libgac

v0.2.2

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Chapter 1

GAC - Gaze Analysis C Library

This is a pure C library to perform basic gaze analysis.

Features:

- Sample filtering with moving average
- Sample gap fill-in through linear interpolation (lerp)
- Fixation detection with I-DT algorithm
- Saccade detection with I-VT algorithm
- Area of interest (AOI) analysis

Quick Start

Initialise the gaze analysis handler:

```
gac_t h;
gac_init( &h, NULL );
```

To perform an AOI analysis, add some AOIs to the gaze analysis handler:

```
gac_aoi_t aoi;
gac_aoi_init( &aoi, "my_circular_aoi" );
gac_aoi_add_point( &aoi, 0.5, 0.4 );
gac_aoi_add_point( &aoi, 0.5, 0.3 );
gac_aoi_add_point( &aoi, 0.6, 0.2 );
gac_aoi_add_point( &aoi, 0.7, 0.2 );
gac_aoi_add_point( &aoi, 0.8, 0.3 );
gac_aoi_add_point( &aoi, 0.8, 0.4 );
gac_aoi_add_point( &aoi, 0.7, 0.5 );
gac_aoi_add_point( &aoi, 0.6, 0.5 );
gac_add_aoi( &h, &aoi );
gac_aoi_init( &aoi, "my_rectangular_aoi" );
gac_aoi_add_rect( &aoi, 0.3, 0.45, 0.1, 0.1 );
gac_add_aoi( &h, &aoi );
```

To parse gaze data for fixations and saccades, for each new sample do the following:

```
int i, count;
bool res;
gac_fixation_t fixation;
gac_saccade_t saccade;
gac_aoi_collection_analysis_result_t analysis;
// update the sample window with data.
count = gac_sample_window_update( &h, sample.origin.x, sample.origin.y,
        sample.oridin.z, sample.point.x, sample.point.y, sample.point.z,
        sample.timestamp );
// updating the sample window may add multiple new samples (due to gap
// filtering). Hence, we need to filter for each sample added.
```

```
for( i = 0; i < count; i++ )
{
    // check for saccade
    res = gac_sample_window_saccade_filter( &h, &saccade );
    if( res == true )
    {
        // perform AOI analysis on saccade data
        gac_aoi_collection_analyse_saccade( &h.aoic, &saccade );
        // saccade structures must be destroyed once they are no longer needed.
        gac_saccade_destroy( &saccade );
    }
    // check for fixation
    res = gac_sample_window_fixation_filter( &h, &fixation );
    if( res == true )
    {
        // perform AOI analysis on fixation data.
        res = gac_aoi_collection_analyse_fixation( &h->aoic, &fixation,
                &analysis );
        if( res == true )
        {
            // An AOI analysis entry is ready, do something with the analysis
            // data
        }
        // fixation structures must be destroyed once they are no longer needed.
        gac_fixation_destroy( &fixation );
    }
    // remove samples from the sample window which are no longer used
    gac_sample_window_cleanup( h );
}
```

After all samples were analysed, a finalization step is required to conclude the AOI analysis:

```
bool res = gac_finalise( &h, &analysis );
if( res )
{
    // An AOI analysis entry is ready, do something with the analysis data
}
```

Finally, destroy the gaze analysis handler:

```
gac_destroy( &h );
```

Basic Concept

The library provides several functions to work with gaze data. The easiest approach is to use the functions `gac_sample_window_*` as these maintain their own sample window and noise and gap filters can be configured through the `gac_filter_paramter_t` structure.

Alternatively it is possible to manually maintain a sample window and work with each filter individually. This means filter structures have to be created and destroyed manually and filtering has to be applied manually to a custom sample window. Refer to the API for more information.

Detection Algorithm

Fixations are detected with the I-DT algorithm (Salvucci & Goldberg 2000). Saccades are detected with the I-VT algorithm (Salvucci & Goldberg 2000).

Note that the resulting fixations and saccades will **not** fit together perfectly (e.g. a saccade follows a fixation and vice versa) because

1. both algorithms work with their own parameters which will most likely lead to gaps (data which is neither classified as part of a fixation nor saccade)
2. gaze data may be a recording of a smooth pursuit
3. gaps in the gaze data because of blinks or other data loss

For more details on the filter parameter options refer to the API documentation.

Filters

Optionally the gaze data is processed by

1. a moving average filter which computes the average of all samples in the filters own sliding window. Sample annotations (e.g. the label, trial ID, and timestamps) are copied from the data sample in the middle of the sliding window.
2. a gap fill-in filter where data samples are filled into gaps using linear interpolation.

For more details on the filter parameter options refer to the API documentation.

3d vs 2d Data

All calculations are performed on 3d data. If only 2d data is available this library cannot be used (yet). The reason for this is that with 3d data it is possible to compute an accurate dispersion and velocity threshold based on the distance of the gaze origin to the gaze point. For 2d data the dispersion and velocity threshold would need to be estimated based on the measured data which is not (yet) supported by the library.

However, it is possible to provide 2d data alongside 3d data for each data sample which will propagated to fixation and saccade result structures. To add 2d data for each sample instead of the function `gac_sample_window_update()` use `gac_sample_window_update_screen()`.

If 2d data is not available it is possible to compute it from 3d data. `gac_sample_window_update()` does this automatically if the screen location is defined. To define the screen location use the function `gac_set_screen()`.

Sample annotations

Each sample has two fields available for custom data annotation:

- `trial_id`: expects an integer number and can be used to e.g. associate a data point to a trial.
- `label`: expects a string and can be used to e.g. describe the currently displayed stimuli.

The annotations are propagated to the fixation and saccade result structures.

Further, each sample has two additional timestamp fields for onset information of the annotations:

- `trial_onset`: the amount of milliseconds since the last change in the field `trial_id`.
- `label_onset`: the amount of milliseconds since the last change in the field `label`.

Area of Interest (AOI) Analysis

The area of interest (AOI) analysis is performed based on fixations. Saccade information can also be used to extend the analysis but fixations are always required. For each distinct trial ID block an analysis of each AOI is performed.

To decide whether a sample point is inside an AOI a ray casting method is used where a virtual ray is drawn from an arbitrary point outside the AOI to the sample point. Then, every intersection with segments of the AOI contour is counted. If an even number of intersection is detected, the point lies outside of the AOI, otherwise the point lies inside the AOI. To improve performance, a coarse detection using a rectangular a bounding box is performed (if the sample point lies outside the bounding box it also lies outside the AOI).

Building the library on Linux (Ubuntu)

In order to build the library the following packages are required:

```
sudo apt install build-essential
sudo apt install autoconf autogen libtool
```

To build the library use the commands

```
autoreconf --install
./configure
make
```

To build and run tests use

```
cd test
make
```

To build and run the example use

```
cd example
make
make run
```

Building the library on Windows

Build the library on windows with `msys2`. Once installed start `msys2.exe`.

Some dependencies need to be installed. To do this type the following commands:

```
pacman -Syyu
pacman -Sy mingw-w64-x86_64-gcc
pacman -Sy autogen autoconf automake libtool
```

Finally, to build the library type

```
make
```

Build the example with the following commands:

```
cd example
make
```

To run the example make sure that the system knows the location of `msys2.dll` (either by adding the location to the PATH or by copying the file to the example folder). Run the example by starting `example.exe`.

Chapter 2

Changelog

`v0.2.2` (latest)

New Features

- Add helper functions to compute timestamps and onsets.

Improvements

- Add non-rectangular AOI to the example.
- Improve reported AOI timestamp information.

Bug Fixes

- Fix trial ID and label onset calculations.

`v0.2.1`

Improvements

- Add aoic structure to gaze handler.

Bug Fixes

- Fix memory leak.

`v0.2.0`

New Features

- Add support for screen resolution (internally 2d coordinates are still stored as normalized values).
- Allow to define area of interests (AOI) and perform a basic analysis based on fixations and saccades.

Improvements

- Add MPL license.
- Add this changelog.
- Use a minimalistic include approach with cglm instead of including everything.
- Split code into individual file pairs (.c and .h) to separate concerns.

Bug Fixes

- Fix doxygen configuration.

`v0.1.1`

Initial release.

Chapter 3

Data Structure Index

3.1 Data Structures

Here are the data structures with brief descriptions:

Chapter 4

File Index

4.1 File List

Here is a list of all documented files with brief descriptions:

Chapter 5

Data Structure Documentation

5.1 gac_aoi_analysis_t Struct Reference

```
#include <gac_aoi_analysis.h>
```

Data Fields

- void ∗ _me
- uint32_t aoi_visited_before_count
- uint32_t fixation_count
- uint32_t enter_saccade_count
- double fixation_count_relative
- double dwell_time
- double dwell_time_relative
- gac_fixation_t first_fixation
- gac_saccade_t first_saccade

5.1.1 Detailed Description

A structure holding the AOI analysis results.
gac_aoi_analysis_s

5.1.2 Field Documentation

5.1.2.1 _me

```
void* gac_aoi_analysis_t::_me
```

Self-pointer to allocated structure for memory management.

5.1.2.2 aoi_visited_before_count

```
uint32_t gac_aoi_analysis_t::aoi_visited_before_count
```

The number of different AOIs visited before the first fixation hit this AOI.

5.1.2.3 dwell_time

```
double gac_aoi_analysis_t::dwell_time
```

The sum of all fixation durations on the AOI.

5.1.2.4 dwell_time_relative

`double gac_aoi_analysis_t::dwell_time_relative`

The relative trial time spent on the AOI. `1` is the sum of all fixation durations within the trial interest period. The trial interest period corresponds to all samples with the same trial ID.

5.1.2.5 enter_saccade_count

`uint32_t gac_aoi_analysis_t::enter_saccade_count`

The number of saccades entering the AOI.

5.1.2.6 first_fixation

`gac_fixation_t gac_aoi_analysis_t::first_fixation`

The first fixation on the AOI.

5.1.2.7 first_saccade

`gac_saccade_t gac_aoi_analysis_t::first_saccade`

The first saccade on the AOI.

5.1.2.8 fixation_count

`uint32_t gac_aoi_analysis_t::fixation_count`

The number of fixations in this AOI.

5.1.2.9 fixation_count_relative

`double gac_aoi_analysis_t::fixation_count_relative`

The relative number of fixations in this AOI where `1` is the number of all fixations within the trial interest period. The trial interest period corresponds to all samples with the same trial ID.

The documentation for this struct was generated from the following file:

- include/gac_aoi_analysis.h

5.2 gac_aoi_collection_analysis_result_t Struct Reference

`#include <gac_aoi_collection_analysis.h>`

Data Fields

- void ∗ _me
- struct {
  struct {
  char **label** [GAC_AOI_MAX_LABEL_LEN]
  gac_aoi_analysis_t **analysis**
  } items [GAC_AOI_MAX]
  uint32_t count
  } aois
- uint32_t trial_id

5.2.1 Detailed Description

A collection of AOIs.

gac_aoi_collection_analysis_result_s

5.2.2 Field Documentation

5.2.2.1 _me

`void* gac_aoi_collection_analysis_result_t::_me`

Self-pointer to allocated structure for memory management.

5.2.2.2 aois

`struct { ... } gac_aoi_collection_analysis_result_t::aois`

The collection of individual AOIs.

5.2.2.3 count

`uint32_t gac_aoi_collection_analysis_result_t::count`

The number of AOIs in the list.

5.2.2.4 items

`struct { ... } gac_aoi_collection_analysis_result_t::items[GAC_AOI_MAX]`

The aoi analysis list.

5.2.2.5 trial_id

`uint32_t gac_aoi_collection_analysis_result_t::trial_id`

The trial ID associated to the analysis.

The documentation for this struct was generated from the following file:

- include/gac_aoi_collection_analysis.h

5.3 gac_aoi_collection_analysis_t Struct Reference

`#include <gac_aoi_collection_analysis.h>`

Data Fields

- void ∗ _me
- uint32_t fixation_count
- uint32_t aoi_visited_count
- uint32_t trial_id
- double dwell_time

5.3.1 Detailed Description

The AOI collection analysis data structure.

gac_aoi_collection_analysis_s

5.3.2 Field Documentation

5.3.2.1 _me

`void* gac_aoi_collection_analysis_t::_me`

Self-pointer to allocated structure for memory management.

5.3.2.2 aoi_visited_count

`uint32_t gac_aoi_collection_analysis_t::aoi_visited_count`

The number of visited aois.

5.3.2.3 dwell_time

```
double gac_aoi_collection_analysis_t::dwell_time
```

The summed duration of all fixations.

5.3.2.4 fixation_count

```
uint32_t gac_aoi_collection_analysis_t::fixation_count
```

The total fixation count.

5.3.2.5 trial_id

```
uint32_t gac_aoi_collection_analysis_t::trial_id
```

A number distingiushing one trial from another
The documentation for this struct was generated from the following file:

- include/gac_aoi_collection_analysis.h

5.4 gac_aoi_collection_t Struct Reference

```
#include <gac_aoi_collection.h>
```

Data Fields

- void ∗ _me
- struct {
  gac_aoi_t ∗ **ptrs** [GAC_AOI_MAX]
  gac_aoi_t items [GAC_AOI_MAX]
  uint32_t count
  } aois
- gac_aoi_collection_analysis_t analysis

5.4.1 Detailed Description

A collection of AOIs.
gac_aoi_collection_s

5.4.2 Field Documentation

5.4.2.1 _me

```
void* gac_aoi_collection_t::_me
```

Self-pointer to allocated structure for memory management.

5.4.2.2 analysis

```
gac_aoi_collection_analysis_t gac_aoi_collection_t::analysis
```

The analysis data of the AOI collection.

5.4.2.3 aois

```
struct { ... } gac_aoi_collection_t::aois
```

The collection of individual AOIs.

5.4.2.4 count

`uint32_t gac_aoi_collection_t::count`

The number of AOIs in the list.

5.4.2.5 items

`gac_aoi_t gac_aoi_collection_t::items[GAC_AOI_MAX]`

The aoi list.

The documentation for this struct was generated from the following file:

- include/gac_aoi_collection.h

5.5 gac_aoi_t Struct Reference

`#include <gac_aoi.h>`

Data Fields

- void * _me
- vec2 ray_origin
- float avg_edge_len
- float resolution_x
- float resolution_y
- char label [GAC_AOI_MAX_LABEL_LEN]
- struct {
  vec2 items [GAC_AOI_MAX_POINTS]
  uint32_t count
  } points
- struct {
  float **x_min**
  float **x_max**
  float **y_min**
  float **y_max**
  } bounding_box
- gac_aoi_analysis_t analysis

5.5.1 Detailed Description

An area of interest (AOI) structure.

gac_aoi_s

5.5.2 Field Documentation

5.5.2.1 _me

`void* gac_aoi_t::_me`

Self-pointer to allocated structure for memory management.

5.5.2.2 analysis

`gac_aoi_analysis_t gac_aoi_t::analysis`

The analysis data of the AOI.

5.5.2.3 avg_edge_len

```
float gac_aoi_t::avg_edge_len
```

The average length of an AOI edge.

5.5.2.4 bounding_box

```
struct { ... } gac_aoi_t::bounding_box
```

A axis aligned bounding box to quickly do a coars check if a point is outside the polygon.

5.5.2.5 count

```
uint32_t gac_aoi_t::count
```

The number of points defining the AOI.

5.5.2.6 items

```
vec2 gac_aoi_t::items[GAC_AOI_MAX_POINTS]
```

The point list.

5.5.2.7 label

```
char gac_aoi_t::label[GAC_AOI_MAX_LABEL_LEN]
```

A label describing the aoi.

5.5.2.8 points

```
struct { ... } gac_aoi_t::points
```

The points forming the AOI. At least 3 points are required for a valid AOI.

5.5.2.9 ray_origin

```
vec2 gac_aoi_t::ray_origin
```

An arbitary point outside the AOI.

5.5.2.10 resolution_x

```
float gac_aoi_t::resolution_x
```

The width of the screen resolution.

5.5.2.11 resolution_y

```
float gac_aoi_t::resolution_y
```

The height of the screen resolution.

The documentation for this struct was generated from the following file:

- include/gac_aoi.h

5.6 gac_filter_fixation_t Struct Reference

```
#include <gac_filter_fixation.h>
```

Data Fields

- void * _me
- double normalized_dispersion_threshold
- double duration_threshold
- bool is_collecting
- gac_queue_t window

- uint32_t new_samples
- double duration
- vec2 screen_point
- vec3 point

5.6.1 Detailed Description

The fixation filter structure holding filter parameters.
gac_filter_fixation_s

5.6.2 Field Documentation

5.6.2.1 _me

`void* gac_filter_fixation_t::_me`
Self-pointer to allocated structure for memory management.

5.6.2.2 duration

`double gac_filter_fixation_t::duration`
The fixation duration

5.6.2.3 duration_threshold

`double gac_filter_fixation_t::duration_threshold`
The duration threashold

5.6.2.4 is_collecting

`bool gac_filter_fixation_t::is_collecting`
A flag indicating whether a fixation is ongoing.

5.6.2.5 new_samples

`uint32_t gac_filter_fixation_t::new_samples`
Counter to keep track of new items in the parent queue.

5.6.2.6 normalized_dispersion_threshold

`double gac_filter_fixation_t::normalized_dispersion_threshold`
The pre-computed dispersion threshold at unit distance

5.6.2.7 point

`vec3 gac_filter_fixation_t::point`
The fixation point

5.6.2.8 screen_point

`vec2 gac_filter_fixation_t::screen_point`
The fixation screen point

5.6.2.9 window

`gac_queue_t gac_filter_fixation_t::window`
A pointer to the sample queue
The documentation for this struct was generated from the following file:

- include/gac_filter_fixation.h

5.7 gac_filter_gap_t Struct Reference

```
#include <gac_filter_gap.h>
```

Data Fields

- void * _me
- bool is_enabled
- double max_gap_length
- double sample_period

5.7.1 Detailed Description

The gap fill-in filter structure.
gac_filter_gap_s

5.7.2 Field Documentation

5.7.2.1 _me

```
void* gac_filter_gap_t::_me
```

Self-pointer to allocated structure for memory management.

5.7.2.2 is_enabled

```
bool gac_filter_gap_t::is_enabled
```

A flag indicating whether the filter is active or not

5.7.2.3 max_gap_length

```
double gac_filter_gap_t::max_gap_length
```

The maximal allowed gap length to be filled-in

5.7.2.4 sample_period

```
double gac_filter_gap_t::sample_period
```

The sample period to compute the number of required fill-in samples
The documentation for this struct was generated from the following file:

- include/gac_filter_gap.h

5.8 gac_filter_noise_t Struct Reference

```
#include <gac_filter_noise.h>
```

Data Fields

- void * _me
- bool is_enabled
- gac_queue_t window
- uint32_t mid
- gac_filter_noise_type_t type

5.8.1 Detailed Description

The noise filter parameters.
gac_filter_noise_s

5.8.2 Field Documentation

5.8.2.1 _me

`void* gac_filter_noise_t::_me`

Self-pointer to allocated structure for memory management.

5.8.2.2 is_enabled

`bool gac_filter_noise_t::is_enabled`

A flag indicating whether the noise filter is active or not

5.8.2.3 mid

`uint32_t gac_filter_noise_t::mid`

The mid-point counter

5.8.2.4 type

`gac_filter_noise_type_t gac_filter_noise_t::type`

The noise filter type

5.8.2.5 window

`gac_queue_t gac_filter_noise_t::window`

The noise filter window

The documentation for this struct was generated from the following file:

- include/gac_filter_noise.h

5.9 gac_filter_parameter_t Struct Reference

`#include <gac.h>`

Data Fields

- void ∗ _me
- struct {
  double max_gap_length
  double sample_period
  } gap
- struct {
  gac_filter_noise_type_t type
  uint32_t mid_idx
  } noise
- struct {
  float velocity_threshold
  } saccade
- struct {
  double duration_threshold
  float dispersion_threshold
  } fixation

5.9.1 Detailed Description

The filter parameter structure to initialise the gaze analysis handeler.
gac_filter_parameter_s

5.9.2 Field Documentation

5.9.2.1 _me

`void* gac_filter_parameter_t::_me`
Self-pointer to allocated structure for memory management.

5.9.2.2 dispersion_threshold

`float gac_filter_parameter_t::dispersion_threshold`
The dispersion threshold in degrees.

5.9.2.3 duration_threshold

`double gac_filter_parameter_t::duration_threshold`
The duration threshold in milliseconds.

5.9.2.4 fixation

`struct { ... } gac_filter_parameter_t::fixation`
Fixation detection.

5.9.2.5 gap

`struct { ... } gac_filter_parameter_t::gap`
The gap filter parameter

5.9.2.6 max_gap_length

`double gac_filter_parameter_t::max_gap_length`
The maximal allowed gap length to be filled-in. Set to zero to disable gap fill-in filter.

5.9.2.7 mid_idx

`uint32_t gac_filter_parameter_t::mid_idx`
The mid index of the window. This is used to compute the length of the window: window_length = mid_idx $*$ 2 + 1. Set to zero to disable noise filtering.

5.9.2.8 noise

`struct { ... } gac_filter_parameter_t::noise`
Noise filter parameter

5.9.2.9 saccade

`struct { ... } gac_filter_parameter_t::saccade`
Saccade detection.

5.9.2.10 sample_period

`double gac_filter_parameter_t::sample_period`
The sample period to compute the number of required fill-in samples

5.9.2.11 type

`gac_filter_noise_type_t gac_filter_parameter_t::type`
The noise filter type.

5.9.2.12 velocity_threshold

`float gac_filter_parameter_t::velocity_threshold`
The velocity threshold in degrees per seconds.
The documentation for this struct was generated from the following file:

- include/gac.h

5.10 gac_filter_saccade_t Struct Reference

`#include <gac_filter_saccade.h>`

Data Fields

- void ∗ _me
- float velocity_threshold
- bool is_collecting
- uint32_t new_samples
- gac_queue_t window

5.10.1 Detailed Description

The saccade filter structure holding filter parameters.
gac_filter_saccade_s

5.10.2 Field Documentation

5.10.2.1 _me

`void∗ gac_filter_saccade_t::_me`
Self-pointer to allocated structure for memory management.

5.10.2.2 is_collecting

`bool gac_filter_saccade_t::is_collecting`
A flag indicating whether a saccade is ongoing

5.10.2.3 new_samples

`uint32_t gac_filter_saccade_t::new_samples`
Counter to keep track of new items in the parent queue.

5.10.2.4 velocity_threshold

`float gac_filter_saccade_t::velocity_threshold`
The velocity threshold

5.10.2.5 window

`gac_queue_t gac_filter_saccade_t::window`
A pointer to the sample queue
The documentation for this struct was generated from the following file:

- include/gac_filter_saccade.h

5.11 gac_fixation_t Struct Reference

```
#include <gac_fixation.h>
```

Data Fields

- void ∗ _me
- vec2 screen_point
- vec3 point
- double duration
- gac_sample_t first_sample

5.11.1 Detailed Description

A fixation sample.
gac_fixation_s

5.11.2 Field Documentation

5.11.2.1 _me

```
void* gac_fixation_t::_me
```

Self-pointer to allocated structure for memory management.

5.11.2.2 duration

```
double gac_fixation_t::duration
```

The fixation duration in milliseconds.

5.11.2.3 first_sample

```
gac_sample_t gac_fixation_t::first_sample
```

The first sample of the fixation.

5.11.2.4 point

```
vec3 gac_fixation_t::point
```

The fixation gaze point.

5.11.2.5 screen_point

```
vec2 gac_fixation_t::screen_point
```

The 2d fixation gaze point on the screen.
The documentation for this struct was generated from the following file:

- include/gac_fixation.h

5.12 gac_plane_t Struct Reference

```
#include <gac_plane.h>
```

Data Fields

- void ∗ _me
- vec3 p1
- vec3 p2
- vec3 p3
- vec3 e1
- vec3 e2
- vec3 norm
- mat4 m

5.12.1 Detailed Description

A genaral plane definition.
gac_plane_s

5.12.2 Field Documentation

5.12.2.1 _me

`void* gac_plane_t::_me`
Self-pointer to allocated structure for memory management.

5.12.2.2 e1

`vec3 gac_plane_t::e1`
The vector pointing from p1 to p2.

5.12.2.3 e2

`vec3 gac_plane_t::e2`
The vector pointing from p1 to p3.

5.12.2.4 m

`mat4 gac_plane_t::m`
Transformation matrix to transform a 3d gaze point to a 2d gaze point.

5.12.2.5 norm

`vec3 gac_plane_t::norm`
The normal of the screen surface.

5.12.2.6 p1

`vec3 gac_plane_t::p1`
A point on the plane 3d space.

5.12.2.7 p2

`vec3 gac_plane_t::p2`
A point on the plane 3d space.

5.12.2.8 p3

```
vec3 gac_plane_t::p3
```

A point on the plane 3d space.

The documentation for this struct was generated from the following file:

- include/gac_plane.h

5.13 gac_queue_item_t Struct Reference

```
#include <gac_queue.h>
```

Data Fields

- gac_queue_item_t ∗ next
- gac_queue_item_t ∗ prev
- void ∗ data

5.13.1 Detailed Description

A generic queue item.

gac_queue_item_s

5.13.2 Field Documentation

5.13.2.1 data

```
void∗ gac_queue_item_t::data
```

A pointer to the arbitrary data structure

5.13.2.2 next

```
gac_queue_item_t∗ gac_queue_item_t::next
```

A pointer to the next queue item (towards the head).

5.13.2.3 prev

```
gac_queue_item_t∗ gac_queue_item_t::prev
```

A pointer to the previous queue item (towards the tail).

The documentation for this struct was generated from the following file:

- include/gac_queue.h

5.14 gac_queue_t Struct Reference

```
#include <gac_queue.h>
```

Data Fields

- void ∗ _me
- gac_queue_item_t ∗ tail
- gac_queue_item_t ∗ head
- uint32_t count
- uint32_t length
- void(∗ rm)(void ∗)

5.14.1 Detailed Description

A generic queue structure.
gac_queue_s

5.14.2 Field Documentation

5.14.2.1 _me

`void* gac_queue_t::_me`
Self-pointer to allocated structure for memory management.

5.14.2.2 count

`uint32_t gac_queue_t::count`
The number of occupied spaces.

5.14.2.3 head

`gac_queue_item_t* gac_queue_t::head`
A pointer to the tail to write to

5.14.2.4 length

`uint32_t gac_queue_t::length`
The number of total available spaces

5.14.2.5 rm

`void( * gac_queue_t::rm) (void *)`
The handler to remove data items

5.14.2.6 tail

`gac_queue_item_t* gac_queue_t::tail`
A pointer to the head of the queue to read from.
The documentation for this struct was generated from the following file:

- include/gac_queue.h

5.15 gac_saccade_t Struct Reference

`#include <gac_saccade.h>`

Data Fields

- void * _me
- gac_sample_t first_sample
- gac_sample_t last_sample

5.15.1 Detailed Description

A saccade sample.
gac_saccade_s

5.15.2 Field Documentation

5.15.2.1 _me

`void* gac_saccade_t::_me`

Self-pointer to allocated structure for memory management.

5.15.2.2 first_sample

`gac_sample_t gac_saccade_t::first_sample`

The first sample of the saccade.

5.15.2.3 last_sample

`gac_sample_t gac_saccade_t::last_sample`

The last sample of the saccade.

The documentation for this struct was generated from the following file:

- include/gac_saccade.h

5.16 gac_sample_t Struct Reference

`#include <gac_sample.h>`

Data Fields

- void * _me
- uint32_t trial_id
- vec2 screen_point
- vec3 point
- vec3 origin
- double timestamp
- double trial_onset
- double label_onset
- char label [GAC_SAMPLE_MAX_LABEL_LEN]

5.16.1 Detailed Description

The gaze data sample.

gac_sample_s

5.16.2 Field Documentation

5.16.2.1 _me

`void* gac_sample_t::_me`

Self-pointer to allocated structure for memory management.

5.16.2.2 label

`char gac_sample_t::label[GAC_SAMPLE_MAX_LABEL_LEN]`

Arbitrary label to annotate the sample.

5.16.2.3 label_onset

`double gac_sample_t::label_onset`

The time in milliseconds since the last change of label.

5.16.2.4 origin

```
vec3 gac_sample_t::origin
```

The gaze origin.

5.16.2.5 point

```
vec3 gac_sample_t::point
```

The gaze point.

5.16.2.6 screen_point

```
vec2 gac_sample_t::screen_point
```

The 2d gaze point on the screen.

5.16.2.7 timestamp

```
double gac_sample_t::timestamp
```

The sample timestamp.

5.16.2.8 trial_id

```
uint32_t gac_sample_t::trial_id
```

The ID of a ongoing trial.

5.16.2.9 trial_onset

```
double gac_sample_t::trial_onset
```

The time in milliseconds since the last change of trial ID.

The documentation for this struct was generated from the following file:

- include/gac_sample.h

5.17 gac_screen_t Struct Reference

```
#include <gac_screen.h>
```

Data Fields

- void * _me
- float width
- float height
- float resolution_x
- float resolution_y
- vec2 origin
- gac_plane_t plane

5.17.1 Detailed Description

Screen definition of the eye tracker.
gac_screen_s

5.17.2 Field Documentation

5.17.2.1 _me

```
void* gac_screen_t::_me
```

Self-pointer to allocated structure for memory management.

5.17.2.2 height

```
float gac_screen_t::height
```

The height of the screen.

5.17.2.3 origin

```
vec2 gac_screen_t::origin
```

The screen origin in 2d space.

5.17.2.4 plane

```
gac_plane_t gac_screen_t::plane
```

The underlying plane definition of the screen

5.17.2.5 resolution_x

```
float gac_screen_t::resolution_x
```

The width of the screen resolution.

5.17.2.6 resolution_y

```
float gac_screen_t::resolution_y
```

The height of the screen resolution.

5.17.2.7 width

```
float gac_screen_t::width
```

The width of the screen.

The documentation for this struct was generated from the following file:

- include/gac_screen.h

5.18 gac_t Struct Reference

```
#include <gac.h>
```

Data Fields

- void ∗ _me
- gac_queue_t samples
- gac_filter_fixation_t fixation
- gac_filter_gap_t gap
- gac_filter_saccade_t saccade
- gac_filter_noise_t noise
- gac_filter_parameter_t parameter
- gac_screen_t ∗ screen
- gac_sample_t ∗ last_sample
- double trial_timestamp
- double label_timestamp
- gac_aoi_collection_t aoic

5.18.1 Detailed Description

The gaze analysis handler structure.

gac_s

5.18.2 Field Documentation

5.18.2.1 _me

```
void* gac_t::_me
```

Self-pointer to allocated structure for memory management.

5.18.2.2 aoic

```
gac_aoi_collection_t gac_t::aoic
```

The AOI collection structure to handle AOIs.

5.18.2.3 fixation

```
gac_filter_fixation_t gac_t::fixation
```

The fixation filter structure

5.18.2.4 gap

```
gac_filter_gap_t gac_t::gap
```

The gap filter structure

5.18.2.5 label_timestamp

```
double gac_t::label_timestamp
```

The timestamp of the last label change.

5.18.2.6 last_sample

```
gac_sample_t* gac_t::last_sample
```

The last sample entered to the window. This remains even if the sample window is cleared.

5.18.2.7 noise

```
gac_filter_noise_t gac_t::noise
```

The noise filter structure

5.18.2.8 parameter

```
gac_filter_parameter_t gac_t::parameter
```

The parameters passed during configuration

5.18.2.9 saccade

```
gac_filter_saccade_t gac_t::saccade
```

The saccade filetr structure

5.18.2.10 samples

```
gac_queue_t gac_t::samples
```

The sample queue

5.18.2.11 screen

```
gac_screen_t* gac_t::screen
```

The screen information.

5.18.2.12 trial_timestamp

```
double gac_t::trial_timestamp
```

The timestamp of the last trial ID change.

The documentation for this struct was generated from the following file:

- include/gac.h

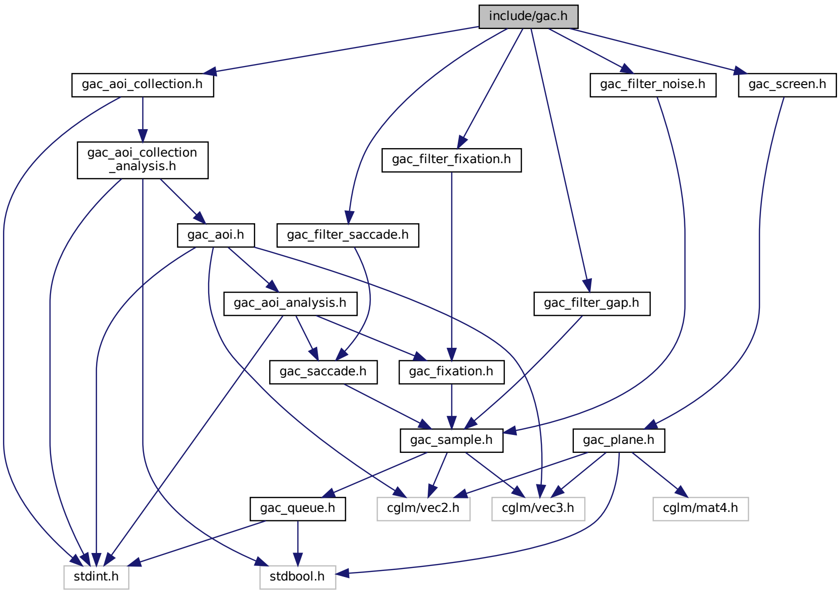
Chapter 6

File Documentation

6.1 include/gac.h File Reference

```
#include "gac_aoi_collection.h"
#include "gac_filter_fixation.h"
#include "gac_filter_gap.h"
#include "gac_filter_noise.h"
#include "gac_filter_saccade.h"
#include "gac_screen.h"
```

Include dependency graph for gac.h:



Data Structures

- struct gac_filter_parameter_t
- struct gac_t

Functions

- bool gac_add_aoi (gac_t ∗h, gac_aoi_t ∗aoi)
- gac_t ∗ gac_create (gac_filter_parameter_t ∗parameter)
- void gac_destroy (gac_t ∗h)

- bool gac_finalise (gac_t ∗h, gac_aoi_collection_analysis_result_t ∗analysis)
- bool gac_init (gac_t ∗h, gac_filter_parameter_t ∗parameter)
- bool gac_get_filter_parameter (gac_t ∗h, gac_filter_parameter_t ∗parameter)
- bool gac_get_filter_parameter_default (gac_filter_parameter_t ∗parameter)
- bool gac_set_screen (gac_t ∗h, float top_left_x, float top_left_y, float top_left_z, float top_right_x, float top↩_right_y, float top_right_z, float bottom_left_x, float bottom_left_y, float bottom_left_z)
- bool gac_sample_window_cleanup (gac_t ∗h)
- bool gac_sample_window_fixation_filter (gac_t ∗h, gac_fixation_t ∗fixation)
- bool gac_sample_window_saccade_filter (gac_t ∗h, gac_saccade_t ∗saccade)
- uint32_t gac_sample_window_update (gac_t ∗h, float ox, float oy, float oz, float px, float py, float pz, double timestamp, uint32_t trial_id, const char ∗label)
- uint32_t gac_sample_window_update_vec (gac_t ∗h, vec2 ∗screen_point, vec3 ∗origin, vec3 ∗point, double timestamp, uint32_t trial_id, const char ∗label)
- uint32_t gac_sample_window_update_screen (gac_t ∗h, float ox, float oy, float oz, float px, float py, float pz, float sx, float sy, double timestamp, uint32_t trial_id, const char ∗label)
- const char ∗ gac_version ()

6.1.1 Detailed Description

Gaze analysis library for fixation and saccade detection in raw gaze data.
gac.h

Author

Simon Maurer

License:

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6.1.2 Function Documentation

6.1.2.1 gac_add_aoi()

```
bool gac_add_aoi (
            gac_t ∗ h,
            gac_aoi_t ∗ aoi )
```

Allows to add an AOI to the gaze analysis handler. This enables the AOI analysis.

Parameters

h	A pointer to the gaze analysis handler.
aoi	A pointer to the AOI structure to add.

Returns

True on success, false otherwise.

6.1.2.2 gac_create()

```
gac_t∗ gac_create (
            gac_filter_parameter_t ∗ parameter )
```

Allocate the gaze analysis structure on the heap. This must be freed. If no parameter structure is provided default values are used. Refer to gac_init() for more information.

Parameters

parameter	An optional filter parameter structure.

Returns

A pointer to the allocated structure or NULL on failure.

6.1.2.3 gac_destroy()

```
void gac_destroy (
            gac_t * h )
```

Destroy the gaze analysis handler.

Parameters

h	A pointer to the gaze analysis handler.

6.1.2.4 gac_finalise()

```
bool gac_finalise (
            gac_t * h,
            gac_aoi_collection_analysis_result_t * analysis )
```

Finalise the AOI analysis.

Parameters

h	A pointer to the gaze analysis handler.
analysis	A location to store the analysis result. This structure is only valid if the function returns true.

Returns

True on success, false otherwise.

6.1.2.5 gac_get_filter_parameter()

```
bool gac_get_filter_parameter (
            gac_t * h,
            gac_filter_parameter_t * parameter )
```

Get the filter parameters.

Parameters

h	A pointer to the gaze analysis structure to initialise.
parameter	A location where the filter parameter values can be stored.

Returns

True on success, false on failure.

6.1.2.6 gac_get_filter_parameter_default()

```
bool gac_get_filter_parameter_default (
            gac_filter_parameter_t * parameter )
```

Get the default filter parameter values.

Parameters

parameter	A location where the filter parameter values can be stored.

Returns

True on success, false on failure.

6.1.2.7 gac_init()

```
bool gac_init (
            gac_t * h,
            gac_filter_parameter_t * parameter )
```

Initialise the gaze analysis structure.
If no parameter structure is provided the following default values are set:

- fixation.dispersion_threshold = 0.5;
- fixation.duration_threshold = 100;
- saccade.velocity_threshold = 20;
- noise.mid_idx = 1;
- noise.type = GAC_FILTER_NOISE_TYPE_AVERAGE;
- gap.max_gap_length = 50;
- gap.sample_period = 16.67;

Parameters

h	A pointer to the gaze analysis structure to initialise.
parameter	An optional filter parameter structure.

Returns

True on success, false on failure.

6.1.2.8 gac_sample_window_cleanup()

```
bool gac_sample_window_cleanup (
            gac_t * h )
```

Cleanup the sample window. This removes all sample data from the sample window which is no longer used for the gaze analysis.

Parameters

h	A pointer to the gaze analysis handler.

Returns

True on success, false on failure.

6.1.2.9 gac_sample_window_fixation_filter()

```
bool gac_sample_window_fixation_filter (
            gac_t * h,
            gac_fixation_t * fixation )
```

The fixation detection algorithm I-DT. This acts on the sample window managed by the functions gac_sample_window_update() and gac_sample_window_cleanup().

Parameters

h	A pointer to the gaze analysis handler.
fixation	A location where a detected fixation is stored. This is only valid if the function returns true.

Returns

True if a fixation was detected, false otherwise.

6.1.2.10 gac_sample_window_saccade_filter()

```
bool gac_sample_window_saccade_filter (
            gac_t * h,
            gac_saccade_t * saccade )
```

The saccade detection algorithm I-VT. This acts on the sample window managed by the functions gac_sample_window_update() and gac_sample_window_cleanup().

Parameters

h	A pointer to the gaze analysis handler.
saccade	A location where a detected saccade is stored. This is only valid if the function returns true.

Returns

True if a saccade was detected, false otherwise.

6.1.2.11 gac_sample_window_update()

```
uint32_t gac_sample_window_update (
            gac_t * h,
            float ox,
            float oy,
            float oz,
            float px,
            float py,
            float pz,
            double timestamp,
            uint32_t trial_id,
            const char * label )
```

Update the sample window with a new sample. If noise filtering is enabled the filtered data is added to the sample window and the raw sample is dismissed. If gap filtering is enabled, sample gaps are filled-in with interpolated data samples.

Parameters

h	A pointer to the gaze analysis handler.
ox	The x coordinate of the gaze origin.
oy	The y coordinate of the gaze origin.
oz	The z coordinate of the gaze origin.
px	The x coordinate of the gaze point.
py	The y coordinate of the gaze point.
pz	The z coordinate of the gaze point.
timestamp	The timestamp of the sample.
trial_id	The ID of the ongoing trial.
label	An optional arbitrary label annotating the sample.

Returns

The number of new samples added to the window.

6.1.2.12 gac_sample_window_update_screen()

```
uint32_t gac_sample_window_update_screen (
            gac_t * h,
            float ox,
            float oy,
            float oz,
            float px,
            float py,
            float pz,
            float sx,
            float sy,
            double timestamp,
            uint32_t trial_id,
            const char * label )
```

Update the sample window with a new sample. If noise filtering is enabled the filtered data is added to the sample window and the raw sample is dismissed. If gap filtering is enabled, sample gaps are filled-in with interpolated data samples.

Parameters

h	A pointer to the gaze analysis handler.
ox	The x coordinate of the gaze origin.
oy	The y coordinate of the gaze origin.
oz	The z coordinate of the gaze origin.
px	The x coordinate of the gaze point.
py	The y coordinate of the gaze point.
pz	The z coordinate of the gaze point.
sx	The x coordinate of the screen gaze point.
sy	The y coordinate of the screen gaze point.
timestamp	The timestamp of the sample.
trial_id	The ID of the ongoing trial.
label	An optional arbitrary label annotating the sample.

Returns

The number of new samples added to the window.

6.1.2.13 gac_sample_window_update_vec()

```
uint32_t gac_sample_window_update_vec (
            gac_t * h,
            vec2 * screen_point,
            vec3 * origin,
            vec3 * point,
            double timestamp,
            uint32_t trial_id,
            const char * label )
```

Update sample window with a new sample.

Parameters

h	A pointer to the gaze analysis handler.
screen_point	The 2d screen gaze point
origin	The gaze origin.
point	The gaze point.
timestamp	The timestamp of the sample.
trial_id	The ID of the ongoing trial.
label	An optional arbitrary label annotating the sample.

Returns

The number of new samples added to the window.

6.1.2.14 gac_set_screen()

```
bool gac_set_screen (
            gac_t * h,
            float top_left_x,
            float top_left_y,
            float top_left_z,
            float top_right_x,
            float top_right_y,
            float top_right_z,
            float bottom_left_x,
            float bottom_left_y,
            float bottom_left_z )
```

Configure the screen position in 3d space. This allows to compute normalized 2d gaze point coordinates.

Parameters

h	A pointer to the gaze analysis handler.
top_left_x	The x coordinate of the top left screen corner.
top_left_y	The y coordinate of the top left screen corner.
top_left_z	The z coordinate of the top left screen corner.
top_right_x	The x coordinate of the top right screen corner.
top_right_y	The y coordinate of the top right screen corner.

Parameters

top_right_z	The z coordinate of the top right screen corner.
bottom_left↩ _x	The x coordinate of the bottom left screen corner.
bottom_left↩ _y	The y coordinate of the bottom left screen corner.
bottom_left↩ _z	The z coordinate of the bottom left screen corner.

Returns

True on success, false on failure.

6.1.2.15 gac_version()

```
const char* gac_version ( )
```

Returns the version of the library.

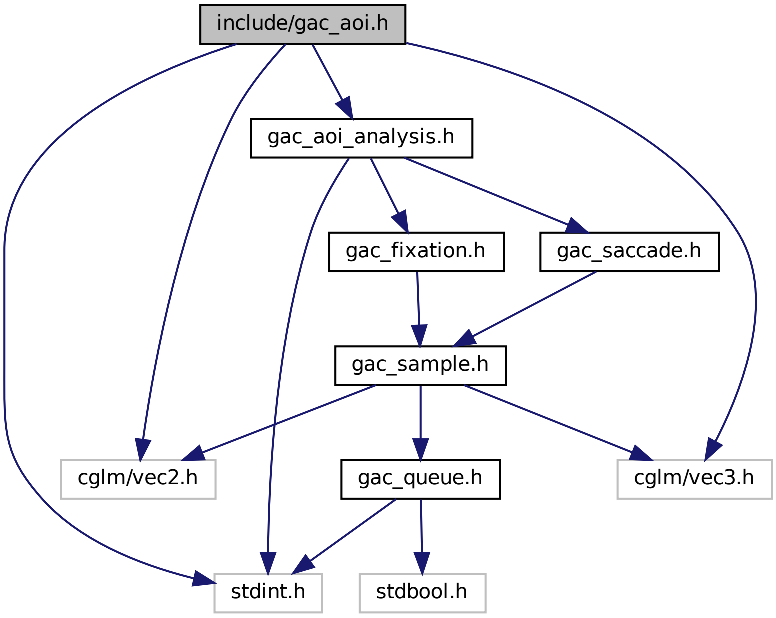
Returns

A version number string of the form `<major>.<minor>.<revision>`.

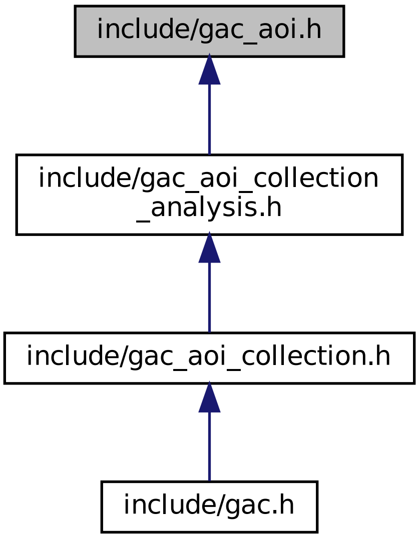
6.2 include/gac_aoi.h File Reference

```
#include "gac_aoi_analysis.h"
#include <stdint.h>
#include <cglm/vec2.h>
#include <cglm/vec3.h>
```

Include dependency graph for gac_aoi.h:



This graph shows which files directly or indirectly include this file:



Data Structures

- struct gac_aoi_t

Macros

- #define GAC_AOI_MAX 100
- #define GAC_AOI_MAX_POINTS 100
- #define GAC_AOI_MAX_LABEL_LEN 100

Typedefs

- typedef enum gac_aoi_orientation_e gac_aoi_orientation_t

Enumerations

- enum gac_aoi_orientation_e { GAC_AOI_ORIENTATION_COLINEAR, GAC_AOI_ORIENTATION_CLOCKWISE, GAC_AOI_ORIENTATION_COUNTER_CLOCKWISE }

Functions

- bool gac_aoi_add_point (gac_aoi_t ∗aoi, float x, float y)
- bool gac_aoi_add_point_res (gac_aoi_t ∗aoi, float x_res, float y_res)
- bool gac_aoi_add_rect (gac_aoi_t ∗aoi, float x, float y, float width, float height)
- bool gac_aoi_add_rect_res (gac_aoi_t ∗aoi, float x, float y, float width, float height)
- gac_aoi_t ∗ gac_aoi_copy (gac_aoi_t ∗aoi)
- bool gac_aoi_copy_to (gac_aoi_t ∗tgt, gac_aoi_t ∗src)
- gac_aoi_t ∗ gac_aoi_create (const char ∗label)
- void gac_aoi_destroy (gac_aoi_t ∗aoi)
- bool gac_aoi_includes_point (gac_aoi_t ∗aoi, float x, float y)

- bool gac_aoi_includes_point_res (gac_aoi_t ∗aoi, float x_res, float y_res)
- bool gac_aoi_init (gac_aoi_t ∗aoi, const char ∗label)
- bool gac_aoi_intersect (vec2 ∗p1, vec2 ∗q1, vec2 ∗p2, vec2 ∗q2)
- bool gac_aoi_point_on_segment (vec2 ∗p, vec2 ∗s1, vec2 ∗s2)
- gac_aoi_orientation_t gac_aoi_orientation_triplet (vec2 ∗p, vec2 ∗q, vec2 ∗r)
- bool gac_aoi_set_resolution (gac_aoi_t ∗aoi, float resolution_x, float resolution_y)

6.2.1 Detailed Description

Area of interest (AOI) structure and helper functions.
gac_aoi.h

Author

Simon Maurer

License:

6.2.2 Macro Definition Documentation

6.2.2.1 GAC_AOI_MAX

```
#define GAC_AOI_MAX 100
```

The maximal allowed area of intersts to analyse.

6.2.2.2 GAC_AOI_MAX_LABEL_LEN

```
#define GAC_AOI_MAX_LABEL_LEN 100
```

The maximal label length

6.2.2.3 GAC_AOI_MAX_POINTS

```
#define GAC_AOI_MAX_POINTS 100
```

The maximal allowed points definig an area of interest.

6.2.3 Typedef Documentation

6.2.3.1 gac_aoi_orientation_t

```
typedef enum gac_aoi_orientation_e gac_aoi_orientation_t
```

gac_aoi_orientation_e

6.2.4 Enumeration Type Documentation

6.2.4.1 gac_aoi_orientation_e

```
enum gac_aoi_orientation_e
```

The order of point triplets. This is used for checking whetehr a point lies within an AOI.

Enumerator

GAC_AOI_ORIENTATION_COLINEAR	Points are colinear.
GAC_AOI_ORIENTATION_CLOCKWISE	Points are ordered clockwise.
GAC_AOI_ORIENTATION_COUNTER_CLOCKWISE	Points are ordered counter clockwise.

6.2.5 Function Documentation

6.2.5.1 gac_aoi_add_point()

```
bool gac_aoi_add_point (
             gac_aoi_t * aoi,
             float x,
             float y )
```

Add a point the AOE definition. An AOE requires at least 3 points to be valid. In addition to attaching the point to the internal array, this function computes a point which is guaranteed to be outside of the AOI at a reasonable distance from the AOI.

Parameters

aoi	A pointer to an AOI structure.
x	The normalised x coordinate of the AOI point to add.
y	The normalised y coordinate of the AOI point to add.

Returns

True on success, false on failure.

Author

Simon Maurer

License:

6.2.5.2 gac_aoi_add_point_res()

```
bool gac_aoi_add_point_res (
             gac_aoi_t * aoi,
             float x_res,
             float y_res )
```

The same as gac_aoi_add_point() but accepting the input coordinates in pixels instead of normalized values. Note that this function will always return false if gac_aoi_set_resolution() was never called.

6.2.5.3 gac_aoi_add_rect()

```
bool gac_aoi_add_rect (
             gac_aoi_t * aoi,
             float x,
             float y,
             float width,
             float height )
```

Add four points describing a rectangle to teh AOI, given the top left point, a width and a height.

Parameters

aoi	A pointer to the AOI structure.
x	The normalized x coordinate of the top left point of the rectangle.
y	The normalized y coordinate of the top left point of the rectangle.
width	The normalized width of the recatngle.
height	The normalized height of the recatngle.

Returns

True on success, false on failure.

6.2.5.4 gac_aoi_add_rect_res()

```
bool gac_aoi_add_rect_res (
             gac_aoi_t * aoi,
             float x,
             float y,
             float width,
             float height )
```

The same as gac_aoi_add_rect() but accepting the input coordinates in pixels instead of normalized values. Note that this function will always return false if gac_aoi_set_resolution() was never called.

6.2.5.5 gac_aoi_copy()

```
gac_aoi_t* gac_aoi_copy (
             gac_aoi_t * aoi )
```

Create a deep copy of an AOI.

Parameters

aoi	A pointer to the AOI to be copied.

Returns

A newly allocated copy of the input AOI.

6.2.5.6 gac_aoi_copy_to()

```
bool gac_aoi_copy_to (
             gac_aoi_t * tgt,
             gac_aoi_t * src )
```

Copy an AOI structure.

Parameters

tgt	A pointer to an AOI to copy to.
src	A pointer to the AOI to be copied.

Returns

True on success, false otherwise.

6.2.5.7 gac_aoi_create()

```
gac_aoi_t* gac_aoi_create (
             const char * label )
```

Allocate a new AOI structure. This must be freed with gac_aoi_destroy().

Parameters

label	An arbitary label, describing the AOI.

Returns

A pointer to the allocated structure or NULL on failure.

6.2.5.8 gac_aoi_destroy()

```
void gac_aoi_destroy (
             gac_aoi_t * aoi )
```

Destroies a AOI structure. This works for structures created with gac_aoi_create() as well as gac_aoi_init().

Parameters

aoi	A pointer to a AOI structure to destroy.

6.2.5.9 gac_aoi_includes_point()

```
bool gac_aoi_includes_point (
             gac_aoi_t * aoi,
             float x,
             float y )
```

Checks whether a point is inside of an AOI. This function uses the ray casting method where a virtual ray is drawn from an arbitraty point outside the AOI to the point. Then, every intersection with segments of the AOI contour is counted. If an even number of intersection is detected, the point lies outside of the AOI, otherwise the point lies inside the AOI.

Parameters

aoi	A pointer to an AOI structure.
x	The normalised x coordinate of the point to check.
y	The normalised y coordinate of the point to check.

Returns

True if the point is inside the AOI, false otherwise.

6.2.5.10 gac_aoi_includes_point_res()

```
bool gac_aoi_includes_point_res (
             gac_aoi_t * aoi,
             float x_res,
             float y_res )
```

The same as gac_aoi_includes_point() but accepting the input coordinates in pixels instead of normalized values. Note that this function will always return false if gac_aoi_set_resolution() was never called.

6.2.5.11 gac_aoi_init()

```
bool gac_aoi_init (
             gac_aoi_t * aoi,
             const char * label )
```

Initialise the AOI structure.

Parameters

aoi	A pointer to the aoi structure to initialise.
label	An arbitary label, describing the AOI.

Returns

True on success, false otherwise.

6.2.5.12 gac_aoi_intersect()

```
bool gac_aoi_intersect (
             vec2 * p1,
             vec2 * q1,
             vec2 * p2,
             vec2 * q2 )
```

Checks whether the line segment p1q1 intersects with the line segment p2q2.

Parameters

p1	A pointer to the staring point of the first segment.
q1	A pointer to the end point of the first segment.
p2	A pointer to the staring point of the second segment.
q2	A pointer to the end point of the second segment.

Returns

True if the two segments intersect, false otherwise.

6.2.5.13 gac_aoi_orientation_triplet()

```
gac_aoi_orientation_t gac_aoi_orientation_triplet (
             vec2 * p,
             vec2 * q,
             vec2 * r )
```

Given three ordered points p, q, and r, this function detects whether the points are colinear, ordered clockwise or counter clockwise.

Parameters

p	A pointer to point p.
q	A pointer to point q.
r	A pointer to point r.

Returns

The orientation of the three points.

6.2.5.14 gac_aoi_point_on_segment()

```
bool gac_aoi_point_on_segment (
            vec2 * p,
            vec2 * s1,
            vec2 * s2 )
```

Given three colinear points, this function checks if a point p lies on a segment s1s2.

Parameters

p	A pointer to the point to check.
s1	The starting point of the segment.
s2	The end point of the segment.

Returns

True if the point lies on the segment, false otherwise.

6.2.5.15 gac_aoi_set_resolution()

```
bool gac_aoi_set_resolution (
            gac_aoi_t * aoi,
            float resolution_x,
            float resolution_y )
```

Set the screen resolution. This allows to use all functions with an `res` suffix. These functions will act exactly like their counter part function without the `res` suffix but use 2d points expressed in the screen resolution.

Parameters

aoi	A pointer to an aoi structure.
resolution↩ _x	The width of the screen resolution.
resolution↩ _y	The height of the screen resolution.

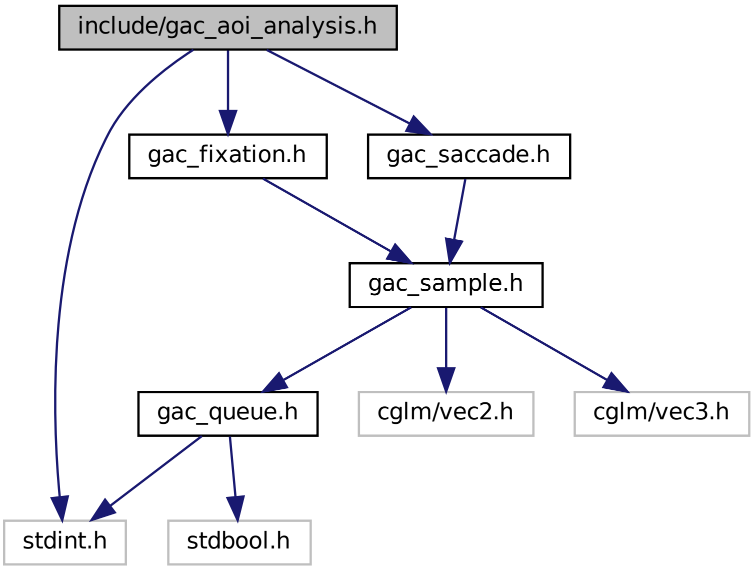
Returns

True on success, false on failure.

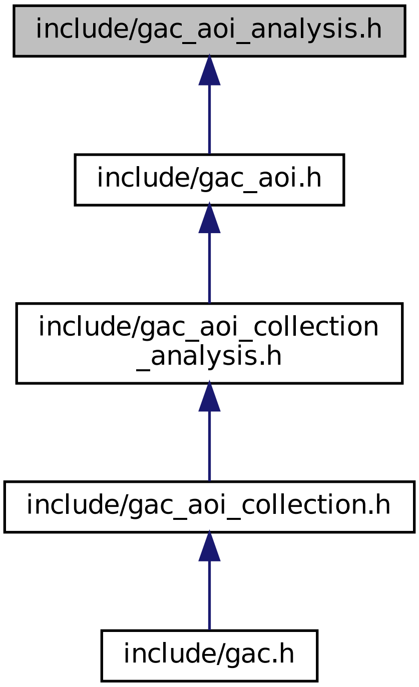
6.3 include/gac_aoi_analysis.h File Reference

```
#include <stdint.h>
#include "gac_fixation.h"
#include "gac_saccade.h"
```

Include dependency graph for gac_aoi_analysis.h:



This graph shows which files directly or indirectly include this file:


include/gac_aoi_analysis.h
include/gac_aoi.h
include/gac_aoi_collection
_analysis.h
include/gac_aoi_collection.h
include/gac.h

Data Structures

- struct gac_aoi_analysis_t

Functions

- bool gac_aoi_analysis_clear (gac_aoi_analysis_t ∗analysis)
- gac_aoi_analysis_t ∗ gac_aoi_analysis_copy (gac_aoi_analysis_t ∗analysis)
- bool gac_aoi_analysis_copy_to (gac_aoi_analysis_t ∗tgt, gac_aoi_analysis_t ∗src)
- gac_aoi_analysis_t ∗ gac_aoi_analysis_create ()
- void gac_aoi_analysis_destroy (gac_aoi_analysis_t ∗analysis)
- bool gac_aoi_analysis_init (gac_aoi_analysis_t ∗analysis)

6.3.1 Detailed Description

The analysis structure definition of an AOI.
gac_aoi_analysis.h

Author

Simon Maurer

License:

6.3.2 Function Documentation

6.3.2.1 gac_aoi_analysis_clear()

```
bool gac_aoi_analysis_clear (
            gac_aoi_analysis_t * analysis )
```

Clear an AIO analysis structure.

Parameters

analysis	A pointer to the structure to clear.

Returns

True on success, false on failure.

Author

Simon Maurer

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6.3.2.2 gac_aoi_analysis_copy()

```
gac_aoi_analysis_t* gac_aoi_analysis_copy (
            gac_aoi_analysis_t * analysis )
```

Create a deep copy of the AOI analysis structure.

Parameters

analysis	A pointer to the analysis structure to be copied.

Returns

A newly allocated copy of the input structure.

6.3.2.3 gac_aoi_analysis_copy_to()

```
bool gac_aoi_analysis_copy_to (
            gac_aoi_analysis_t * tgt,
            gac_aoi_analysis_t * src )
```

Copy an AOI analysis structure.

Parameters

tgt	A pointer to the analysis structure to copy to.
src	A pointer to the analysis structure to be copied.

Returns

True on success, false otherwise.

6.3.2.4 gac_aoi_analysis_create()

```
gac_aoi_analysis_t* gac_aoi_analysis_create ( )
```

Allocate a new AOI analysis structure on the heap. This needs to be freed with gac_aoi_analysis_destroy().

Returns

A pointer to the newly allocated structure.

6.3.2.5 gac_aoi_analysis_destroy()

```
void gac_aoi_analysis_destroy (
             gac_aoi_analysis_t * analysis )
```

Destroy an AOI analysis structure.

Parameters

analysis	A pointer to the analysis structure to destroy.

6.3.2.6 gac_aoi_analysis_init()

```
bool gac_aoi_analysis_init (
             gac_aoi_analysis_t * analysis )
```

Initialise an AIO analisis structure.

Parameters

analysis	A pointer to the structure to initialise.

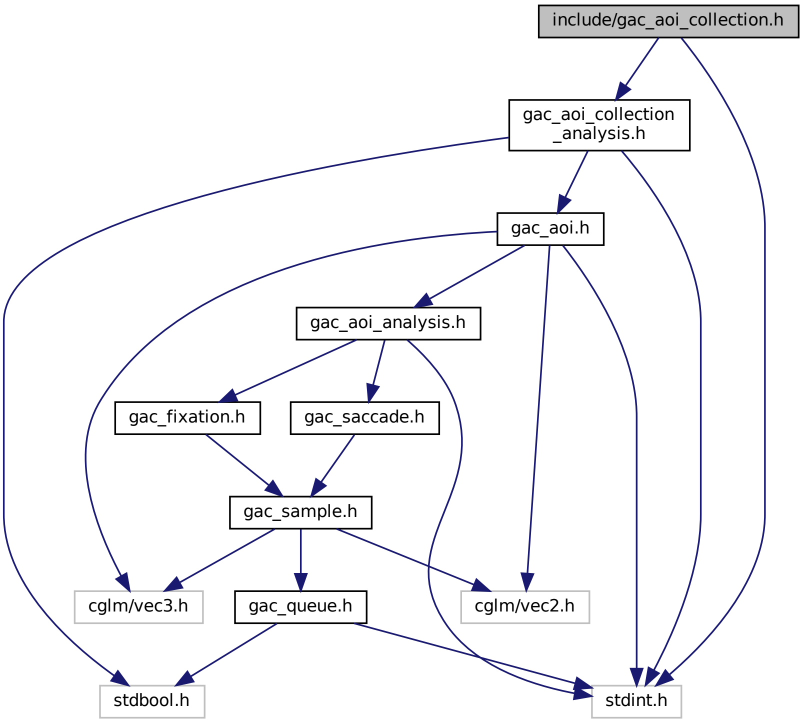
Returns

True on success, false on failure.

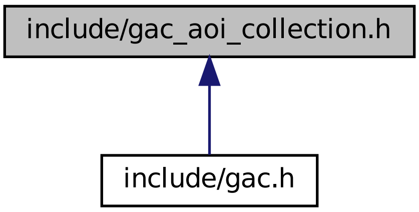
6.4 include/gac_aoi_collection.h File Reference

```
#include "gac_aoi_collection_analysis.h"
#include <stdint.h>
```

Include dependency graph for gac_aoi_collection.h:



This graph shows which files directly or indirectly include this file:



Data Structures

- struct gac_aoi_collection_t

Functions

- bool gac_aoi_collection_add (gac_aoi_collection_t ∗aoic, gac_aoi_t ∗aoi)
- bool gac_aoi_collection_analyse_clear (gac_aoi_collection_t ∗aoic)
- bool gac_aoi_collection_analyse_finalise (gac_aoi_collection_t ∗aoic, gac_aoi_collection_analysis_result_t ∗analysis)

- bool gac_aoi_collection_analyse_fixation (gac_aoi_collection_t ∗aoic, gac_fixation_t ∗fixation, gac_aoi_↩ collection_analysis_result_t ∗analysis)
- bool gac_aoi_collection_analyse_saccade (gac_aoi_collection_t ∗aoic, gac_saccade_t ∗saccade)
- bool gac_aoi_collection_assign (gac_aoi_collection_t ∗aoic, gac_aoi_t ∗aoi)
- gac_aoi_collection_t ∗ gac_aoi_collection_create ()
- void gac_aoi_collection_destroy (gac_aoi_collection_t ∗aoic)
- bool gac_aoi_collection_init (gac_aoi_collection_t ∗aoic)

6.4.1 Detailed Description

The AOI collection structure and associated functions. This is used to aggregate information during the AOI analysis. gac_aoi_collection.h

Author

Simon Maurer

License:

6.4.2 Function Documentation

6.4.2.1 gac_aoi_collection_add()

```
bool gac_aoi_collection_add (
            gac_aoi_collection_t ∗ aoic,
            gac_aoi_t ∗ aoi )
```

Add an AOI to an AOI collection. Do **not** destroy an AOI which was added to the collection. Memory management is taken care of by the collection.

Parameters

aoic	A pointer to the AOI collection
aoi	A pointer to the AOI to add.

Returns

True on success, false otherwise.

Author

Simon Maurer

License:

6.4.2.2 gac_aoi_collection_analyse_clear()

```
bool gac_aoi_collection_analyse_clear (
            gac_aoi_collection_t ∗ aoic )
```

Clear all analysis structures of al AOIS in the AOI collection.

Parameters

aoic	A pointer to the AOI collection structurre to clear.

Returns

True on success, false otherwise.

6.4.2.3 gac_aoi_collection_analyse_finalise()

```
bool gac_aoi_collection_analyse_finalise (
            gac_aoi_collection_t * aoic,
            gac_aoi_collection_analysis_result_t * analysis )
```

Finalise the AOI analysis. This function computes the relative values in each AOI structure based on the collection analysis data.

Parameters

aoic	A pointer to the AOI collection.
analysis	A location to store the analysis result. This structure is only valid if the function returns true.

Returns

True on success, false otherwise.

6.4.2.4 gac_aoi_collection_analyse_fixation()

```
bool gac_aoi_collection_analyse_fixation (
            gac_aoi_collection_t * aoic,
            gac_fixation_t * fixation,
            gac_aoi_collection_analysis_result_t * analysis )
```

Add a fixation to the AOI collection and update the analysis.

Parameters

aoic	A pointer to an AOI collection.
fixation	The fixation point to add.
analysis	A location to store the analysis result. This structure is only valid if the function returns true.

Returns

True on success, false on failure.

6.4.2.5 gac_aoi_collection_analyse_saccade()

```
bool gac_aoi_collection_analyse_saccade (
            gac_aoi_collection_t * aoic,
            gac_saccade_t * saccade )
```

Add a saccade to the AOI collection and update the analysis. Note that this only extends the AOI analysis but no AOI can happen based on saccades only. Always call this function bevore fixation analysis (see gac_aoi_collection_analyse_fixation).

Parameters

aoic	A pointer to an AOI collection.
saccade	The saccade point to add.

Returns

True on success, false on failure.

6.4.2.6 gac_aoi_collection_assign()

```
bool gac_aoi_collection_assign (
            gac_aoi_collection_t * aoic,
            gac_aoi_t * aoi )
```

Assign a new AOI to an AOI collection. This function acts similar to gac_aoi_collection_add() but only creates a copy if the AOI to assign is allocated on the stack. If a heap allocated AOI is assigned the AOI is not copied and must, therefore, no longer be freed as it will be freed automatically with gac_aoi_collection_destroy().

Parameters

aoic	A pointer to an AOI collection.
aoi	A pointer to the AOI to be assigned.

Returns

True on success, false otherwise.

6.4.2.7 gac_aoi_collection_create()

```
gac_aoi_collection_t* gac_aoi_collection_create ( )
```

Allocate a new AOI collection on the heap.

Returns

A pointer to the newly allocated AOI collection.

6.4.2.8 gac_aoi_collection_destroy()

```
void gac_aoi_collection_destroy (
            gac_aoi_collection_t * aoic )
```

Destroy an AOI collection.

Parameters

aoic	Destroy an AOI collection.

6.4.2.9 gac_aoi_collection_init()

```
bool gac_aoi_collection_init (
            gac_aoi_collection_t * aoic )
```

Initialise an AOI collection.

Parameters

aoic	A pointer to an AOI collection to initialise.

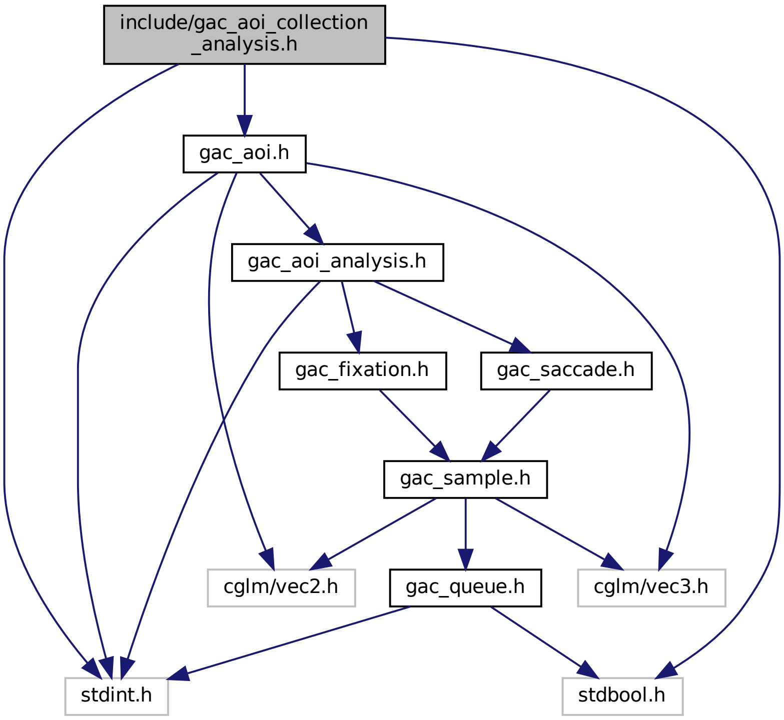
Returns

True on success, false otherwise.

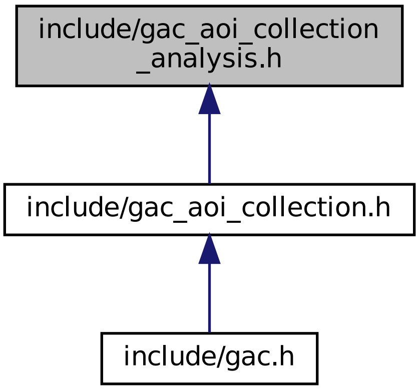
6.5 include/gac_aoi_collection_analysis.h File Reference

```
#include "gac_aoi.h"
#include <stdint.h>
#include <stdbool.h>
```

Include dependency graph for gac_aoi_collection_analysis.h:



This graph shows which files directly or indirectly include this file:


include/gac_aoi_collection_analysis.h
include/gac_aoi_collection.h
include/gac.h

Data Structures

- struct gac_aoi_collection_analysis_t
- struct gac_aoi_collection_analysis_result_t

Functions

- bool gac_aoi_collection_analysis_clear (gac_aoi_collection_analysis_t ∗analysis)
- gac_aoi_collection_analysis_t ∗ gac_aoi_collection_analysis_create ()
- void gac_aoi_collection_analysis_destroy (gac_aoi_collection_analysis_t ∗analysis)
- bool gac_aoi_collection_analysis_init (gac_aoi_collection_analysis_t ∗analysis)

6.5.1 Detailed Description

The analysis structure definition of an AOI collection.
gac_aoi_collection_analysis.h

Author

Simon Maurer

License:

6.5.2 Function Documentation

6.5.2.1 gac_aoi_collection_analysis_clear()

```
bool gac_aoi_collection_analysis_clear (
             gac_aoi_collection_analysis_t * analysis )
```

Clear the analysis structure.

Parameters

analysis	A pointer to the AOI collection analysis structure to clear.

Returns

True on success, false otherwise.

Author

Simon Maurer

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6.5.2.2 gac_aoi_collection_analysis_create()

```
gac_aoi_collection_analysis_t* gac_aoi_collection_analysis_create ( )
```

Allocate a new AOI collection analysis structure on the heap.

Returns

A pointer to the newly allocated structure.

6.5.2.3 gac_aoi_collection_analysis_destroy()

```
void gac_aoi_collection_analysis_destroy (
             gac_aoi_collection_analysis_t * analysis )
```

Destroy an AOI collection analysis structure.

Parameters

analysis	A pointer to the AOI collection analysis structure to be destroied.

6.5.2.4 gac_aoi_collection_analysis_init()

```
bool gac_aoi_collection_analysis_init (
             gac_aoi_collection_analysis_t * analysis )
```

Initialise an AOI collection analysis structure.

Parameters

analysis	A pointer to the AOI collection analysis structure to initialise.

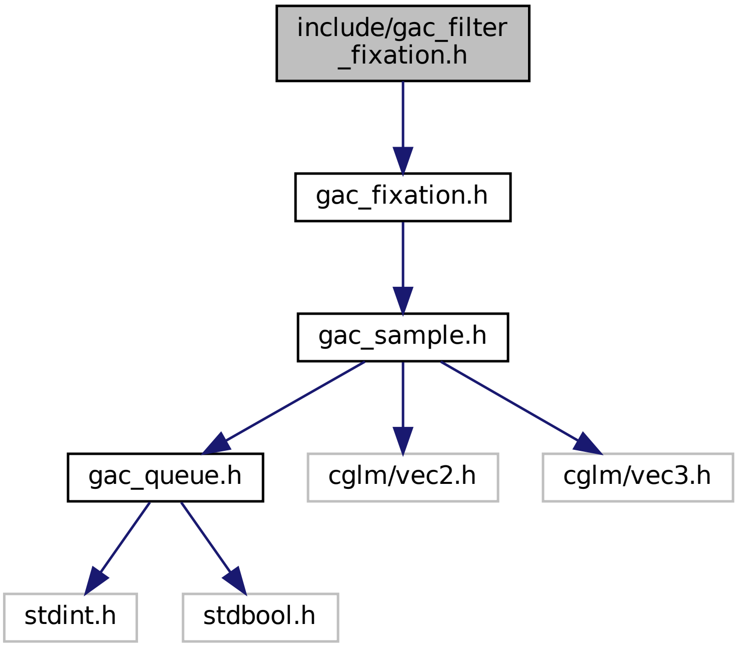
Returns

True on success, false otherwise.

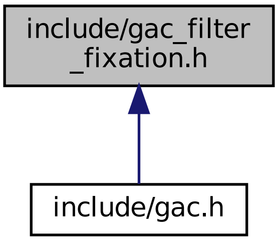
6.6 include/gac_filter_fixation.h File Reference

```
#include "gac_fixation.h"
```

Include dependency graph for gac_filter_fixation.h:



This graph shows which files directly or indirectly include this file:



Data Structures

- struct gac_filter_fixation_t

Functions

- bool gac_filter_fixation (gac_filter_fixation_t ∗filter, gac_sample_t ∗sample, gac_fixation_t ∗fixation)
- gac_filter_fixation_t ∗ gac_filter_fixation_create (float dispersion_threshold, double duration_threshold)
- void gac_filter_fixation_destroy (gac_filter_fixation_t ∗filter)
- bool gac_filter_fixation_init (gac_filter_fixation_t ∗filter, float dispersion_threshold, double duration_threshold)

6.6.1 Detailed Description

Gaze analysis fixation filter implementation.
gac_filter_fixation.h

Author

Simon Maurer

License:

6.6.2 Function Documentation

6.6.2.1 gac_filter_fixation()

```
bool gac_filter_fixation (
             gac_filter_fixation_t * filter,
             gac_sample_t * sample,
             gac_fixation_t * fixation )
```

The fixation detection algorithm I-DT.

Parameters

filter	The gap filter structure holding the configuration parameters.
sample	The lastes sample
fixation	A location where a detected fixation is stored. This is only valid if the function returns true.

Returns

True if a fixation was detected, false otherwise.

Author

Simon Maurer

License:

6.6.2.2 gac_filter_fixation_create()

```
gac_filter_fixation_t* gac_filter_fixation_create (
             float dispersion_threshold,
             double duration_threshold )
```

Allocate a new fixation filter structure on the heap. This structure must be freed.

Parameters

dispersion_threshold	The dispersion thresholad in degrees.
duration_threshold	The duration threshold in milliseconds.

Returns

The allocated fixation filter structure or NULL on failure.

6.6.2.3 gac_filter_fixation_destroy()

```
void gac_filter_fixation_destroy (
            gac_filter_fixation_t * filter )
```

Destroy the fixation filter structure.

Parameters

filter	A pointer to the structure to destroy.

6.6.2.4 gac_filter_fixation_init()

```
bool gac_filter_fixation_init (
            gac_filter_fixation_t * filter,
            float dispersion_threshold,
            double duration_threshold )
```

Initialise a fixation filter structure.

Parameters

filter	The filter structure to initialise.
dispersion_threshold	The dispersion thresholad in degrees.
duration_threshold	The duration threshold in milliseconds.

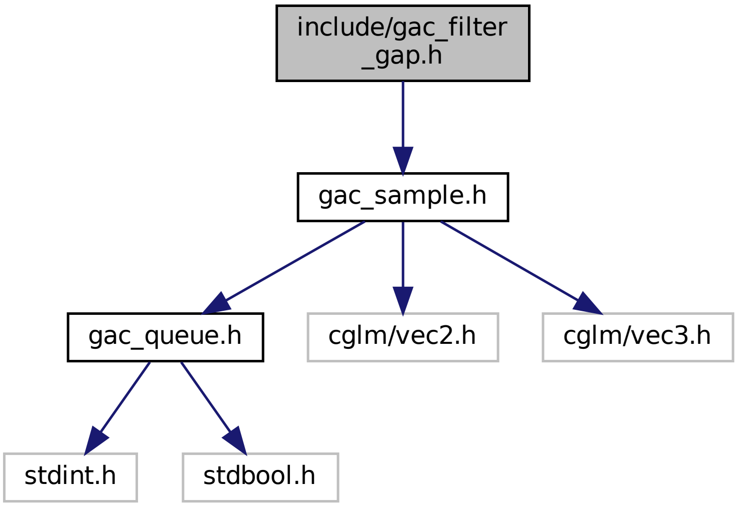
Returns

True on success, false on failure.

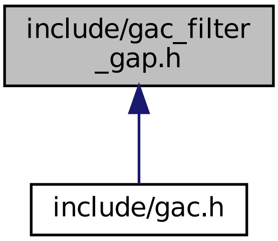
6.7 include/gac_filter_gap.h File Reference

```
#include "gac_sample.h"
```

Include dependency graph for gac_filter_gap.h:



This graph shows which files directly or indirectly include this file:



Data Structures

- struct gac_filter_gap_t

Functions

- uint32_t gac_filter_gap (gac_filter_gap_t ∗filter, gac_queue_t ∗samples, gac_sample_t ∗sample)
- gac_filter_gap_t ∗ gac_filter_gap_create (double max_gap_length, double sample_period)
- void gac_filter_gap_destroy (gac_filter_gap_t ∗filter)
- bool gac_filter_gap_init (gac_filter_gap_t ∗filter, double max_gap_length, double sample_period)

6.7.1 Detailed Description

Gaze analysis gap filter implementation.
gac_filter_gap.h

Author

Simon Maurer

License:

6.7.2 Function Documentation

6.7.2.1 gac_filter_gap()

```
uint32_t gac_filter_gap (
            gac_filter_gap_t * filter,
            gac_queue_t * samples,
            gac_sample_t * sample )
```

Fill in gaps between the last sample and the current sample if any. The number of samples to be filled in depends on the sample period. To avoid filling up large gaps the gap filling is limited to a maximal gap length (in milliseconds). The sample passed to the function is added as well.

Parameters

filter	The gap filter structure holding the configuration parameters.
samples	The sample queue to be filled in
sample	The lastes sample

Returns

The number of samples added to the sample window.

Author

Simon Maurer

License:

6.7.2.2 gac_filter_gap_create()

```
gac_filter_gap_t* gac_filter_gap_create (
            double max_gap_length,
            double sample_period )
```

Allocate the filter gap structure on the heap. this needs to be freed.

Parameters

max_gap_length	The maximal gap length in milliseconds to fil-in. Larger gaps are ignored. If set to 0 the filter is disabled.
sample_period	The expected average sample period in milliseconds (1000 / sample_rate).

Returns

A pointer to the allocated filter gap structure.

6.7.2.3 gac_filter_gap_destroy()

```
void gac_filter_gap_destroy (
            gac_filter_gap_t * filter )
```

Destroy the gap filter structure.

Parameters

filter	A pointer to the structure to destroy.

6.7.2.4 gac_filter_gap_init()

```
bool gac_filter_gap_init (
            gac_filter_gap_t * filter,
            double max_gap_length,
            double sample_period )
```

Initialise a filter gap structure.

Parameters

filter	A pointer to the struct to be initialised.
max_gap_length	The maximal gap length in milliseconds to fil-in. Larger gaps are ignored. If set to 0 the filter is disabled.
sample_period	The expected average sample period in milliseconds (1000 / sample_rate).

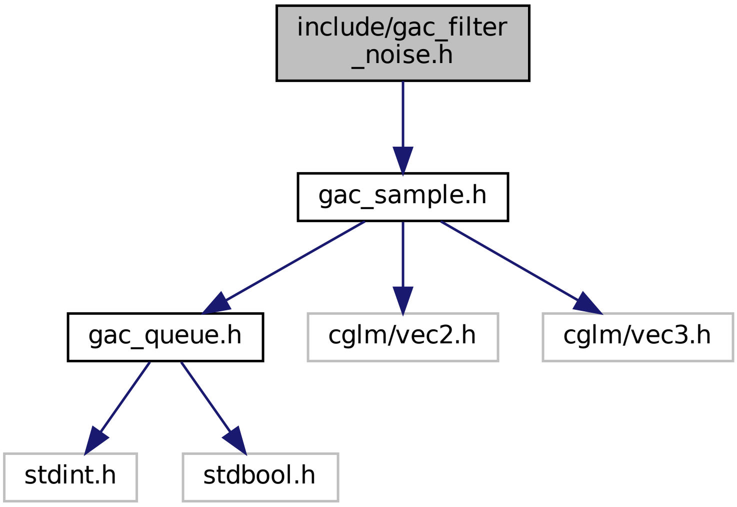
Returns

True on success, false on failure.

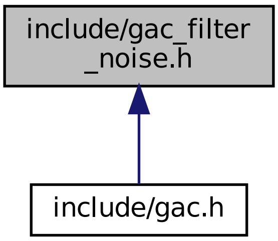
6.8 include/gac_filter_noise.h File Reference

```
#include "gac_sample.h"
```

Include dependency graph for gac_filter_noise.h:



This graph shows which files directly or indirectly include this file:



Data Structures

- struct gac_filter_noise_t

Typedefs

- typedef enum gac_filter_noise_type_e gac_filter_noise_type_t

Enumerations

- enum gac_filter_noise_type_e { GAC_FILTER_NOISE_TYPE_AVERAGE, GAC_FILTER_NOISE_TYPE_MEDIAN }

Functions

- gac_sample_t ∗ gac_filter_noise (gac_filter_noise_t ∗filter, gac_sample_t ∗sample)
- gac_filter_noise_t ∗ gac_filter_noise_create (gac_filter_noise_type_t type, uint32_t mid_idx)
- void gac_filter_noise_destroy (gac_filter_noise_t ∗filter)
- bool gac_filter_noise_init (gac_filter_noise_t ∗filter, gac_filter_noise_type_t type, uint32_t mid_idx)
- gac_sample_t ∗ gac_filter_noise_average (gac_filter_noise_t ∗filter)

6.8.1 Detailed Description

Gaze analysis noise filter implementation.
gac_filter_noise.h

Author

Simon Maurer

License:

6.8.2 Typedef Documentation

6.8.2.1 gac_filter_noise_type_t

```
typedef enum gac_filter_noise_type_e gac_filter_noise_type_t
```

gac_filter_noise_type_e

6.8.3 Enumeration Type Documentation

6.8.3.1 gac_filter_noise_type_e

```
enum gac_filter_noise_type_e
```

The available noise filter types

Enumerator

GAC_FILTER_NOISE_TYPE_AVERAGE	Moving average filtering
GAC_FILTER_NOISE_TYPE_MEDIAN	[not implemented] Moving median filtering

6.8.4 Function Documentation

6.8.4.1 gac_filter_noise()

```
gac_sample_t* gac_filter_noise (
            gac_filter_noise_t * filter,
            gac_sample_t * sample )
```

A noise filter. The filter consecutively collects samples into a window and returns a filtered value when the window is full, otherwise the passed sample is returned. The filter maintains its won sample window.

Parameters

filter	The filter parameters.
sample	The sample to add to the filter window.

Returns

A filtered sample if the filter window is full or the sample passed to the function otherwise.

Author

Simon Maurer

License:

6.8.4.2 gac_filter_noise_average()

```
gac_sample_t* gac_filter_noise_average (
            gac_filter_noise_t * filter )
```

A moving average noise filter. It computes the average sample point and origin from all samples in the filter window and assigns the timestamp of the median sample (the sample in the middle of the window) to the averaged sample.

Parameters

filter	The filter parameters

Returns

A new averaged sample if the filter window is full or the sample passed to the function otherwise.

6.8.4.3 gac_filter_noise_create()

```
gac_filter_noise_t* gac_filter_noise_create (
            gac_filter_noise_type_t type,
            uint32_t mid_idx )
```

Allocate the noise filter structure. This needs to be freed.

Parameters

type	The noise filter type.
mid_idx	The mid index of the window. This is used to compute the length of the window: window_length = mid_idx ∗ 2 + 1. If set to 0 the filter is disabled.

Returns

A pointer to the allocated structure or NULL on failure.

6.8.4.4 gac_filter_noise_destroy()

```
void gac_filter_noise_destroy (
            gac_filter_noise_t * filter )
```

Destroy the noise filter structure.

Parameters

filter	A pointer to the structure to destroy.

6.8.4.5 gac_filter_noise_init()

```
bool gac_filter_noise_init (
            gac_filter_noise_t * filter,
            gac_filter_noise_type_t type,
            uint32_t mid_idx )
```

Initialises a noise filter structure.

Parameters

filter	A pointer to the structure to initialise.
type	The noise filter type.
mid_idx	The mid index of the window. This is used to compute the length of the window: window_length = mid_idx ∗ 2 + 1. If set to 0 the filter is disabled.

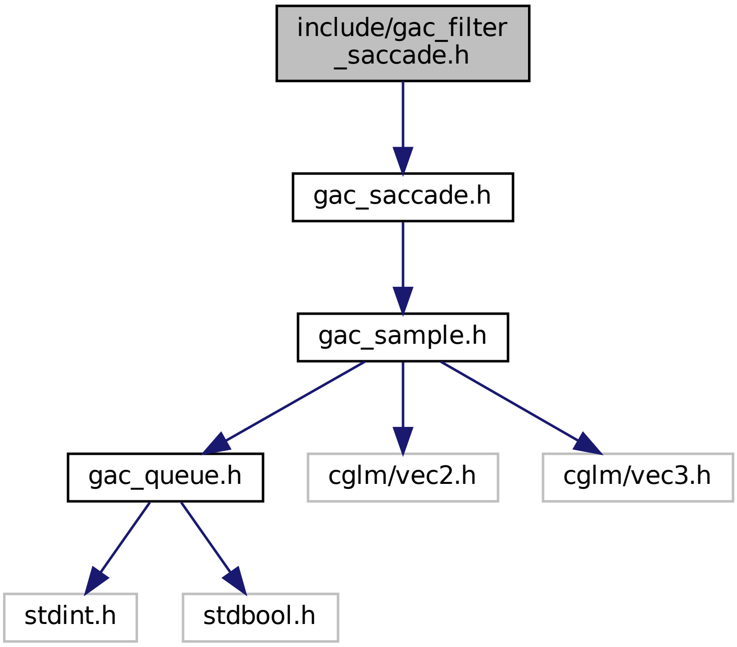
Returns

True on success, false on failure.

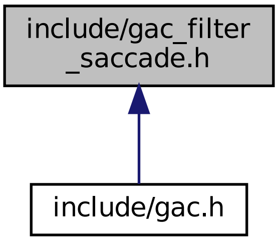
6.9 include/gac_filter_saccade.h File Reference

```
#include "gac_saccade.h"
```

Include dependency graph for gac_filter_saccade.h:



This graph shows which files directly or indirectly include this file:



Data Structures

- struct gac_filter_saccade_t

Functions

- bool gac_filter_saccade (gac_filter_saccade_t ∗filter, gac_sample_t ∗sample, gac_saccade_t ∗saccade)
- gac_filter_saccade_t ∗ gac_filter_saccade_create (float velocity_threshold)
- void gac_filter_saccade_destroy (gac_filter_saccade_t ∗filter)
- bool gac_filter_saccade_init (gac_filter_saccade_t ∗filter, float velocity_threshold)

6.9.1 Detailed Description

Gaze analysis saccade filter implementation.
gac_filter_saccade.h

Author

Simon Maurer

License:

6.9.2 Function Documentation

6.9.2.1 gac_filter_saccade()

```
bool gac_filter_saccade (
             gac_filter_saccade_t * filter,
             gac_sample_t * sample,
             gac_saccade_t * saccade )
```

The saccade detection algorithm I-VT.

Parameters

filter	The filter parameters
sample	The lastes sample
saccade	A location where a detected saccade is stored. This is only valid if the function returns true.

Returns

True if a saccade was detected, false otherwise.

Author

Simon Maurer

License:

6.9.2.2 gac_filter_saccade_create()

```
gac_filter_saccade_t* gac_filter_saccade_create (
             float velocity_threshold )
```

Allocate a new saccade filter structure on the heap. This needs to be freed.

Parameters

velocity_threshold	The velocity threshold in degrees per second.

Returns

A pointer to the allocated filter structure or NUll on failure.

6.9.2.3 gac_filter_saccade_destroy()

```
void gac_filter_saccade_destroy (
            gac_filter_saccade_t * filter )
```

Destroy the saccade filter structure.

Parameters

filter	A pointer to the structure to destroy.

6.9.2.4 gac_filter_saccade_init()

```
bool gac_filter_saccade_init (
            gac_filter_saccade_t * filter,
            float velocity_threshold )
```

Initialise a saccade filter structure.

Parameters

filter	A pointer to the filter structure to initialise.
velocity_threshold	The velocity threshold in degrees per second.

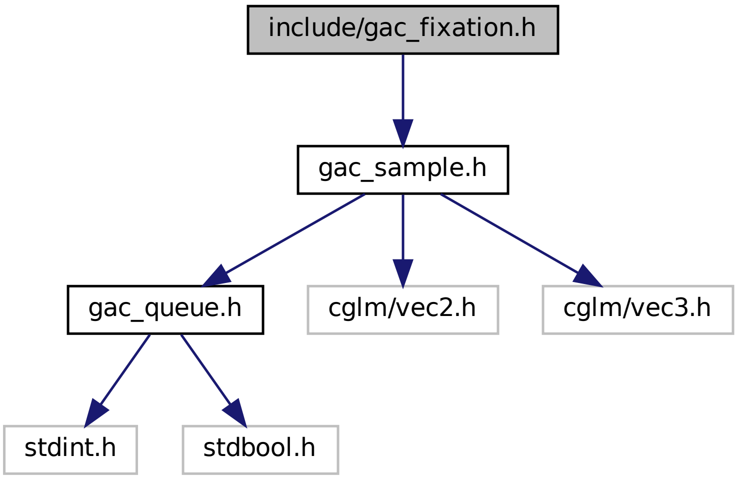
Returns

True on success, false on failure.

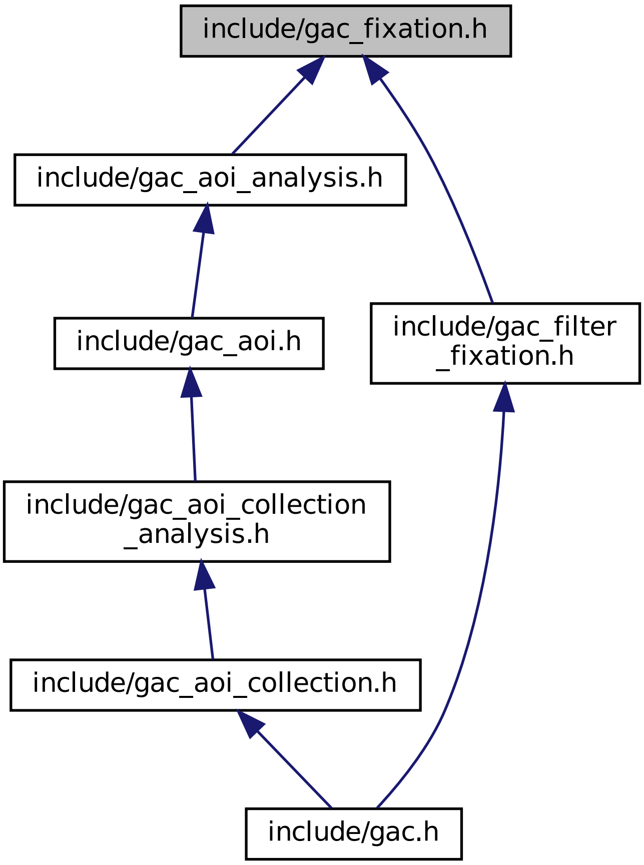
6.10 include/gac_fixation.h File Reference

```
#include "gac_sample.h"
```

Include dependency graph for gac_fixation.h:



This graph shows which files directly or indirectly include this file:


include/gac_fixation.h
include/gac_aoi_analysis.h
include/gac_aoi.h
include/gac_filter _fixation.h
include/gac_aoi_collection _analysis.h
include/gac_aoi_collection.h
include/gac.h

Data Structures

- struct gac_fixation_t

Functions

- gac_fixation_t ∗ gac_fixation_copy (gac_fixation_t ∗fixation)
- bool gac_fixation_copy_to (gac_fixation_t ∗tgt, gac_fixation_t ∗src)
- gac_fixation_t ∗ gac_fixation_create (vec2 ∗screen_point, vec3 ∗point, double duration, gac_sample_↩ t ∗first_sample)
- void gac_fixation_destroy (gac_fixation_t ∗fixation)
- bool gac_fixation_init (gac_fixation_t ∗fixation, vec2 ∗screen_point, vec3 ∗point, double duration, gac_↩ sample_t ∗first_sample)
- float gac_fixation_normalised_dispersion_threshold (float angle)

6.10.1 Detailed Description

The fixation data structure.
gac_fixation.h

Author

Simon Maurer

License:

6.10.2 Function Documentation

6.10.2.1 gac_fixation_copy()

```
gac_fixation_t* gac_fixation_copy (
            gac_fixation_t * fixation )
```

Create a new copy of fixation.

Parameters

fixation	A pointer to the fixation to copy.

Returns

A pointer to a newly allocated fixation.

Author

Simon Maurer

License:

6.10.2.2 gac_fixation_copy_to()

```
bool gac_fixation_copy_to (
            gac_fixation_t * tgt,
            gac_fixation_t * src )
```

Copy a fixation structure.

Parameters

tgt	A pointer to a fixation structure to cpy to.
src	A pointer to the fixation structure to be copied.

6.10.2.3 gac_fixation_create()

```
gac_fixation_t* gac_fixation_create (
            vec2 * screen_point,
            vec3 * point,
            double duration,
            gac_sample_t * first_sample )
```

Allocate a new fixation structure on the heap. This structure must be freed.

Parameters

screen_point	The fixation screen point.
point	The fixation point.
duration	The duration of the fixation.
first_sample	The first sample in the fixation.

Returns

The allocated fixation structure or NULL on failure.

6.10.2.4 gac_fixation_destroy()

```
void gac_fixation_destroy (
            gac_fixation_t * fixation )
```

Destroy a fixation structure.

Parameters

fixation	A pointer to the fixation structure to destroy.

6.10.2.5 gac_fixation_init()

```
bool gac_fixation_init (
            gac_fixation_t * fixation,
            vec2 * screen_point,
            vec3 * point,
            double duration,
            gac_sample_t * first_sample )
```

Initialise a fixation structure.

Parameters

fixation	The fixation structure to initialise.
screen_point	The fixation screen point.
point	The fixation point.
duration	The duration of the fixation.
first_sample	The first sample in the fixation.

Returns

True on success, false on failure.

6.10.2.6 gac_fixation_normalised_dispersion_threshold()

```
float gac_fixation_normalised_dispersion_threshold (
            float angle )
```

Compute a dispersion threashold assuming a unit distance. To get the actual dispersion threshold multiply this by the distance of the gaze origin to the gaze point.

Parameters

angle	The angel in degrees for which the dispersion threshold is computetd. Usual values range from 0.5 to 1 degree.

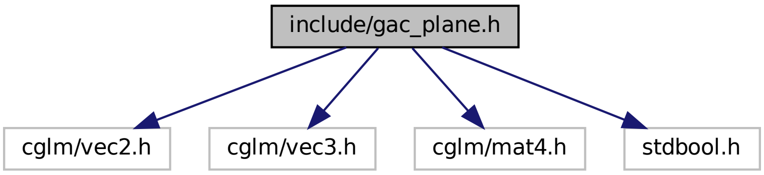
Returns

The normalized dispersion threshold.

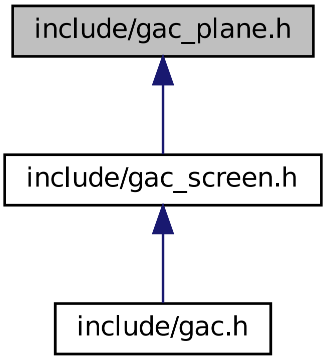
6.11 include/gac_plane.h File Reference

```
#include <cglm/vec2.h>
#include <cglm/vec3.h>
#include <cglm/mat4.h>
#include <stdbool.h>
```

Include dependency graph for gac_plane.h:



This graph shows which files directly or indirectly include this file:



Data Structures

- struct gac_plane_t

Functions

- gac_plane_t ∗ gac_plane_create (vec3 ∗p1, vec3 ∗p2, vec3 ∗p3)

- void gac_plane_destroy (gac_plane_t ∗plane)
- bool gac_plane_init (gac_plane_t ∗plane, vec3 ∗p1, vec3 ∗p2, vec3 ∗p3)
- bool gac_plane_intersection (gac_plane_t ∗plane, vec3 ∗origin, vec3 ∗dir, vec3 ∗intersection)
- bool gac_plane_point (gac_plane_t ∗plane, vec3 ∗point3d, vec2 ∗point2d)

6.11.1 Detailed Description

Plane definitions to work with 3d to 2d conversions. A plane is defined through three arbitrary points.
gac_plane.h

Author

Simon Maurer

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6.11.2 Function Documentation

6.11.2.1 gac_plane_create()

```
gac_plane_t* gac_plane_create (
             vec3 * p1,
             vec3 * p2,
             vec3 * p3 )
```

Allocate a plane in 3d space. This need to be freed with `gac_plane_destroy()`.

Parameters

p1	The 3d coordinates of a point in 3d space.
p2	The 3d coordinates of a point in 3d space.
p3	The 3d coordinates of a point in 3d space.

Returns

A pointer to the allocated plane or NULL on failure.

Author

Simon Maurer

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6.11.2.2 gac_plane_destroy()

```
void gac_plane_destroy (
             gac_plane_t * plane )
```

Destroy a plane structure.

Parameters

plane	A pointer to the plane structure to destroy.

6.11.2.3 gac_plane_init()

```
bool gac_plane_init (
            gac_plane_t * plane,
            vec3 * p1,
            vec3 * p2,
            vec3 * p3 )
```

Initialise a plane in 3d space.

Parameters

plane	A pointer to the plane structure to initialise.
p1	The 3d coordinates of a point in 3d space.
p2	The 3d coordinates of a point in 3d space.
p3	The 3d coordinates of a point in 3d space.

Returns

True on succes and false on failure.

6.11.2.4 gac_plane_intersection()

```
bool gac_plane_intersection (
            gac_plane_t * plane,
            vec3 * origin,
            vec3 * dir,
            vec3 * intersection )
```

Compute the 3d intersection point with a plane.

Parameters

plane	A pointer to the plane structure.
origin	The origin of the gaze.
dir	The gaze direction.
intersection	A location to store the intersection point. This is only valid if the function returns true.

Returns

True if an intersection was found, false otherwise.

6.11.2.5 gac_plane_point()

```
bool gac_plane_point (
            gac_plane_t * plane,
            vec3 * point3d,
            vec2 * point2d )
```

Transform a 3d gaze point into a 2d point on a plane. This only works for 3d points which coincide with the plane. To compute an intersection use the function gac_plane_intersection().

Parameters

plane	A pointer to the plane structure.
point3d	The 3d point to transform.
point2d	A location where the 2d point will be stored. This is only valid if the function returns true.

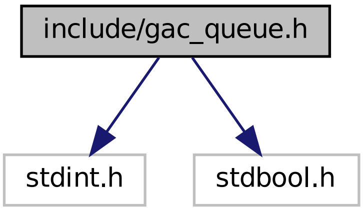
Returns

True on success, false otherwise.

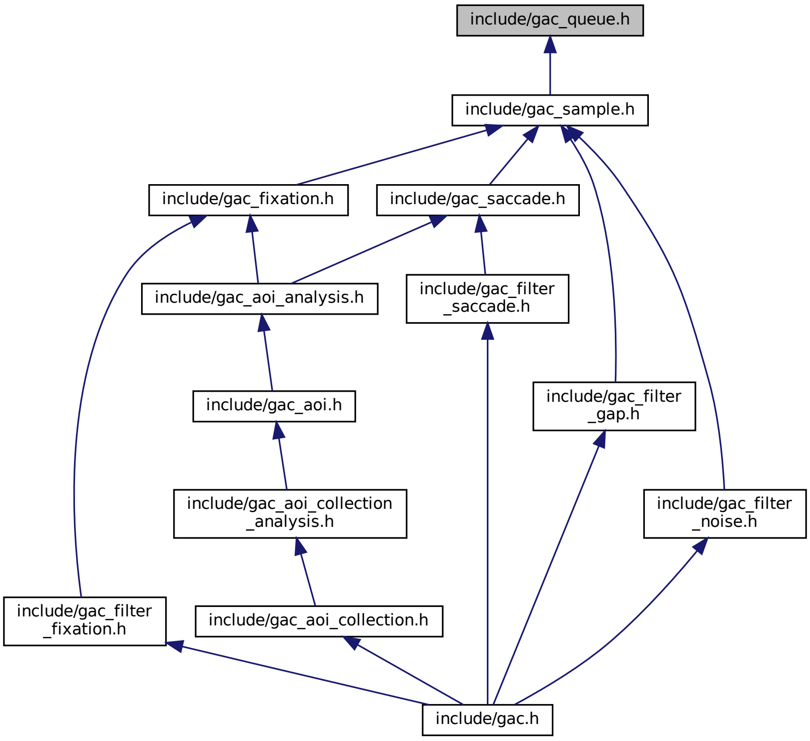
6.12 include/gac_queue.h File Reference

```
#include <stdint.h>
#include <stdbool.h>
```

Include dependency graph for gac_queue.h:



This graph shows which files directly or indirectly include this file:


include/gac_queue.h
include/gac_sample.h
include/gac_fixation.h
include/gac_saccade.h
include/gac_aoi_analysis.h
include/gac_filter _saccade.h
include/gac_aoi.h
include/gac_filter _gap.h
include/gac_aoi_collection _analysis.h
include/gac_filter _noise.h
include/gac_filter _fixation.h
include/gac_aoi_collection.h
include/gac.h

Data Structures

- struct gac_queue_item_t
- struct gac_queue_t

Functions

- bool gac_queue_clear (gac_queue_t ∗queue)
- gac_queue_t ∗ gac_queue_create (uint32_t length)
- void gac_queue_destroy (gac_queue_t ∗queue)
- bool gac_queue_grow (gac_queue_t ∗queue, uint32_t count)
- bool gac_queue_init (gac_queue_t ∗queue, uint32_t length)
- bool gac_queue_pop (gac_queue_t ∗queue, void ∗∗data)
- bool gac_queue_push (gac_queue_t ∗queue, void ∗data)
- bool gac_queue_remove (gac_queue_t ∗queue)
- bool gac_queue_set_rm_handler (gac_queue_t ∗queue, void(∗rm)(void ∗))

6.12.1 Detailed Description

A queue structure whcih grows dynamically with added items.
gac_queue.h

Author

Simon Maurer

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6.12.2 Function Documentation

6.12.2.1 gac_queue_clear()

```
bool gac_queue_clear (
            gac_queue_t * queue )
```

Remove all data items from the queue. The queue remove handler is used to free the data.

Parameters

queue	The queue to clear

Returns

True on success, false on failure.

Author

Simon Maurer

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6.12.2.2 gac_queue_create()

```
gac_queue_t* gac_queue_create (
            uint32_t length )
```

Allocate a new queue structure. This needs to be freed.

Parameters

length	The length of the queue.

Returns

The allocated queue structure.

6.12.2.3 gac_queue_destroy()

```
void gac_queue_destroy (
            gac_queue_t * queue )
```

Destroy a queue, all ist items and all data inside the items.

Parameters

queue	A pointer to the queue to destroy

6.12.2.4 gac_queue_grow()

```
bool gac_queue_grow (
             gac_queue_t * queue,
             uint32_t count )
```

Grow the queue.

Parameters

queue	A pointer to the queue to grow.
count	The number of spaces to add.

Returns

True on success, false on failure.

6.12.2.5 gac_queue_init()

```
bool gac_queue_init (
             gac_queue_t * queue,
             uint32_t length )
```

Initialise a queue structure.

Parameters

queue	A pointer to the queue to initialise.
length	The length of the queue

Returns

True on success, false on failure.

6.12.2.6 gac_queue_pop()

```
bool gac_queue_pop (
             gac_queue_t * queue,
             void ** data )
```

Remove a the data from the head of the queue and link the the now free space to the tail of the queue.

Parameters

queue	A pointer to the queue.
data	An optional location to store the popped data.

Returns

True on success, false on failure.

6.12.2.7 gac_queue_push()

```
bool gac_queue_push (
            gac_queue_t * queue,
            void * data )
```

Add a new item to the tail of the queue. If no more space is available, the queue is grown by one.

Parameters

queue	A pointer to the queue.
data	The data sample to be added to the tail of the queue.

Returns

True on success, false on failure.

6.12.2.8 gac_queue_remove()

```
bool gac_queue_remove (
            gac_queue_t * queue )
```

The same as gac_queue_pop() but also freeing the data item with the configured remove handler.

Parameters

queue	A pointer to the queue.

Returns

True on success, false on failure.

6.12.2.9 gac_queue_set_rm_handler()

```
bool gac_queue_set_rm_handler (
            gac_queue_t * queue,
            void(*)(void *) rm )
```

Set a remove handler which will be called whenever an item is removed from the queue.

Parameters

queue	A pointer to the queue.
rm	The renmove handler.

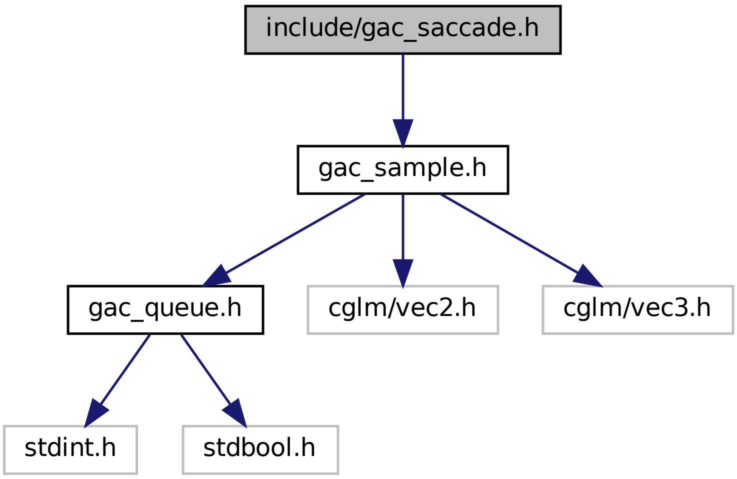
Returns

True on success, false on failure.

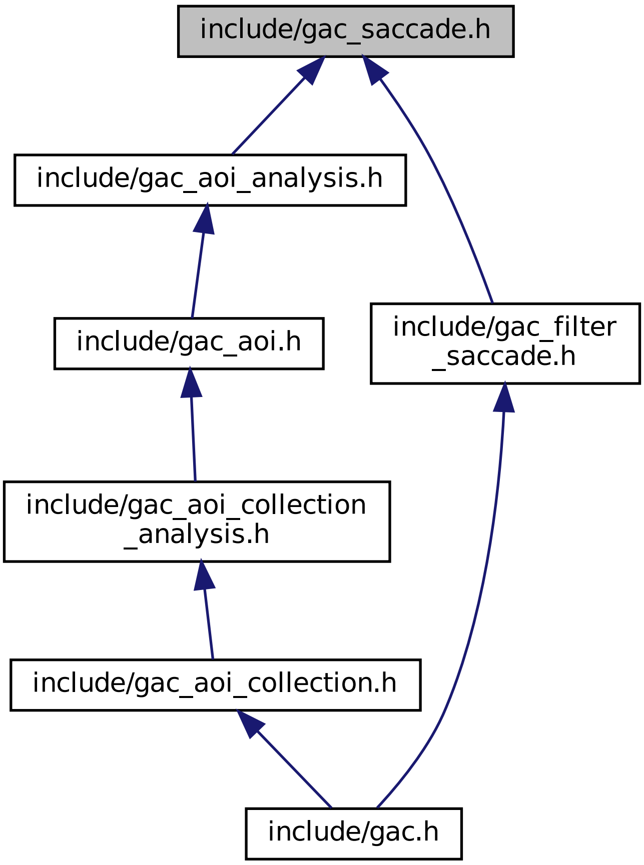
6.13 include/gac_saccade.h File Reference

```
#include "gac_sample.h"
```

Include dependency graph for gac_saccade.h:



This graph shows which files directly or indirectly include this file:


include/gac_saccade.h
include/gac_aoi_analysis.h
include/gac_aoi.h
include/gac_filter_saccade.h
include/gac_aoi_collection_analysis.h
include/gac_aoi_collection.h
include/gac.h

Data Structures

- struct gac_saccade_t

Functions

- gac_saccade_t ∗ gac_saccade_copy (gac_saccade_t ∗saccade)
- bool gac_saccade_copy_to (gac_saccade_t ∗tgt, gac_saccade_t ∗src)
- gac_saccade_t ∗ gac_saccade_create (gac_sample_t ∗first_sample, gac_sample_t ∗last_sample)
- void gac_saccade_destroy (gac_saccade_t ∗saccade)
- bool gac_saccade_init (gac_saccade_t ∗saccade, gac_sample_t ∗first_sample, gac_sample_t ∗last_sample)

6.13.1 Detailed Description

The saccade data structure.
gac_saccade.h

Author

Simon Maurer

License:

6.13.2 Function Documentation

6.13.2.1 gac_saccade_copy()

```
gac_saccade_t* gac_saccade_copy (
             gac_saccade_t * saccade )
```

Create a new copy of saccade.

Parameters

saccade	A pointer to the saccade to copy.

Returns

A pointer to a newly allocated saccade.

Author

Simon Maurer

License:

6.13.2.2 gac_saccade_copy_to()

```
bool gac_saccade_copy_to (
             gac_saccade_t * tgt,
             gac_saccade_t * src )
```

Copy a saccade structure.

Parameters

tgt	A pointer to a saccade structure to cpy to.
src	A pointer to the saccade structure to be copied.

6.13.2.3 gac_saccade_create()

```
gac_saccade_t* gac_saccade_create (
             gac_sample_t * first_sample,
             gac_sample_t * last_sample )
```

Allocate a new saccade structure on the heap. This needs to be freed.

Parameters

first_sample	The first sample of the saccade, holding the source point.
last_sample	The last sample of the saccade, holding the target point.

Returns

The allocated saccade structure on success or NULL on failure.

6.13.2.4 gac_saccade_destroy()

```
void gac_saccade_destroy (
            gac_saccade_t * saccade )
```

Destroy a saccade structure.

Parameters

saccade	A pointer to the saccade structure to destroy.

6.13.2.5 gac_saccade_init()

```
bool gac_saccade_init (
            gac_saccade_t * saccade,
            gac_sample_t * first_sample,
            gac_sample_t * last_sample )
```

Initialise a saccade structure.

Parameters

saccade	A pointer to the saccade structure to initialise.
first_sample	The first sample of the saccade, holding the source point.
last_sample	The last sample of the saccade, holding the target point.

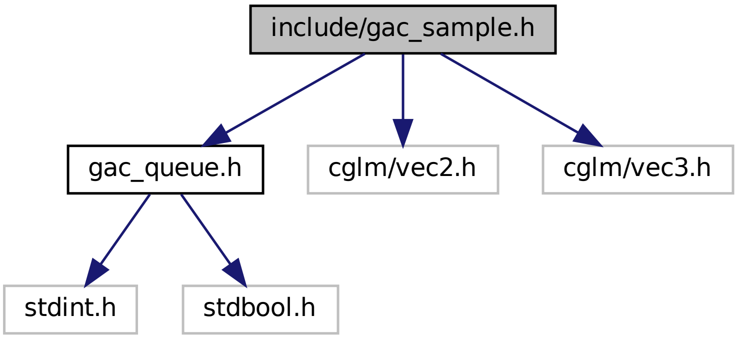
Returns

True on success, false on failure.

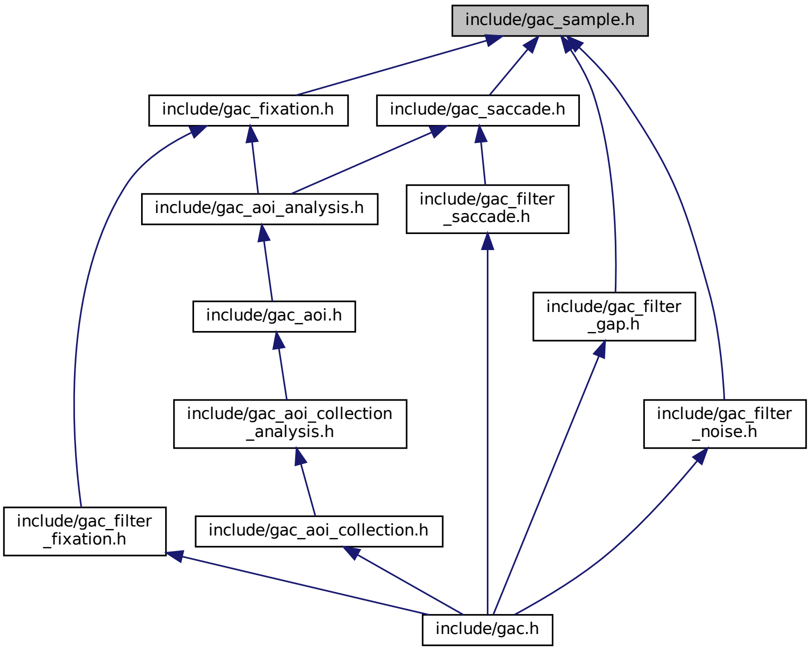
6.14 include/gac_sample.h File Reference

```
#include "gac_queue.h"
#include <cglm/vec2.h>
#include <cglm/vec3.h>
```

Include dependency graph for gac_sample.h:



This graph shows which files directly or indirectly include this file:



Data Structures

- struct gac_sample_t

Macros

- #define GAC_SAMPLE_MAX_LABEL_LEN 100

Functions

- gac_sample_t ∗ gac_sample_create (vec2 ∗screen_point, vec3 ∗origin, vec3 ∗point, double timestamp, uint32_t trial_id, const char ∗label)
- gac_sample_t ∗ gac_sample_copy (gac_sample_t ∗sample)
- bool gac_sample_copy_to (gac_sample_t ∗dest, gac_sample_t ∗sample)
- void gac_sample_destroy (void ∗sample)
- double gac_sample_get_label_timestamp (gac_sample_t ∗sample)
- double gac_sample_get_onset (gac_sample_t ∗sample, double ref)
- double gac_sample_get_trial_timestamp (gac_sample_t ∗sample)
- bool gac_sample_init (gac_sample_t ∗sample, vec2 ∗screen_point, vec3 ∗origin, vec3 ∗point, double timestamp, uint32_t trial_id, const char ∗label)
- bool gac_samples_average_point (gac_queue_t ∗samples, vec3 ∗avg, uint32_t count)
- bool gac_samples_average_origin (gac_queue_t ∗samples, vec3 ∗avg, uint32_t count)
- bool gac_samples_average_screen_point (gac_queue_t ∗samples, vec2 ∗avg, uint32_t count)
- bool gac_samples_dispersion (gac_queue_t ∗samples, float ∗dispersion, uint32_t count)

6.14.1 Detailed Description

Gaze analysis sample definitions and helper functions.
gac_sample.h

Author

Simon Maurer

License:

6.14.2 Macro Definition Documentation

6.14.2.1 GAC_SAMPLE_MAX_LABEL_LEN

```
#define GAC_SAMPLE_MAX_LABEL_LEN 100
```

The maximal label length

6.14.3 Function Documentation

6.14.3.1 gac_sample_copy()

```
gac_sample_t* gac_sample_copy (
            gac_sample_t * sample )
```

Create a deep copy of a sample. This needs to be freed with gac_sample_destroy().

Parameters

sample	The sample to copy

Returns

A pointer to the new sample or NULL.

Author

Simon Maurer

License:

6.14.3.2 gac_sample_copy_to()

```
bool gac_sample_copy_to (
            gac_sample_t * dest,
            gac_sample_t * sample )
```

Deep copy of a sample to a target. This needs to be freed with gac_sample_destroy().

Parameters

dest	The location where the sample will be copied to.
sample	The sample to copy

Returns

A pointer to the new sample or NULL.

6.14.3.3 gac_sample_create()

```
gac_sample_t* gac_sample_create (
            vec2 * screen_point,
            vec3 * origin,
            vec3 * point,
            double timestamp,
            uint32_t trial_id,
            const char * label )
```

Allocate a new sample structure on the heap. This needs to be freed.

Parameters

screen_point	The 2d screen gaze point vector.
origin	The gaze origin vector.
point	The gaze point vector.
timestamp	The timestamp of the sample.
trial_id	The ID of the ongoing trial.
label	An optional arbitrary label annotating the sample.

Returns

The allocated sample structure or NULL on failure.

6.14.3.4 gac_sample_destroy()

```
void gac_sample_destroy (
            void * sample )
```

Destroy a sample structure.

Parameters

sample	A pointer to the structure to be destroyed.

6.14.3.5 gac_sample_get_label_timestamp()

```
double gac_sample_get_label_timestamp (
            gac_sample_t * sample )
```

Compute the label timestamp of a sample.

Parameters

sample	A pointer to a sample.

Returns

The label timestamp in milliseconds.

6.14.3.6 gac_sample_get_onset()

```
double gac_sample_get_onset (
            gac_sample_t * sample,
            double ref )
```

Compute the sample onset in milliseconds given a refernece timestamp.

Parameters

sample	A pointer to a sample.
ref	A refernce timestamp.

Returns

The sample onset in milliseconds.

6.14.3.7 gac_sample_get_trial_timestamp()

```
double gac_sample_get_trial_timestamp (
            gac_sample_t * sample )
```

Compute the trial timestamp of a sample.

Parameters

sample	A pointer to a sample.

Returns

The trial timestamp in milliseconds.

6.14.3.8 gac_sample_init()

```
bool gac_sample_init (
            gac_sample_t * sample,
            vec2 * screen_point,
            vec3 * origin,
            vec3 * point,
            double timestamp,
            uint32_t trial_id,
            const char * label )
```

Initialise a sample structure.

Parameters

sample	The sample structure to initialise.
screen_point	The 2d screen gaze point vector.
origin	The gaze origin vector.
point	The gaze point vector.
timestamp	The timestamp of the sample.
trial_id	The ID of the ongoing trial.
label	An optional arbitrary label annotating the sample.

Returns

True on success, false on failure.

6.14.3.9 gac_samples_average_origin()

```
bool gac_samples_average_origin (
            gac_queue_t * samples,
            vec3 * avg,
            uint32_t count )
```

Compute the average gaze origin of samples in the sample window.

Parameters

samples	A pointer to the sample window.
avg	A location to store the average gaze origin. This is only valid if the function returns true.
count	The number of samples to perform the computation on, starting by the queue tail (newest first). If 0 is passed, all samples are included.

6.14.3.10 gac_samples_average_point()

```
bool gac_samples_average_point (
            gac_queue_t * samples,
            vec3 * avg,
            uint32_t count )
```

Compute the average gaze point of samples in the sample window.

Parameters

samples	A pointer to the sample window.
avg	A location to store the average gaze point. This is only valid if the function returns true.

Parameters

count	The number of samples to perform the computation on, starting by the queue tail (newest first). If 0 is passed, all samples are included.

6.14.3.11 gac_samples_average_screen_point()

```
bool gac_samples_average_screen_point (
            gac_queue_t * samples,
            vec2 * avg,
            uint32_t count )
```

Compute the average screen gaze point of samples in the sample window.

Parameters

samples	A pointer to the sample window.
avg	A location to store the average gaze point. This is only valid if the function returns true.
count	The number of samples to perform the computation on, starting by the queue tail (newest first). If 0 is passed, all samples are included.

6.14.3.12 gac_samples_dispersion()

```
bool gac_samples_dispersion (
            gac_queue_t * samples,
            float * dispersion,
            uint32_t count )
```

Compute the gaze point dispersion of samples in the sample window.

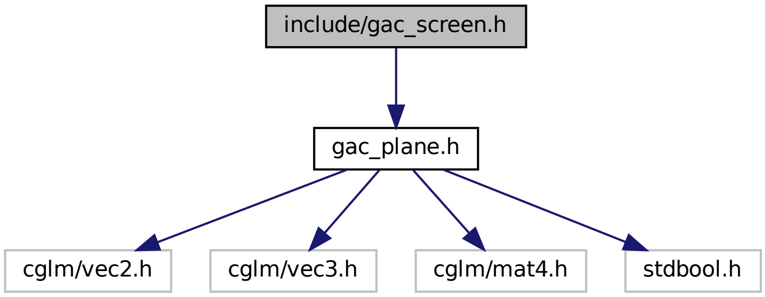
Parameters

samples	A pointer to the sample window.
dispersion	A location to store the dispersion value. This is only valid if the function returns true.
count	The number of samples to perform the computation on, starting by the queue tail (newest first). If 0 is passed, all samples are included.

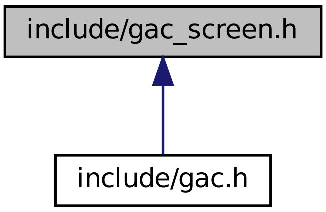
6.15 include/gac_screen.h File Reference

```
#include "gac_plane.h"
```

Include dependency graph for gac_screen.h:



This graph shows which files directly or indirectly include this file:



Data Structures

- struct gac_screen_t

Functions

- gac_screen_t ∗ gac_screen_create (vec3 ∗top_left, vec3 ∗top_right, vec3 ∗bottom_left)
- void gac_screen_destroy (gac_screen_t ∗screen)
- bool gac_screen_init (gac_screen_t ∗screen, vec3 ∗top_left, vec3 ∗top_right, vec3 ∗bottom_left)
- bool gac_screen_point (gac_screen_t ∗screen, vec3 ∗point3d, vec2 ∗point2d)
- bool gac_screen_point_res (gac_screen_t ∗screen, vec3 ∗point3d, vec2 ∗point2d)
- bool gac_screen_set_resolution (gac_screen_t ∗screen, float resolution_x, float resolution_y)

6.15.1 Detailed Description

Screen definitions to work with 3d to 2d conversions. A screen is defined through three points building the top left, top right and bottom left points of a rectangle. The width of a screen is defined by the length of the vector top left -> top right and the height of the screen is defined by the length of the vector top left -> bottom left.
gac_screen.h

Author

Simon Maurer

License:

6.15.2 Function Documentation

6.15.2.1 gac_screen_create()

```
gac_screen_t* gac_screen_create (
            vec3 * top_left,
            vec3 * top_right,
            vec3 * bottom_left )
```

Allocate the screen structure. This needs to be freed with gac_screen_destroy(). The screen is defined through the top left, the top right and the bottom left point of the screen in 3d space. The width, the height, and the bottom right point of the screen are computed based on these three points. Make sure to provide points that describe a rectangle for this to make sense.

Parameters

top_left	The 3d coordinates of the top left screen point.
top_right	The 3d coordinates of the top right screen point.
bottom_left	The 3d coordinates of the bottom left screen point.

Returns

A pointer to the allocated screen structure or NULL on failure.

Author

Simon Maurer

License:

6.15.2.2 gac_screen_destroy()

```
void gac_screen_destroy (
            gac_screen_t * screen )
```

Destroy a screen structure.

Parameters

screen	A pointer to the screen structure to destroy

6.15.2.3 gac_screen_init()

```
bool gac_screen_init (
            gac_screen_t * screen,
            vec3 * top_left,
            vec3 * top_right,
            vec3 * bottom_left )
```

Initialise a screen structure through the top left, the top right and the bottom left point of the screen in 3d space. The width, the height, and the bottom right point of the screen are computed based on these three points. Make sure to provide points that describe a rectangle for this to make sense.

Parameters

screen	A pointer to the screen structure to initialise.
top_left	The 3d coordinates of the top left screen point.
top_right	The 3d coordinates of the top right screen point.
bottom_left	The 3d coordinates of the bottom left screen point.

Returns

True on succes and false on failure.

6.15.2.4 gac_screen_point()

```
bool gac_screen_point (
            gac_screen_t * screen,
            vec3 * point3d,
            vec2 * point2d )
```

Transform a 3d gaze point into a normalized 2d point on the screen. (0, 0) represents the top left corner of the screen and (1, 1) represents the bottom right corner.

Parameters

screen	A pointer to the screen structure.
point3d	The 3d point to transform.
point2d	A location where the 2d point will be stored. This is only valid if the function returns true.

Returns

True on success, false otherwise.

6.15.2.5 gac_screen_point_res()

```
bool gac_screen_point_res (
            gac_screen_t * screen,
            vec3 * point3d,
            vec2 * point2d )
```

The same as gac_screen_point() but storing the resulting 2d point in terms of screen resolution with (0, 0) being the top left corner of the screen. Note that this function will always return false if gac_screen_set_resolution() was never called.

6.15.2.6 gac_screen_set_resolution()

```
bool gac_screen_set_resolution (
            gac_screen_t * screen,
            float resolution_x,
            float resolution_y )
```

Set the screen resolution. This allows to use all functions with an `res` suffix. These functions will act exactly like their counter part function without the `res` suffix but use 2d points expressed in the screen resolution.

Parameters

screen	A pointer to a screen structure.
resolution↩_x	The width of the screen resolution.
resolution↩_y	The height of the screen resolution.

Returns

True on success, false on failure.

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