Solution Data Structures

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INVENTORY DATA

INVENTORY DATA TYPES AND STATES

KIT COMPOSITIONS

- Garments Only
- Sensor Kit Only
- Brainpack Only
- Full Kit

EQUIPMENT STATUSES

- ready
- in use
- defective
- In production
- Testing

SENSOR TYPES

- Nod IMU
- EM IMU
- StretchSense

BRAINPACKS QA STATUSES

- Buttons 1 mm of recess Pass/Fail
- Buttons return to initial depth Pass/Fail
- Power button working Pass/Fail
- Reset button working Pass/Fail
- Record button working Pass/Fail
- Charging indicator LED Pass/Fail
- State indicator LED Pass/Fail
- LED colors Pass/Fail
- Settings file updated Pass/Fail
- Pairing with IMUs Pass/Fail
- SD card is electronically labeled with battery pack ID Pass/Fail
- App pairs brainpack Pass/Fail
- App locates brainpack Pass/Fail
- App connects to to brainpack Pass/Fail
- App disconnects from brainpack Pass/Fail
- State change: idle to recording Pass/Fail
- State change: recording to idle Pass/Fail
- State change: recording to reset Pass/Fail
- State change: idle to reset Pass/Fail
- State change: recording to error Pass/Fail
- Recovery from shutdown Pass/Fail
- Set recording name Pass/Fail
- Recording File name saved Pass/Fail
- Full Charging Cycle Pass/Fail
- Tested and Ready

SENSORS QA STATUSES

- Firmware Updated Pass/Fail
- Sensor seating in base Pass/Fail
- Sensor LED Pass/Fail
- Sensor Orientation Pass/Fail
- Sensor drift Pass/Fail
- Tested and Ready

SHIRTS – SHIRTS OCTOPI QA STATUSES

- Baseplates inspection Pass/Fail
- Wiring inspection Pass/Fail
- Connector inspection Pass/Fail
- Heat Shrink Inspection Pass/Fail
- Power inspection Pass/Fail
- Seams inspection Pass/Fail
- ID label inspection Pass/Fail
- Tested and Ready

PANTS – PANTS OCTOPI QA STATUSES

- Baseplates inspection Pass/Fail
- Wiring inspection Pass/Fail
- Connector inspection Pass/Fail
- Heat Shrink Inspection Pass/Fail
- Power inspection Pass/Fail
- Seams inspection Pass/Fail
- ID label inspection Pass/Fail
- Tested and Ready

ANATOMICAL LOCATIONS

- Trunk
- Left Upper arm
- Left Fore arm
- Left Thigh
- Left Lower Leg
- Right Upper arm
- Right Fore arm
- Right Thigh
- Right Lower Leg

INVENTORY DATA EXTRACTION

- Kits ready to use
- Kits producible
- Brainpacks ready to use
- Brainpacks producible
- Sensor sets ready to use
- Sensor sets producible
- Shirts ready to use
- Shirts producible

- Pants ready to use
- Pants producible
- Sensors ready to use
- Sensors defective

COMPONENTS TYPES

- Batteries
- BP Screws
- Capsule Screws
- USB Cables
- USB Chargers
- Narrows (m)
- Over-mold Bases
- Light Pipes
- BP top
- BP bottom
- Old BP top
- Old BP bottom
- Micro SD
- SD Cover
- Capsule top
- Capsule Bottom
- Sensor PCB
- Ribbon Cable (m)
- BP Buttons
- Capsule Washers
- Aux Cables
- Capsule Buttons

INVENTORY DATA STRUCTURES

ORGANIZATION (CONTINUED)

- Org ID
- List of Related Kits

KITS

- Kit ID (=serial number)
- Kit location
- Kit status
- Related User ID
- Related Brainpack ID
- Related Sensors Set ID
- Related Shirt ID
- Related Pants ID
- Related Org ID

COMPONENTS

- Component type ID
- Component Status
- Quantity

BRAINPACKS

- Brainpack ID (=serial number)
- Brainpack Location
- Brainpack Version
- Brainpack Status
- Brainpack QA status
- Related Power Board ID
- Related Data Board ID
- Related Kit ID

POWER BOARDS

- Power board ID (=Serial Number)
- Power board Version
- Power board Firmware version
- Power board Status
- Related Brainpack ID

DATA BOARDS

- Data board ID (=Serial Number)
- Data board Version
- Data board Firmware version
- Data board Status
- Related Brainpack ID

SENSOR SETS

- Sensor Set ID
- List of related sensors
- Sensor set QA status
- Related Kit ID

SENSORS

- Sensor ID (=Serial Number)
- Sensor Type
- Sensor Version
- Sensor Location
- Sensor Firmware
- Sensor Status
- Sensor QA Status
- Related Sensor Set ID
- Sensor Anatomical location ID

TOP GARMENTS

- Shirt ID (=Serial Number)
- Related Octopus ID
- Related Kit ID
- Shirt Size
- Shirt Location
- Shirt Status
- Shirt QA Status

BOTTOM GARMENTS

- Pants ID (=Serial Number)
- Related Octopus ID
- Related Kit ID

- Pants Size
- Pants Location
- Pants Status
- Pants QA Status

SHIRTS OCTOPI

- Shirt Octopus ID (=Serial Number)
- Related top garment ID
- Shirt Octopus Size
- Shirt Octopus Location
- Shirt Octopus Status
- Shirt Octopus QA Status

PANTS OCTOPI

- Pants Octopus ID (=Serial Number)
- Related bottom garment ID
- Pants Octopus Size
- Pants Octopus Location
- Pants Octopus Status
- Pants Octopus QA Status

USERS & LICENSING DATA

ORGANIZATION (CONTINUED)

- Org ID
- List of Related Licenses
- List of Related Users

ROLES

- Collector
- Analyst
- Organization
- Admin

LICENSE TYPES

- Collector
- Analyst

LICENSE STATUSES

- Unassigned
- Assigned
- Activated
- Expired

TEAM

- Team ID
- Team name
- Team address
- List of Related Users on team
- Related Org ID

USERS

- User ID (= User Name)
- User Password
- User Role
- User email
- List of Related Users on team
- Related Kit ID
- Related License ID
- Related Meta Data ID
- Related Org ID

META DATA

- Meta Data ID
- Related User ID
- Height
- Weight
- Gender
- DOB
- First Name
- Last Name

LICENSE

- License ID
- License generated key
- License Type
- License Status
- License Expiry date
- Related User ID
- Related Org ID

User	Role	License	License Status	Team
User 1	Analyst	Analyst license #1345	Assigned	#1
User 2	Analyst	Analyst license #1346	Activated	#2
User 3	Collector	Collector license #2269	Activated	#1
User 4	Collector	Collector license #2270	Activated	#1
User 5	Collector	Collector license #2271	Activated	#1
User 6	Collector	Collector license #2272	Activated	#1
User 7	Collector	Collector license #2273	Expired	#1
User 8	Collector	Collector license #2274	Expired	#2
User 9	Collector	Collector license #2275	Assigned	#2
User 10	Collector	Collector license #2276	Assigned	#3
User 11	Analyst	-		#2
User 12	Collector	-		#2
User 13	Collector	-		#2
User 14	Collector	-		#1

BRAINPACK DATA

BRAINPACK V1.5 RAW CONTENT

File name	File ext.	File content description
Recording_name.dat	Dat	The recording contains all frame data for the recording (from the moment user presses on recording button up until they press it again to stop) All recordings are stored in a directory that matches the root name of the file. The default name is "MovementLog". The files themselves are prepended with the serial number of the brainpack, and are appended with the recording number with padding of up to 5 zeros. For example, "S00042_MovementLog00001.dat/hsm " is the first recording for brainpack S00042. If the user changes the name of the recording using the application, that name will replace the movement log name. So if the name is changed to "LisaArmTest" then the directory will be "LisaArmTest" and the recording name will be "S00042_LisaArmTest00001.dat/hsm"
logIndex.dat	Dat	the log index tracker (logIndex.dat) each recording directory contains the current recording file number. This file is used internally by the brainpack when creating files.
Settings.dat	Dat	this contains the information for the NODs, it should always remain on the brainpacks SD card in the root directory.
sysHdk.bin	Bin	Internal System Logs. this file contain debug information used

RECORDING FILE

- Related Organization ID
- Related User ID
- Related Kit ID
- Time stamp when uploaded
- Time stamp when recorded
- recording file

MOVEMENT LOG FILE

- Related Organization ID
- Related User ID
- Related Kit ID
- Time stamp when uploaded
- Time stamp when recorded
- Log file

SETTINGS FILE

- Related Organization ID
- Related User ID
- Related Kit ID
- Time stamp when uploaded
- Settings file

SYSTEM LOG FILE

- Related Organization ID
- Related User ID
- Related Kit ID
- Time stamp when uploaded
- Time stamp when recorded
- System log file

BRAINPACK INTERACTIONS & DATA TYPES

INITIALIZING

- Power up
- Battery status check
- Connect to sensors
- If no sensors - go to Reporting mode
- Start BLE Broadcast
- Connect to previous Wi-Fi
- Log end of initialization
- Ready to use

CALIBRATING

- Start calibration process
- Repeat [0…N calib sequences]
    - Start calibration sequence
    - Capture T-Pose
    - Capture calibration sequence movement
    - Log sensors frames outputs
    - End calibration sequence
- Ready to Record

RECORDING

- Receive recording name
- Start recording
- Log sensors frames output
- Stop recording

HOTSPOT LOGGING

- Identify Hotspot type entered (pain/concern)
- Log Date, Time and Geolocation if available

UPDATING FIRMWARE:

- Send current FW version to established connection (Broadcast UDP/Status)
- Receive FW update request
- Go to update FW mode
- Receive new FW
- Update firmware
- Send update completed
- Reset

CONNECTING TO CLIENT

- OS connects to BP BLE
- APP connects to BP Through BLE
- App request configuration of BP Wi-Fi
- Receive Wi-Fi SSID and PWD
- Receive Cloud Server address
- Connect to Wi-Fi
- Connect to Cloud Server
- Broadcast BP ID (WAN/LAN)
- Receive Connection request (WAN/LAN)
- Connection established

STREAMING TO CLIENT

- Receive streaming request from established connection
- Broadcast data over UDP (to server or connected app)
- Receive streaming end request
- End streaming process

SYNCHING WITH CLIENT

- Receive Synching request from established connection
- Receive go to send new data
- Send new data
- End synching process

RESETTING

- Log start of reset
- Start re-initialization process
- ready to use

CHARGING

- Detect charging plug
- Broadcast charging %
- Go into charging state

IDLE

- = ready to use after x time of inactivity

ERROR

- Log error state
- Reset

REPORTING EVENT TYPES

- Pain event
- Concern event

CHARGING STATES

- Charging
- battery full
- battery low
- battery critically low

WI-FI STATES

- Disabled
- Enabled

FRAMES TYPES

- Recording frame
- Calibration frame

BRAINPACK STATES

- IDLE
- Initializing
  - Powering up
  - Connecting to sensors
  - Initializing BLE Broadcast
  - Connecting to previous Wi-Fi
- Resetting
- Updating Firmware:
  - Receiving new FW
  - Installing firmware
- Calibrating
  - Recording calibration Sequence N
- Recording & Hotspot logging
- Connecting to Client
  - Connecting to app BLE
  - configuring Wi-Fi
  - Connecting to Wi-Fi
  - Connecting to app Wi-Fi
- Streaming to Client
- Synching with Client
- Error

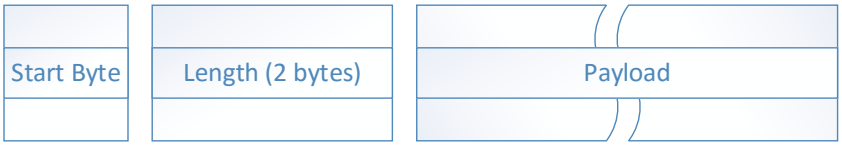
BRAINPACK BLE COMMUNICATIONS

These parameters are set directly through BLE characteristics:

- Brainpack state (read/notify)
- Battery Charge State (read/notify)
- Battery charge Level (read/notify)
- Wi-Fi Configuration (read/write)
  - SSID
  - Passphrase
  - Security Type
  - Configuration Port
  - Advertising Port
  - Enable
- GPS location (write only)
- Error Type (read/notify)
- Modify State (write only)
- Report event (read/write)
- Raw Data (read/write)

BRAINPACK PACKETS FORMAT

All protocol buffer serialized packets are sent wrapped in the following format. Also this wrapping format will be used in data saved to the SD card. It will allow the packets to be decoded even in the event of a corrupt save process.



There are two control bytes that can be used in this packet, the start byte and the escape byte which are 0xDF and 0xDE respectively. These bytes are used to ensure that the start byte is only used in one location, and if it appears in either the length or the payload it is escaped using the escape character. The escape character must also not appear in the length.

The escape procedure is as follows, if either the start byte or the escape byte is seen in the length or payload, the escape character is placed in the stream followed by the escaped byte with 0x10 added.

For example, The byte stream:

0x01	0x03	0xDE	0x02	0xDF
Byte 1	Byte 2	Byte 3 (needs to be escaped)	Byte 4	Byte 5 (needs to be escaped)

Will be sent as follows:

0xDF	0x00	0x05	0x01	0x03	0xDE	0xEE	0x02	0xDE	0xEF
Start	Length = 5		Byte 1	Byte 2	Byte 3 w/ escape		Byte 4	Byte 5 w/ escape	

PROTOCOL BUFFER PACKET TYPES

The below table describes all of the packet types used in the communication between the brainpack and the application.

Packet Type	Included Fields	Origin	Description
Status Request	N/A	App	Sent from the application to request the status of the brainpack
Status Response	Brainpack State firmware Version serial Number battery Level charge State	BP	Contains information about the brainpacks current state.
Set Wi-Fi Configuration	Wi-Fi Configuration SSID security Type passphrase Wi-Fi State UDP Broadcast Port connection Timeout	App	Contains all information needed to configure the brainpack to a Wi-Fi configuration.
Recordings List Request	N/A	App	Sent from the application to query the brainpacks list of un-synchronized calibration and recording files.
Recording List Response	Recordings Response Recordings Count Recordings Filenames Calibrations Count Calibrations Filenames	BP	Response to the recordings list request. Contains a listing of all the recordings and calibration files that need to be synchronized with the application.
File Download Request	File Download Download Endpoint Download Filename	App	Sent from the application to initiate a file upload from the brainpack to the application.
File Download Response	Message Status	BP	Sent from the brainpack when the file download has completed. Contains a Boolean representing the success of the file download (true = pass, false = fail)
Clear Brainpack Request	N/A	App	Sent from the application to clear the data on the brainpack. The brainpack will return a Message Status packet in response.
Calibration Request	N/A	App	Sent from the application to request that the brainpack run a calibration sequence.
Calibration Response	Calibration Filename Message Status	BP	Sent from the brainpack after a calibration cycle has completed. Contains the filename of the calibration, and also the status of how the calibration process went (true = pass, false = fail)
Start Data Stream	Recording Sampling Rate Recording Filename Recording ID Endpoint	App	Sent from the application to initiate a live data stream from the brainpack. Includes the endpoint where the DataStream should be directed along with the recording filename and data rate in Hz, and the recording unique ID to sync the stream recording with the application. Brainpack responds with a Message Status packet to indicate the success of starting the stream.
Stop Data Stream	N/A	App	Sent from the application to end a DataStream. Brainpack responds

			with a Message Status packet to indicate the success of the command.
Configure Recording Settings	Recording sampling Rate Recording Filename	App	Sent from the application to configure offline recordings.
Data Frame	FullDataFrame Timestamp Report Type GPS Coordinates Calibration Id imuDataFrame	BP	Sent from the brainpack and saved to file when it is making a recording. Contains sensor frame information and pain/concern reports.
Recording Information	Firmware Version BP Serial Number Date Time Recording sampling Rate Calibration Filename	BP	Sent from the brainpack and saved as the first frame of a data file to identify the recording/stream. This frame is also used to identify which calibration file should be used to properly process the recording.
Last Calibration Request	N/A	App	Sent from the application to request the filename for the last calibration performed on the brainpack.
Last Calibration Response	Calibration Filename Date Time	BP	Response to the last Calibration Request, the string is returned as NULL if no calibration has been performed on the brainpack. Also returns a Date Time string indicating when the last calibration was performed.
Advertising Packet	Firmware Version BP Serial Number Configuration Port	BP	This packet is sent when the brainpack first connects to a Wi-Fi network, it is used by the application to identify a new brainpack on the network. The configuration port is used by the brainpack to accept commands.
Update Firmware Request	Firmware Update Firmware Endpoint Firmware Filename	App	Sent from the application to initiate a firmware update of the brainpack. The brainpack will download the file from the application using the filename and endpoint information provided in the message.
Updated Firmware Response	Message Status	BP	Sent from the brainpack when the firmware has been downloaded and verified. If successful, the brainpack will restart and apply the new firmware.
Set Time Request	Date Time	App	Sent from the application to set the brainpacks on board clock. The brainpack responds with a Message Status packet.
Message Status	message Status	BP	General message status packet, contains a true/false value indicating the success of a received message.

PROTOCOL BUFFER FIELDS DESCRIPTION

The below table describes each of the fields found in the protocol buffer and how they are linked to specific packet types.

Name	Type	Member of	Description
type	Required enum	HeddokoPacket	The enumeration that determines what kind of packet it is. The types are listed below • Status Request • Status Response • Set Wi-Fi Configuration • Recordings List Request • Recording List Response • File Download Request • File Download Response • Clear Brainpack Request • Calibration Request • Calibration Response • Start Data Stream • Stop Data Stream • Configure Recording Settings • Data Frame • Recording Information • Last Calibration Request • Last Calibration Response • Advertising Packet • Update Firmware Request • Updated Firmware Response • Set Time Request • Message Status
Brainpack State	Optional enum	HeddokoPacket	Contains the current state of the brainpack • Initializing • Idle • Calibrating • Recording • Streaming • Syncing • Error Is populated in the status response packets.
Firmware Version	Optional String	HeddokoPacket	Contains a string with the current version of the brainpack. Is populated in the status response, recording information and advertising packets.
Serial Number	Optional String	HeddokoPacket	Contains a string with the factory set serial number of the brainpack. Is populated in the
Battery Level	Optional Uint32	HeddokoPacket	Contains the current brainpack battery level in percent (0-100). Is populated in status response packet.
Charge State	Optional enum	HeddokoPacket	Contains the current charger state of the brainpack. • Battery Low • Battery Nominal • Battery Full • Charging Is populated in the status response packet.
Message Status	Optional Bool	HeddokoPacket	Contains a general pass/fail response for various packets. Is populated in File Download Response, Calibration Response, Update

			Firmware Response, and Message Status Response Packets.
Calibration Filename	Optional String	HeddokoPacket	Contains a filename for a calibration file. Is populated in the Calibration Response, Recording Information and Last Calibration Response packets.
Recording sampling Rate	Optional Uint32	HeddokoPacket	Contains the recording rate that the brainpack should record at in Hz (30Hz to 120Hz). Is populated in the Recording Information, Configure Recording, and Start Data Stream packets.
Recording Filename	Optional String	HeddokoPacket	Is used to configure the recording filename root. Is populated in the Configure Recording and Start Data Stream packets.
Date Time	Optional String	HeddokoPacket	A string that contains a date and time stamp, in the format YYYY-MM-DDTHH:MM:SS (ex 2016-07-18T13:52:12) Is populated in the Recording Information and Set Time Request packets
Configuration Port	Optional Uint32	HeddokoPacket	Port that is opened when the brainpack is connected to a WIFI network. This port is used for configuration commands. Is populated in WIFI Configuration and Advertising Packet packets.
Sensor Mask	Optional Uint32	HeddokoPacket	It is a binary sensor mask that can be used to configure which sensor reading values should be recorded in each frame. Is populated in the Configure Recording Packet.
Wi-Fi Configuration	Optional Wi-Fi Configuration	HeddokoPacket	Contains all the Wi-Fi configuration parameters. Is populated in Set WIFI Configuration packet.
SSID	Required String	Wi-Fi Configuration	Contains the string for the SSID of a WIFI network. Is required in the Set WIFI Configuration packet.
security Type	Required Enum	Wi-Fi Configuration	Contains an enumeration representing the security type of a WIFI network. • WEP • WPA • Open Is required in the Set WIFI Configuration packet.
passphrase	Optional String	Wi-Fi Configuration	Contains a string representing the passphrase of a Wi-Fi network. Is only populated when the security type enumeration is either WEP or WPA. Is required in the Set WIFI Configuration packet.
Wi-Fi State	Required Bool	Wi-Fi Configuration	Enabled state of the WIFI on the brainpack. Set to true to enable WIFI and false to disable. Is required in the Set WIFI Configuration packet.
UDP Broadcast Port	Optional Uint32	Wi-Fi Configuration	Contains the UDP port that the brainpack should advertise its presence on when it connects to a WIFI network. If not populated and default port is used. Is populated as part of the Set WIFI Configuration packet.
Connection Timeout	Optional Uint32	Wi-Fi Configuration	Contains the number of seconds that the brainpack should attempt to connect to a WIFI network. Is populated as part of the Set WIFI Configuration packet.

Recordings Response	Optional Message	HeddokoPacket	Contains the list of filenames for the recordings response. Both the calibration and recordings files. Is populated in the List of Recordings Response packet.
Recordings Count	Required Uint32	Recordings Response	Contains a number of recordings that need to be synchronized to the application. Is required in the List of Recordings Response packet.
Recording Filename	Repeated String	Recordings Response	Contains a set of repeated strings representing the recording filenames on the brainpack that have not been synched to the app. Is populated in the List of Recordings Response packet
Calibration Files Count	Required Uint32	Recordings Response	Contains a number of calibration files that need to be synchronized to the application. Is required in the List of Recordings Response packet.
Calibrations Filenames	Repeated String	Recordings Response	Contains a set of repeated strings representing the calibration filenames on the brainpack that have not been synched to the app. Is populated in the List of Recordings Response packet
File Download	Optional File Download	HeddokoPacket	Contains the information needed by the brainpack to upload a file to the application. Including endpoint and filename. Is populated in the File Download Request packet
Download Endpoint	Required Endpoint	File Download	Contains the server address and port where a file should be uploaded to. Is required in the File Download Request packet
Download Filename	Required String	File Download	Contains the filename for the file that needs to be uploaded to the application. Is required in the File Download Request packet.
Firmware Update	Optional Firmware Update	HeddokoPacket	Contains the information needed by the brainpack to initiate the firmware update process. Including the location of the firmware file, and also the filename. Is populated in the Update Firmware Request packet.
FW Endpoint	Required Endpoint	Firmware Update	Contains the server address and port where the firmware file can be downloaded from. Is required in the Update Firmware Request packet.
FW Filename	Required String	Firmware Update	Contains the filename for the firmware file that needs to be downloaded from the application. Is required in the Update Firmware Request packet.
Full Data Frame	Optional FullDataFrame	HeddokoPacket	Data frame from the brainpack. Contains all sensor data and reporting information from the brainpack. Is populated in the Data Frame packet.
timestamp	Required Uint32	FullDataFrame	Uint32 representing the time (in ms) when the frame was captured. Is populated in the Data Frame packet.
Report Type	Optional Enum	FullDataFrame	Enumeration representing what type of reporting occurred. Pain Concern More types may be added later. This field will only be populated when one of the above events occurs. Is populated in the Data Frame packet.
GPS Coordinates	Optional String	FullDataFrame	String representing the GPS coordinates of the brainpack. This is used in conjunction with the report types. It is only populated when the

			brainpack is connected to a phone via BLE. This is where the GPS coordinates originate from. Is populated in the Data Frame packet.
Calibration Id	Optional Uint32	FullDataFrame	A number used for identifying what stage of the calibration the specific frame belongs to. This field is only populated when the recording type is calibration. Is populated in the Data Frame packet.
imuDataFrame	Repeated ImuDataFrame	FullDataFrame	Contains: • IMU ID • bit mask indicating which pieces of data are present • Quaternions 4x float32 • Mag 3x Int16 • Accel 3x Int16 • Gyro 3x Int16 This is a repeated item and exists for each sensor on the suit. Is populated in the Data Frame packet.
Server Address	Required String	Endpoint	The server address or IP address used for initializing a transfer between the brainpack and the app. Is populated in the File Download Request, Firmware Update Request, and Start Data Stream packets.
Port	Required Uint32	Endpoint	The port used for initializing a transfer between the brainpack and the app. Is populated in the File Download Request, Firmware Update Request, and Start Data Stream packets.
Endpoint	Optional Endpoint	HeddokoPacket	Endpoint used when configuring the live data stream. Is populated in the Start Data Stream packet.
Protocol Version	Optional String	HeddokoPacket	Version of the protocol used in the brainpack

APPLICATION DATA

DATA PROCESSING PIPELINE

BODY

- Body ID
- Body Type
- Related Kit ID
- Related User ID
- Related Calibration ID
- List of body Segments
- Current Body Frame
- Initial Body Frame

BODY SEGMENT

- Body segment type
- Related parent body ID
- List of body sub segments

BODY SUB SEGMENT

- Body Sub Segment Type
- Sub Segment Orientation (4x float32)
- Sub Segment Position (3x float32)
- List of Related Sensors IDs

BODY TYPES

- Full Body
- Upper Body only
- Lower Body only
- Limbs only
- Trunk only

SEGMENT TYPES

- Trunk
- Right Arm
- Left Arm
- Right Leg
- Left Leg

SUB SEGMENT TYPES

- Upper Spine
- Lower Spine
- Right Upper Arm
- Right Forearm
- Left Upper Arm
- Left Forearm
- Right Thigh
- Right Lower Leg
- Left Thigh
- Left Lower leg

BODY SENSORS POSITIONS

- Upper Spine
- Lower Spine
- Right Upper Arm
- Right Forearm
- Left Upper Arm
- Left Forearm
- Right Thigh
- Right Calf
- Left Thigh
- Left Calf
- Right Elbow
- Left Elbow
- Right Knee
- Left Knee

SENSORS TYPES

- Biomech
- Flexcore

BODY RAW FRAME

- Related Kit ID (is it necessary?)
- Related User ID (is it necessary?)
- Related Recording ID (is it necessary?)
- Related Calibration ID (is it necessary?)
- Related Body ID (is it necessary?)
- Frame Size (int32)
- Proto Packet = Brainpack Data Frame (protobuf format)

BODY FRAME

- Timestamp
- List of converted orientations: (Sensor Id / Position, 4x Float 32)
- List of mapped orientations: (Sensor Id / Position, 4x Float 32)
- List of fused orientations: (Sensor Id / Position, 4x Float 32)
- Raw Frame data
- Frame analysis data
- Related Kit ID (is it necessary?)
- Related User ID (is it necessary?)
- Related Recording ID (is it necessary?)
- Related Calibration ID (is it necessary?)
- Related Body ID (is it necessary?)
- Frame Type

REPORT EVENT

- Timestamp
- Event Type
- Geolocation
- Related sub segment Type
- Comments

FRAMES TYPES

- Raw Recording frame
- Processed Recording frame
- Calibration frame
- Analysis frame

REPORTING EVENT TYPES

- Pain event
- Concern event

RECORDING DATA

- Recording ID
- Related Kit ID
- Related User ID
- Related Recording ID
- Related Calibration ID
- Related Body ID
- Recording Creation time
- Recording file name
- Number of raw frames
- List of tags (strings)
- List of raw frames
- Recording Processed?

CALIBRATION DATA

- Calibration ID
- Related Kit ID
- Related User ID
- Related Recording ID
- Related Body ID
- Calibration Creation time
- Calibration file name
- Number of calibration sequences
- List of calibration sequences
    - Number of raw frames per sequence
    - List of frames per sequence

USERS DATA

- User ID
- User Name
- User Password
- User Role
- User email
- Related Kit ID
- Related License ID
- Related Org ID
- Physical information
    - Weight
    - Height
    - Gender
    - DOB
    - Package weight handled
    - Years with company
    - Shift time

ANALYSIS DATA SETTINGS

TRUNK FLEXION/EXTENSION CATEGORIES

- Extension
- Neutral
- Slight
- Moderate
- Severe

TRUNK TWISTING CATEGORIES

- Neutral
- Moderate
- Severe

TRUNK THRESHOLDS

- Trunk Extension threshold
- Trunk Neutral flexion threshold
- Trunk Min/Max slight flexion threshold
- Trunk Min/Max Moderate flexion threshold
- Trunk Min/Max Severe flexion threshold
- Trunk twisting threshold
- Trunk neutral twisting threshold
- Trunk Min/Max Moderate twisting threshold
- Trunk Min/Max Severe twisting threshold
- Trunk movement frequency threshold
- Trunk hold range
- Trunk hold time threshold

SHOULDER FLEXION/EXTENSION CATEGORIES

- Category 1 (-20° to 20°)
- Category 2 (< -20°)
- Category 3 (+20° to +45°)
- Category 4 (+45° to +90°)
- Category 5 (>+90°)

SHOULDER THRESHOLDS

- Shoulder Min/Max Category 1 flexion threshold
- Shoulder Min/Max Category 2 flexion threshold
- Shoulder Min/Max Category 3 flexion threshold
- Shoulder Min/Max Category 4 flexion threshold
- Shoulder Min/Max Category 5 flexion threshold
- Shoulder abduction threshold
- Shoulder Internal/External rotation threshold
- Shoulder hold range
- Shoulder hold time threshold

ELBOW FLEXION/EXTENSION CATEGORIES

- Category 1 (60° to 100°)
- Category 2 (0° to 60°)
- Category 3 (>100°)

ELBOW THRESHOLDS

- Elbow Min/Max Category 1 flexion threshold
- Elbow Min/Max Category 2 flexion threshold
- Elbow Min/Max Category 3 flexion threshold
- Elbow Pronation/Supination Threshold
- Elbow hold range
- Elbow hold time threshold

HAND POSITION AREAS

- Between shoulder height and 1m from floor
- Higher than shoulder height
- Lower than 1m from the floor

KNEE FLEXION CATEGORIES

- Category 1 (30° to 60°)
- Category 2 (>60°)

KNEE/HIPS THRESHOLDS

- Knee Min/Max Category 1 flexion threshold
- Knee Min/Max Category 2 flexion threshold
- Knee hold range
- Knee hold time threshold
- Hips hold range
- Hips hold time threshold

LEGS ASYMMETRY CATEGORIES

- Legs and feet are well supported and in an evenly balanced posture
- Legs and feet are not evenly balanced and supported

ANALYSIS DATA

ANALYSIS DATA PER FRAME

- Global indicators for posture
  - Elbows close to body
  - Knees bent while lifting
  - Trunk in neutral position
  - Trunk lateral bent
  - Trunk twisted
  - Knees unlocked during standing activities
  - Holding load close to body
  - Wide base of support
  - Shoulder raised
- Approximate location of center of mass
- Trunk Flexion/Extension angle
- Trunk Twisting angle
- Trunk Lateral Flexion angle
- Trunk Flexion/Extension category
- Trunk Twisting category
- Trunk Flexion/Extension angular velocity
- Trunk Twisting angular velocity
- Trunk Lateral Flexion angular velocity
- Trunk Flexion/Extension angular acceleration
- Trunk Twisting angular acceleration
- Trunk Lateral Flexion angular acceleration
- Shoulder Flexion/Extension angle
- Shoulder Abduction angle
- Shoulder Internal/External angle
- Shoulder Flexion/Extension Category
- Shoulder Abduction Boolean
- Shoulder Internal/External Boolean
- Shoulder Flexion/Extension angular velocity
- Shoulder abduction angular velocity
- Shoulder Internal/External angular velocity
- Shoulder Flexion/Extension angular acceleration
- Shoulder abduction angular acceleration
- Shoulder Internal/External angular acceleration
- Elbow Flexion/Extension angle
- Forearm Pronation/Supination angle
- Elbow Flexion/Extension angular velocity
- Elbow Pronation/Supination angular velocity
- Elbow Flexion/Extension angular acceleration
- Forearm Pronation/Supination angular acceleration
- Hand distance from center of mass
- Hand/elbow position area
- Hips flexion angle
- Hips Abduction angle
- Hips rotation angle
- Hips flexion angular velocity
- Hips Abduction angular velocity
- Hips rotation angular velocity
- Hips flexion angular acceleration
- Hips Abduction angular acceleration
- Hips rotation angular acceleration
- Knee flexion angle
- Knee flexion angular velocity
- Knee flexion angular acceleration
- Knee flexion category
- Legs Asymmetry category
- RULA/REBA Trunk score
- RULA/REBA Left Arm score
- RULA/REBA Right Arm score
- RULA/REBA Left Leg score
- RULA/REBA Right Leg score
- Full body RULA/REBA score
- Ergo Score

ANALYSIS DATA PER RANGE OF FRAMES

- Range of (Max/min) trunk angles
- Range of (Max/min) elbow flexion
- Range of (Max/min) shoulder angles
- Range of (Max/min) knee flexion
- Range of (Max/min) hip angles
- Average RULA/REBA body score
- Average RULA/REBA Trunk score
- Average RULA/REBA Left Arm score
- Average RULA/REBA Right Arm score
- Average RULA/REBA Left Leg score
- Average RULA/REBA Right Leg score
- Min/Max RULA/REBA body score
- Min/Max RULA/REBA Trunk score
- Min/Max RULA/REBA Left arm score
- Min/Max RULA/REBA Right arm score
- Min/Max RULA/REBA Left leg score
- Min/Max RULA/REBA Right leg score
- % per Trunk flexion/extension category
- % of trunk twisting
- % per trunk twisting category
- % of trunk lateral flexion
- % per Shoulder Flexion/Extension Category
- % of Shoulder Abduction
- % of Shoulder Internal/External
- % per elbow Flexion category

- % per Hand position area
- % per Knee Flexion category
- Frequency per range of trunk angles
- Number of rapid trunk changes per direction
- Number of trunk acceleration spikes per direction
- Peak trunk velocity per direction
- Average trunk velocity per direction
- Frequency per range of shoulder angles
- Number of rapid shoulder changes per direction
- Number of shoulder acceleration spikes per direction
- Peak shoulder velocity per direction
- Average shoulder velocity per direction
- Frequency per range of elbow flexion
- Number of rapid elbow flexion changes
- Number of elbow flexion acceleration spikes
- Peak elbow flexion velocity
- Average elbow flexion velocity
- Average Hand distance from center of mass
- Min/Max Hand distance from center of mass
- Frequency per range of knee flexion
- Number of rapid knee flexion changes
- Number of knee flexion acceleration spikes
- Peak knee flexion angular velocity
- Average knee flexion angular velocity
- List of events of Trunk hold for more than threshold time within hold range
- List of events of Shoulder hold for more than threshold time within hold range
- List of events of Elbow hold for more than threshold time within hold range
- List of events of Knee hold for more than threshold time within hold range
- List of events of Hips hold for more than threshold time within hold range
- Total number of reported events per sub segment
- Average Ergo Score

OTHER POSTURE ANALYSIS (NOT INCLUDED BUT FOR FUTURE REFERENCES)

- Vibrations detection
- Load on L5/S1
    - Moment (Nm)
    - Compressive force (N)
    - Comparison to NIOSH thresholds