf_R_b: matrix, wf_p_b: vector, q_j: vector, dq_j: vector, v_b: vector, tau: vector, foot_conf: struct)
+forwardDynamics(out dstvChi: vector, obj, t: double, stvChi: vector, fhTrqControl: function_handle)
+forwardDynamicsExt(out dstvChi: vector, obj, t: integer, stvChi: vector, fhTrqControl: function_handle, foot_conf: struct)
+intForwardDynamics(out t: vector, out stmChi: matrix, obj, fhTrqControl: function_handle, tspan: vector, stvChi_0: vector, ode_opt: struct)
+intForwardDynamics(out t: vector, out stmChi: matrix, obj, fhTrqControl: function_handle, tspan: vector, stvChi_0: vector, ode_opt: struct, foot_conf: struct)
+initFootBalanceConfig(out foot_conf: struct, obj, qj_init: vector, feet_on_ground: vector)
+initFootBalanceConfig(out foot_conf: struct, obj, qj_init: vector, feet_on_ground: vector, k_p: double)
+initFootBalanceConfig(out foot_conf: struct, obj, qj_init: vector, feet_on_ground: vector, k_p: double, k_v: double)
+initFootBalanceConfig(out foot_conf: struct, obj, qj_init: vector, veT_lfoot: vector, veT_rfoot: vector, feet_on_ground: vector, k_p: double, k_v: double)
+getFwdDynVisualizationData(out vis_data: struct, obj, stmChi: matrix, fhTrqControl: function_handle, foot_conf: struct)
+setupSimulation(out sim_config: absSimConfig, sim_config: absSimConfig)
+visualizeForwardDynamics(obj, pos_out: matrix, sim_config: absSimConfig, sim_tstep: double, vis_ctrl: struct)
+simulateForwardDynamics(obj, pos_out: matrix, sim_config: absSimConfig, sim_tstep: double, nRpts: integer, vis_ctrl: struct)
+plotCoMTrajectory(obj, stmChi: matrix, prop: struct)
+setLinkPayloads(obj, link_names: string[1..*], pl_data: matrix)
+getPayloadLinks(out pl_links: wbmPayloadLink[0..*], out nPlds: integer, obj)
+getPayloadTable(out pl_tbl: table, obj)
+payloadFrame(out wf_H_pl: matrix, obj, wf_R_b: matrix, wf_p_b: vector, q_j: vector, pl_idx: integer)
+payloadFrame(out wf_H_pl: matrix, obj, wf_R_b: matrix, wf_p_b: vector, q_j: vector)
+payloadFrame(out wf_H_pl: matrix, obj, pl_idx: integer)
+payloadFrame(out wf_H_pl: matrix, obj)
+setToolLinks(obj, ee_link_names: string[1..*], frames_tt: matrix)
+getToolLinks(out tool_links: wbmToolLink[0..*], out nTools: integer, obj)
+getToolTable(out tool_tbl: table, obj)
+updateToolFrame(obj, t_idx: integer, new_frm_tt: vector)
+toolFrame(out wf_H_tt: matrix, obj, wf_R_b: matrix, wf_p_b: vector, q_j: vector, t_idx: integer)
+toolFrame(out wf_H_tt: matrix, obj, wf_R_b: matrix, wf_p_b: vector, q_j: vector)
+toolFrame(out wf_H_tt: matrix, obj, t_idx: integer)
+toolFrame(out wf_H_tt: matrix, obj)
+jacobianTool(out J_tt: matrix, obj, wf_R_b: matrix, wf_p_b: vector, q_j: vector, t_idx: integer)
+jacobianTool(out J_tt: matrix, obj, wf_R_b: matrix, wf_p_b: vector, q_j: vector)
+jacobianTool(out J_tt: matrix, obj, t_idx: integer)
+jacobianTool(out J_tt: matrix, obj)
+getStateChains(out chn_q: cell, out chn_dq: cell, obj, chain_names: string[1..*])
+getStateChains(out chn_q: cell, out chn_dq: cell, obj, chain_names: string[1..*], q_j: vector, dq_j: vector)
+getStateJointNames(out jnt_q: vector, out jnt_dq: vector, obj, joint_names: string[1..*])
+getStateJointNames(out jnt_q: vector, out jnt_dq: vector, obj, joint_names: string[1..*], q_j: vector, dq_j: vector)
+getStateJointIdx(out jnt_q: vector, out jnt_dq: vector, obj, joint_idx: integer[1..*])
+getStateJointIdx(out jnt_q: vector, out jnt_dq: vector, obj, joint_idx: integer[1..*], q_j: vector, dq_j: vector)
+getStateParams(out stParams: wbmStateParams, obj, stChi: vector)
+getStateParams(out stParams: wbmStateParams, obj, stChi: matrix)
+getPositions(out vqT_b: vector, out q_j: vector, obj, stChi: vector)
+getPositions(out vqT_b: matrix, out q_j: matrix, obj, stChi: matrix)
+getPositionsData(out stmPos: matrix, obj, stmChi: matrix)
+getMixedVelocities(out v_b: vector, out dq_j: vector, obj, stChi: vector)
+getMixedVelocities(out v_b: matrix, out dq_j: matrix, obj, stChi: matrix)
+getBaseVelocities(out v_b: vector, obj, stChi: vector)
+getBaseVelocities(out v_b: matrix, obj, stChi: matrix)
+get.stvChiInit(out stvChi: vector, obj)
+get.stvLen(out stvLen: integer, obj)
+get.vqTInit(out vqT_b: vector, obj)
+get.stvqT(out vqT_b: vector, obj)
+get.robot_body(out robot_body: wbmBody, obj)
+get.robot_config(out robot_config: wbmBaseRobotConfig, obj)
+get.robot_params(out robot_params: wbmBaseRobotParams, obj)
+set.init_state(obj, stInit: wbmStateParams)
+get.init_state(out stInit: wbmStateParams, obj)
+dispConfig(obj, prec: integer)
-initConfig(obj, robot_config: wbmBaseRobotConfig)
-getJointValues(out jnt_q: vector, out jnt_dq: vector, obj, q_j: vector, dq_j: vector, joint_idx: integer[1..*], len: integer)
-checkInitStateDimensions(out result: logical, obj, stInit: wbmStateParams)
-getLinkName(out lnk_name: string, obj, lnk_list: vector, idx: integer)

«use»

«dataType»
wbmBody
+chains.name: string[1..*] {readOnly}
+chains.start_idx: integer[1..*] {readOnly}
+chains.end_idx: integer[1..*] {readOnly}
+nChains: integer {readOnly}
+joints.name: string[1..*] {readOnly}
+joints.idx: integer[1..*] {readOnly}
+nJoints: integer {readOnly}

+wbmBody(out obj: wbmBody, chain_names: string[1..*], chain_idx: matrix, joint_names: string[1..*], joint_idx: vector)
+getChainIndices(out jnt_idx: vector, obj, chain_name: string)
+getJointIndex(out jnt_idx: integer, obj, joint_name: string)
+getJointNames(out jnt_names: string[1..*], obj, joint_idx: vector)
+getChainTable(out chn_tbl: table, obj)
+getJointTable(out jnt_tbl: table, obj)

Robot.YourRobotName_ModelType

«dataType»
yourOwnSimConfig

General configuration data for the environment and the robot in the simulaton.

«dataType»
genericSimConfig
+DF_GROUND_COLOR_2: vector {readOnly}
+genericSimConfig(out obj: genericSimConfig, main_title: string, robot_sim_body: wbmSimBody, env_settings: wbmSimEnvironment)