[redacted] [redacted] [redacted] [redacted] [redacted] [redacted]

[redacted]

[redacted]: Python 3.12+, OpenCV, MediaPipe Holistic, PyAutoGUI, PyQt6, JSON
[redacted]: [redacted] (`main.py`), [redacted] (`gestures.py`), [redacted] (`gui_app.py`), [redacted] (`gestures_config.json`).

[redacted]

---

1. [redacted]
2. [redacted]
3. [redacted]
4. [redacted]
5. [redacted]
6. [redacted]
7. [redacted]
8. [redacted] (A0–A2)
9. [redacted]
10. [redacted]
11. [redacted]
12. [redacted]
13. [redacted]
14. [redacted]
15. [redacted]
16. [redacted]
17. [redacted]

---

1. [redacted]

[redacted] «[redacted]». [redacted] — [redacted]: [redacted], [redacted], [redacted]

[redacted] [redacted] [redacted] [redacted] [redacted] **PyAutoGUI**.

[redacted] [redacted] [redacted] [redacted] [redacted] [redacted] [redacted] [redacted] [redacted] **(SWITCH-[redacted])**: [redacted] [redacted] [redacted] [redacted] **A0**, **A1**, **A2**, [redacted] [redacted] [redacted] `GestureController`.

1.1. [redacted] [redacted]

[redacted]	[redacted]	[redacted]
[redacted] [redacted] ([redacted])	`main.py`	[redacted] [redacted], [redacted] OpenCV
[redacted] [redacted] (GUI)	`gui_app.py`	[redacted], [redacted] [redacted] [redacted], [redacted] [redacted]
[redacted] [redacted]	`gestures.py`	[redacted] `GestureController`
[redacted]	`gestures_config.json`	[redacted] «[redacted] → [redacted]»
[redacted]	`requirements.txt`	[redacted] [redacted]
[redacted]	`doc/`	[redacted] [redacted] [redacted] PNG-[redacted]

1.2. [redacted] [redacted]

- [redacted]**:** `python main.py` — [redacted] «Gesture Control», [redacted] [redacted] `q`.
- [redacted]**:** `python gui_app.py` — [redacted] [redacted], [redacted] [redacted] [redacted] [redacted].

---

2. [redacted] [redacted] [redacted] [redacted] [redacted] [redacted]

2.1. [redacted] [redacted]

[redacted] [redacted] [redacted] [redacted]:

1. [redacted] [redacted] [redacted] [redacted]-[redacted] [redacted] [redacted] [redacted] ([redacted] [redacted] `0`).
2. [redacted] [redacted] 21 [redacted] [redacted] [redacted] [redacted] [redacted] (**MediaPipe Holistic**, [redacted] [redacted]).
3. [redacted] [redacted] [redacted] (0–5) [redacted] [redacted] [redacted] [redacted] ([redacted] [redacted] — [redacted] [redacted] X).
4. [redacted] [redacted] [redacted] [redacted]: **UP**, **DOWN**, **LEFT**, **RIGHT**.

5. [redacted] (`[redacted]`, `[redacted]`, `[redacted]`) [redacted] `gestures_config.json`.
6. [redacted] `pyautogui.hotkey(...)`.
7. [redacted] (`[redacted]`, `[redacted]`).

2.2. [redacted]

2.2.1. [redacted]

- [redacted] `right_hand_landmarks`, `left_hand_landmarks`.
- [redacted] Holistic: `min_detection_confidence=0.5`, `min_tracking_confidence=0.5`.

2.2.2. [redacted]

- [redacted] `count_fingers(hand_landmarks)`.
- [redacted] MediaPipe: [redacted] `[4,8,12,16,20]`, [redacted] `[3,6,10,14,18]`.
- [redacted]: [redacted] `landmark[4].x` [redacted] `landmark[3].x` [redacted] `is_right_hand` ([redacted] vs [redacted]).
- [redacted]: [redacted] «[redacted]», [redacted] `tip.y < pip.y` ([redacted]).

2.2.3. [redacted]

- [redacted]: [redacted], [redacted] [redacted] `fingers > 0`; [redacted] `fingers > 0`.
- [redacted]: [redacted] (0) [redacted] MCP [redacted] (9).
- [redacted]: `collections.deque`, [redacted] `history_length=20`.
- [redacted] `len(hand_positions) >= HISTORY_LENGTH // 2` (10 [redacted] defaults).
- [redacted]: `movement_threshold=80` ([redacted] `*1000`).
- [redacted] ([redacted] `main/gui` [redacted] `cv2.flip`).

2.2.4. [redacted]

- [redacted] JSON-[redacted].
- [redacted]: `hand`, `fingers`, `direction`, `action` ([redacted] `hotkey`).

2.2.5. [redacted]

- **main.py:** [redacted] `Gesture`, `Fingers`, `Gesture: ACTIVE/INACTIVE`, [redacted] ([redacted]).

- **gui_app.py:** `QLabel` [redacted], [redacted]; [redacted] [redacted].

2.3. [redacted]

[redacted]	[redacted]
[redacted]	≥ 15 FPS ([redacted] 25–30 [redacted] CPU)
[redacted] → [redacted]	≤ 0,3 [redacted] [redacted]
[redacted]	640×480 [redacted] ([redacted] [redacted])

2.4. [redacted]

[redacted] [redacted] [redacted] `gestures_config.json`:

```
{ "hand": "right_hand", "fingers": 4, "direction": "LEFT", "action": ["prevtrack"] }
```

- `hand`: `"left_hand"` | `"right_hand"`
- `fingers`: [redacted] 1–5 ([redacted]; 0 [redacted] [redacted])
- `direction`: `"UP"` | `"DOWN"` | `"LEFT"` | `"RIGHT"`
- `action`: [redacted] PyAutoGUI ([redacted]. [redacted])

[redacted]: [redacted], [redacted] GUI (`ConfigEditorWindow`) [redacted].

2.5. [redacted] (

[redacted]	[redacted]	[redacted]	[redacted]
left_hand	3	DOWN	win, d
left_hand	3	UP	win, d
left_hand	2	RIGHT	alt, shift, tab
left_hand	2	LEFT	alt, tab
right_hand	5	DOWN	volumedown
right_hand	5	UP	volumeup
right_hand	5	RIGHT	volumeup
right_hand	4	RIGHT	nexttrack

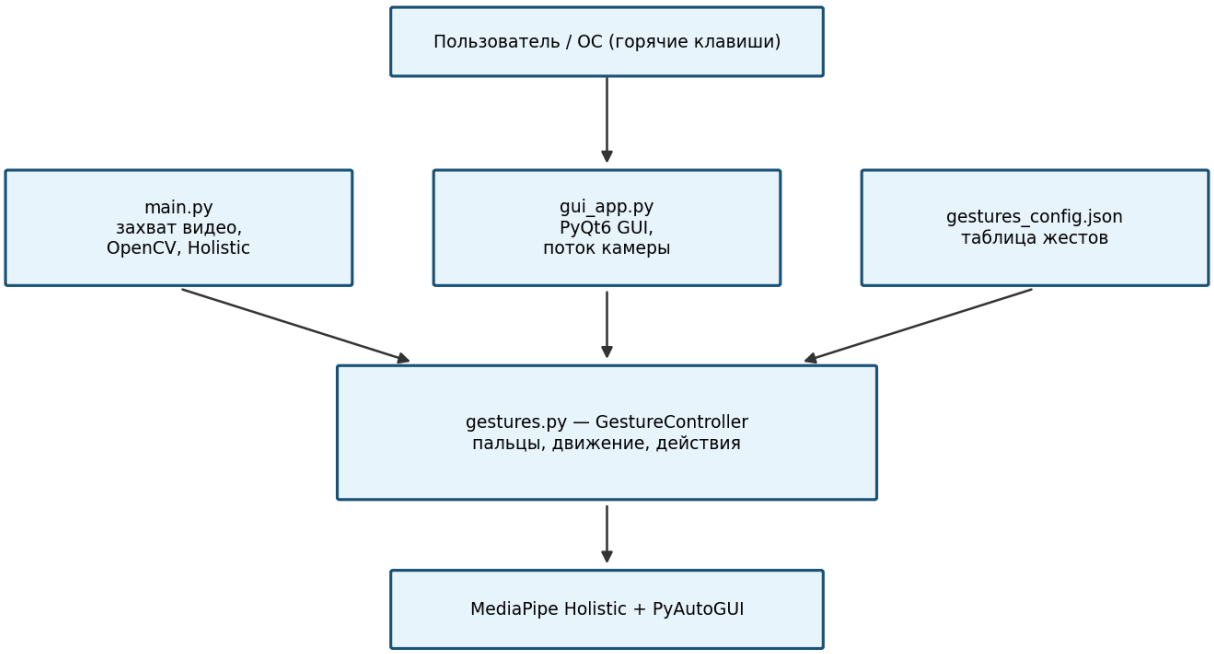
right_hand	4	LEFT	prevtrack
right_hand	4	UP	playpause
right_hand	4	DOWN	pause

---

3. [redacted]

3.1. [redacted]

3.1. Общая структурная схема ПО

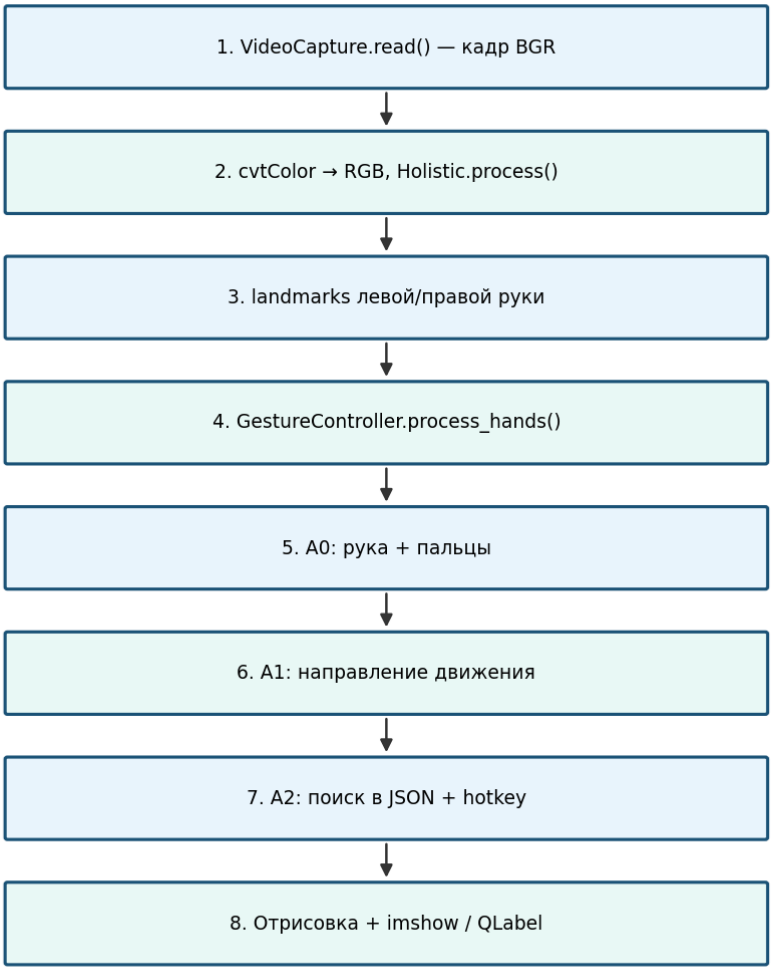


[redacted]:

[redacted]	[redacted]
`main.py`	`VideoCapture`, [redacted] [redacted], Holistic, [redacted], [redacted] `process_hands`
`gui_app.py`	PyQt6: [redacted], [redacted] `VideoThread`, [redacted] JSON
`gestures.py`	`GestureController`: A0–A2, [redacted] [redacted]
`gestures_config.json`	[redacted] [redacted] [redacted]

3.2. [redacted] (**[redacted]**)

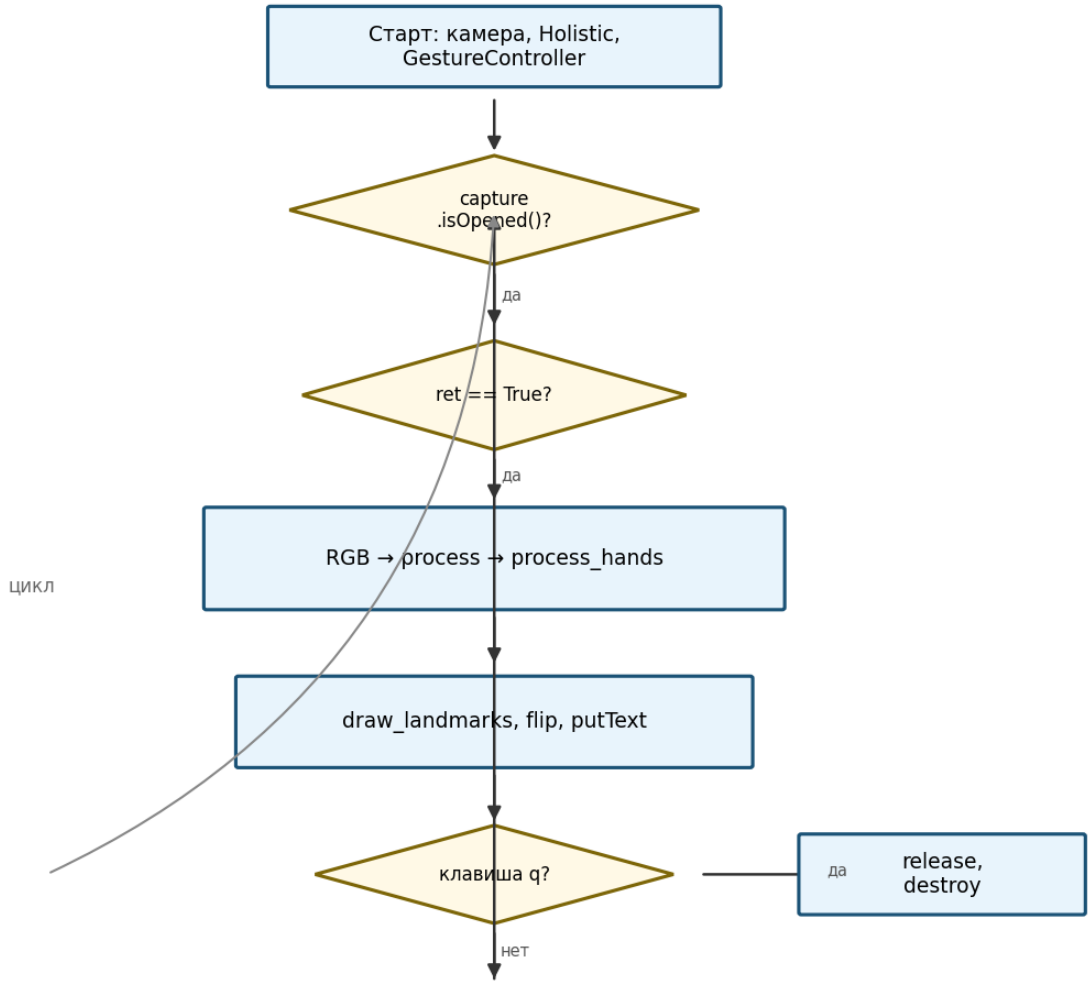
3.2. Порядок взаимодействия модулей (один кадр)



1. `capture.read()` → [redacted] BGR.
2. [redacted] RGB, `holistic_model.process(image)`.
3. [redacted] `right_hand_landmarks`, `left_hand_landmarks` [redacted] `process_hands`.
4. [redacted]: **A0** → **A1** → **A2** ([redacted]).
5. [redacted] landmarks, `flip`, [redacted], `imshow` / [redacted] GUI.

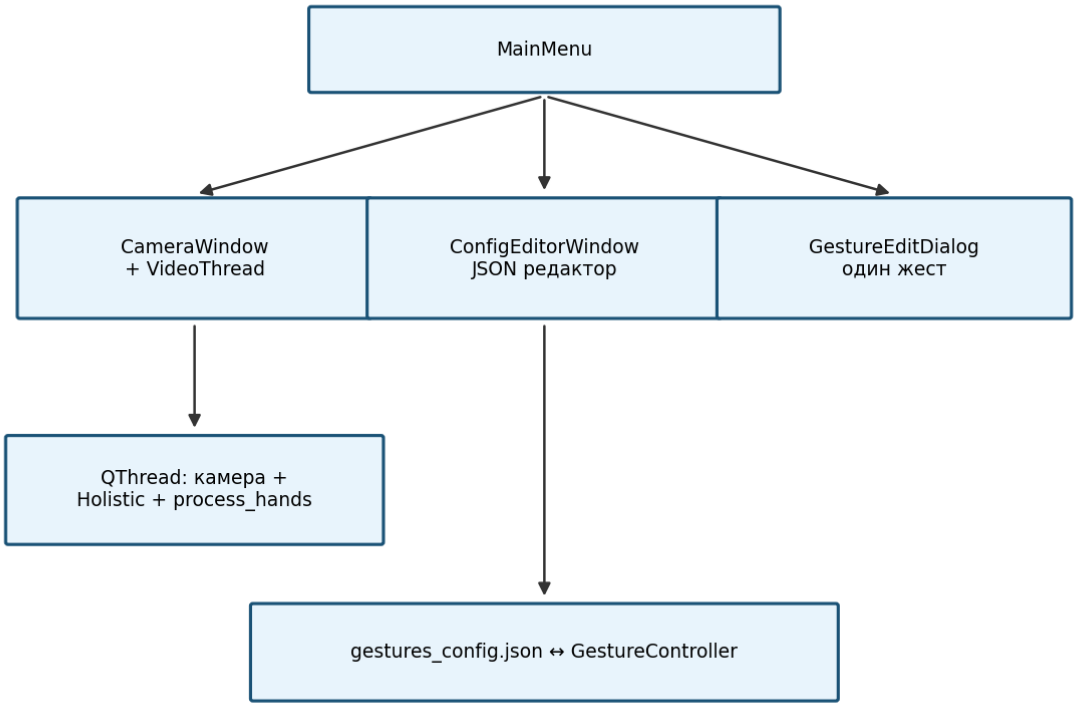
3.3. [redacted]

Блок-схема главного цикла (main.py)



3.4. ■■■■■■■■■■■■ GUI

Структура графического интерфейса (gui_app.py)



[redacted]: `MainMenu`, `CameraWindow`, `VideoThread`, `ConfigEditorWindow`, `GestureEditDialog`.

---

4. [redacted] [redacted] [redacted]

[redacted] [redacted] [redacted] [redacted] ([redacted] [redacted]) [redacted] [redacted] [redacted] [redacted].

[redacted]	[redacted]	[redacted]	[redacted]
m18	NEW_FRAME	[redacted] [redacted] [redacted]	`capture.read()`
m63	RIGHT_HAND	[redacted] [redacted] [redacted]	`results.right_hand_landmarks`
m73	LEFT_HAND	[redacted] [redacted] [redacted]	`results.left_hand_landmarks`
g50	FINGERS_CHANGED	[redacted] [redacted] [redacted] [redacted] [redacted]	[redacted] `current_fingers_count`
g211u	MOVE_UP	[redacted] [redacted] [redacted]	`detect_movement` → `"UP"`

g211d	MOVE_DOWN	[redacted]	`"DOWN"`
g199l	MOVE_LEFT	[redacted]	`"LEFT"`
g199r	MOVE_RIGHT	[redacted]	`"RIGHT"`
g414	HISTORY_READY	[redacted] ≥ HISTORY/2	`len(hand_positions)`
g268	ACTION_DONE	[redacted]	`perform_action`
m91	KEY_Q	[redacted]	`waitKey` == `q`

5. [redacted]

[redacted]	[redacted]	[redacted]	[redacted]
g92r	right_hand_landmarks	NormalizedLandmarkList	[redacted] MediaPipe
g92l	left_hand_landmarks	NormalizedLandmarkList	[redacted]
g413	MOVEMENT_THRESHOLD	int	[redacted] (80)
g415	ACTION_COOLDOWN	float	[redacted] (; [redacted] `process_hands`)
g416	HISTORY_LENGTH	int	[redacted] deque (20)
g41	config_data	list[dict]	[redacted] JSON
g17	config_file	str	[redacted]

6. [redacted]

[redacted]	[redacted]	[redacted]
m63	show_hand_info	[redacted] `r: N f` / `l: N f` [redacted]
m91	show_fingers	`Fingers: N`
m89	show_direction	`Gesture: UP/DOWN/...`
g268	execute_action	`pyautogui.hotkey(*action)`
g92	set_active_hand	`current_hand`, `gesture_active=True`
m90	draw_landmarks	[redacted] HAND_CONNECTIONS
s01	gui_gesture_signal	`gesture_info_signal` [redacted] PyQt

---

7. [redacted] [redacted] [redacted]

7.1. [redacted]

- [redacted] — [redacted]: [redacted].
- [redacted] — [redacted]: [redacted].
- [redacted] — [redacted] [redacted] [redacted] (m, *g*).
- [redacted] — [redacted] [redacted] [redacted].

7.2. [redacted] [redacted]

[redacted] [redacted] [redacted] [redacted]; [redacted] [redacted] [redacted] `process_hands` [redacted] `return`:

```
hand_info = self.detect_hand_and_fingers(...) # A0 if not hand_info: return None # [redacted]
active_hand current_position = self.get_hand_position(...)
self.hand_positions.append(current_position) if len(self.hand_positions) >=
self.HISTORY_LENGTH // 2: direction = self.detect_movement(...) # A1 action =
self.get_action_from_config(...) # A2 if action: self.perform_action(action)
```

---

8. [redacted] [redacted]

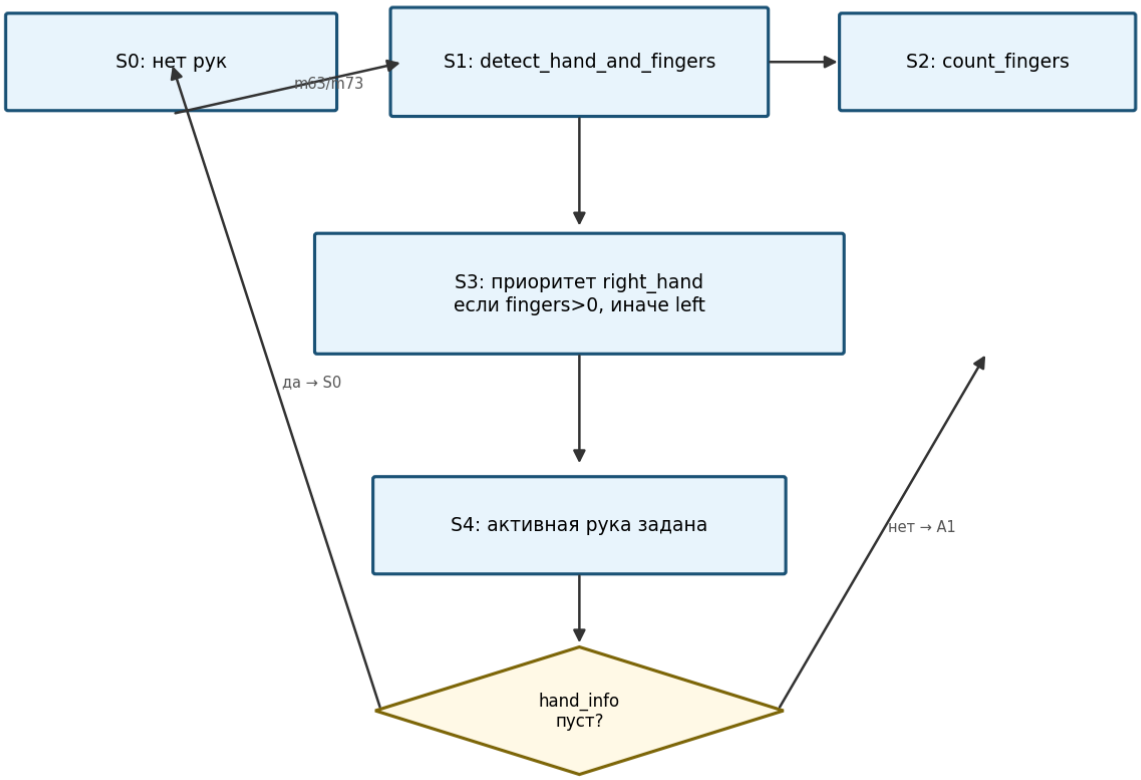
8.1. [redacted] A0 — [redacted] [redacted] [redacted] [redacted]

8.1.1. [redacted]

1. **S0:** [redacted] → `gesture_active=False`, [redacted] `None`.
2. **S1:** [redacted] `detect_hand_and_fingers` — [redacted] `{right_hand: n, left_hand: m}`.
3. **S2:** [redacted] [redacted] `count_fingers`.
4. **S3:** [redacted] `right_hand` [redacted] `fingers>0` → [redacted] `right_hand`; [redacted] [redacted] `left_hand` [redacted] `fingers>0` → `left_hand`; [redacted] S0.
5. **S4:** [redacted] `current_hand`, `current_fingers_count`, [redacted] [redacted] [redacted].

8.1.2. [redacted] [redacted] [redacted] [redacted]

8.1. Автомат A0 — выбор руки и подсчёт пальцев



8.1.3. [redacted] [redacted]

- `detect_hand_and_fingers(right, left)` → `dict | None`
- `count_fingers(hand_landmarks)` → `int`
- [redacted] [redacted] [redacted] `process_hands` ([redacted] 310–325 `gestures.py`)

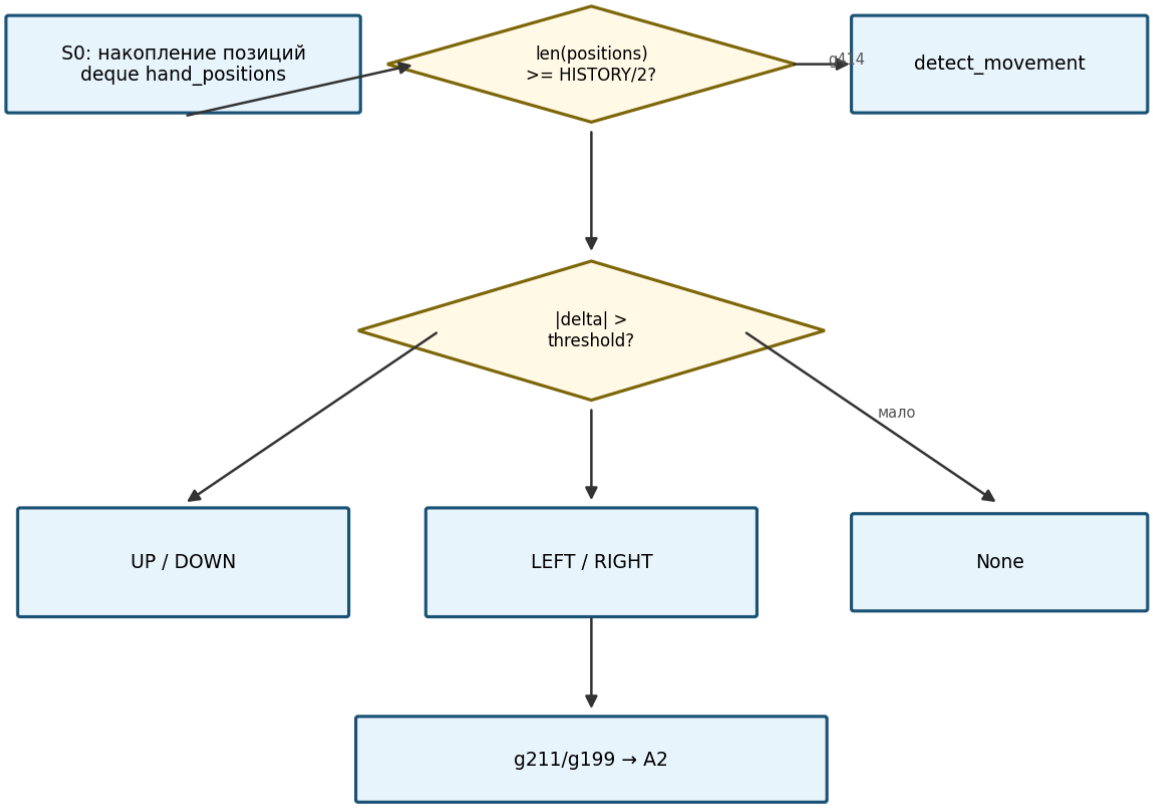
8.2. [redacted] A1 — [redacted] [redacted]

8.2.1. [redacted] [redacted]

1. [redacted] **S0** [redacted] [redacted] `(avg_x, avg_y)` [redacted] `hand_positions`.
2. [redacted] **g414** (`len >= HISTORY_LENGTH//2`) [redacted] `detect_movement`.
3. [redacted] [redacted] 5 [redacted] ([redacted] [redacted] [redacted] [redacted] [redacted]).
4. [redacted] [redacted] `delta_x`, `delta_y`, [redacted] `*1000`.
5. [redacted] `|delta_x|>|delta_y|` [redacted] [redacted] [redacted] [redacted] → LEFT/RIGHT [redacted] [redacted] `active_hand`.
6. [redacted] [redacted] [redacted] [redacted] [redacted] → UP (`delta_y < 0`) / DOWN (`delta_y > 0`).
7. [redacted] [redacted] `None` ([redacted] [redacted] [redacted] [redacted]).

8.2.2. [redacted]

8.2. Автомат A1 — направление движения



8.2.3. [redacted] [redacted]

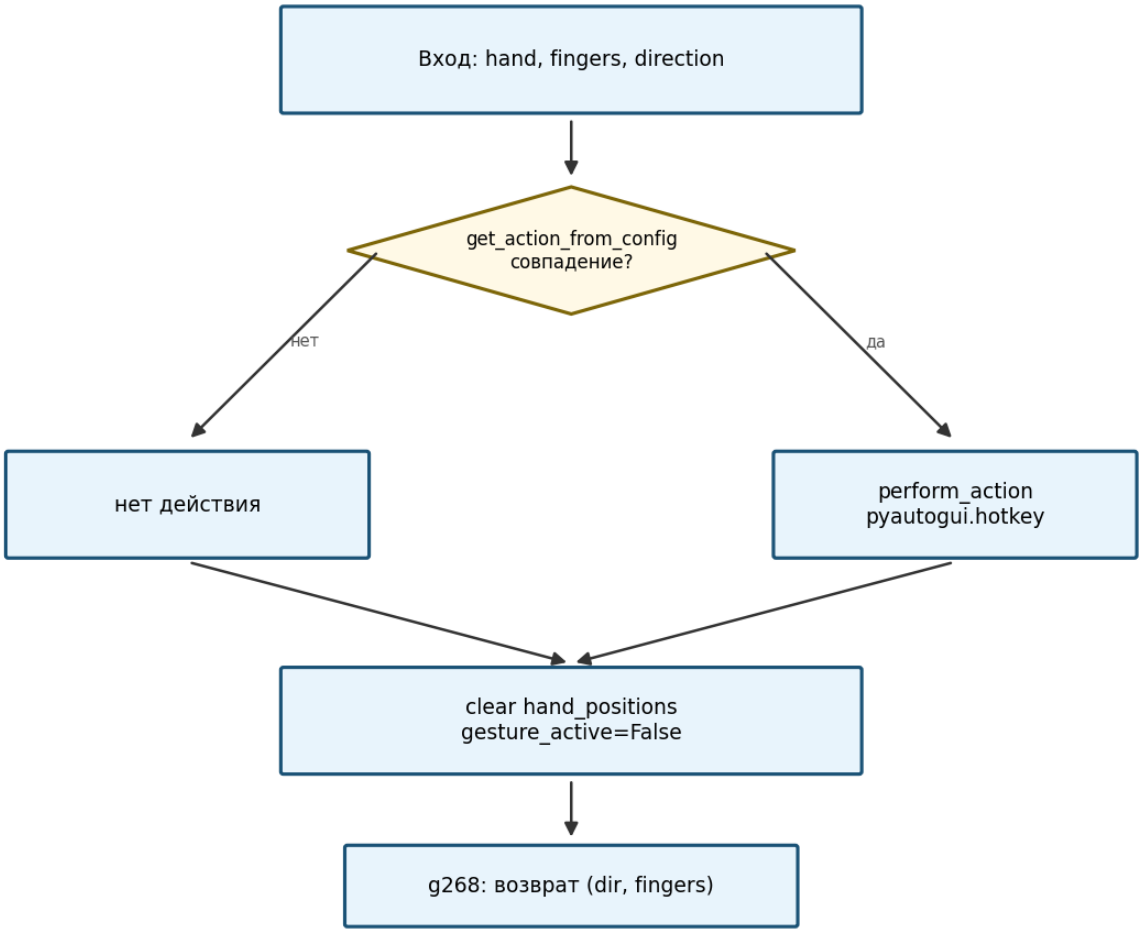
- `detect_movement(positions, active_hand)` → `str | None`
- `get_hand_position(hand_landmarks)` → `(float, float) | None`

8.3. [redacted] A2 — [redacted]

8.3.1. [redacted]

1. [redacted]: `active_hand`, `fingers_count`, `direction`.
2. `get_action_from_config` — [redacted].
3. [redacted] `action` ([redacted]) → `perform_action` (1–5 [redacted]).
4. [redacted] `hand_positions`, `gesture_active=False`, [redacted] `(direction, fingers_count)`.
5. [redacted] (**[redacted]**).

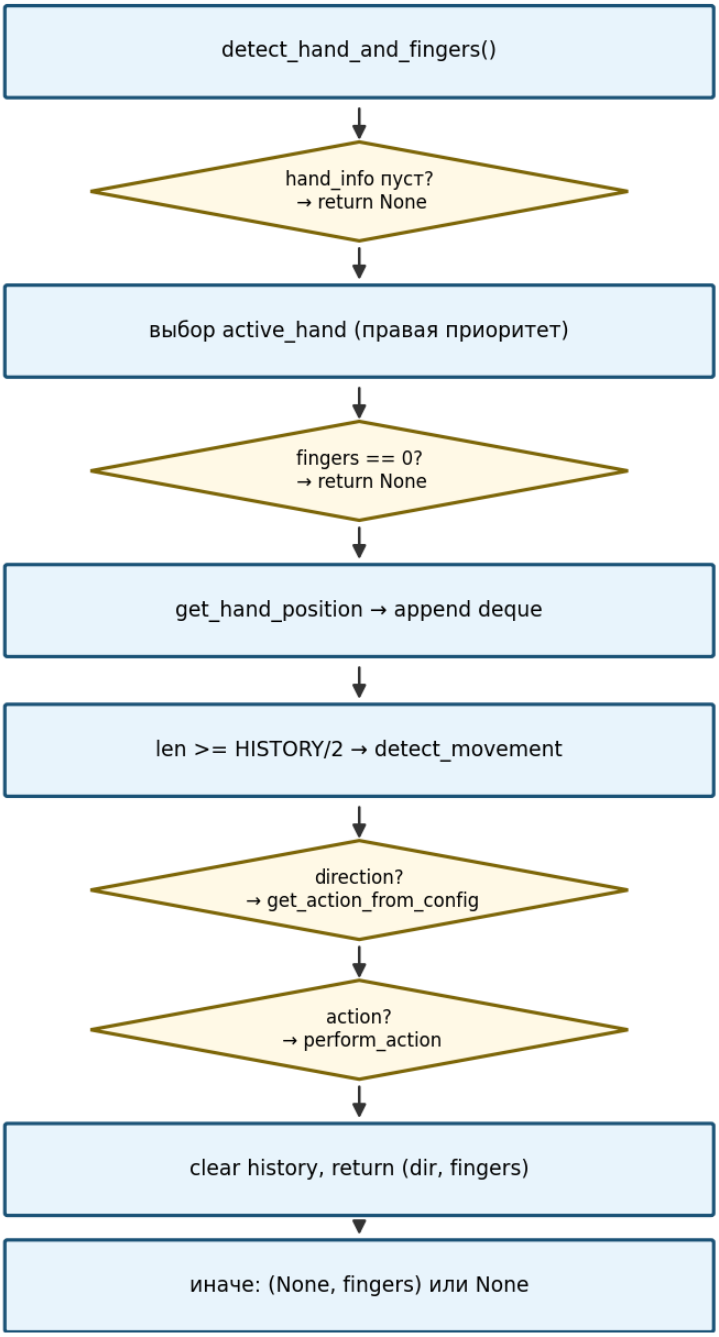
8.3.2. [redacted]



8.3.3. [redacted]

- `get_action_from_config(hand, fingers, direction)` → `list | None`
- `perform_action(action_array)` → [redacted] `pyautogui.hotkey`

8.4. [redacted] process_hands



---

9. [redacted]

[redacted]. [redacted] — [redacted].

9.1. main.py — [redacted]

[redacted]: `mp_holistic.Holistic`, `cv2.VideoCapture(0)`, `GestureController()`.

[redacted]: [redacted] → RGB → `process` → `process_hands` → [redacted] → `flip` → [redacted] → `imshow` → [redacted] `q`.

9.2. gestures.py — [redacted] GestureController

[redacted]	[redacted]
`__init__`	[redacted], deque, [redacted] JSON
`count_fingers`	[redacted] 0–5
`detect_hand_and_fingers`	A0
`get_hand_position`	[redacted] [redacted]
`detect_movement`	A1
`get_action_from_config`	[redacted] [redacted] [redacted]
`perform_action`	hotkey 1–5 [redacted]
`process_hands`	[redacted] A0–A2
`is_gesture_active`	[redacted] [redacted]

[redacted] `create_default_gesture_controller()` — [redacted] 30, history 15, cooldown 1.

9.3. gui_app.py

- **VideoThread** — [redacted] [redacted] [redacted] ([redacted] `main.py`).
- **CameraWindow** — [redacted] `QPixmap`, [redacted] [redacted] `gesture_info_signal`.
- **ConfigEditorWindow** — CRUD [redacted], [redacted] JSON.
- **GestureEditDialog** — [redacted]: [redacted], [redacted] 1–5, [redacted], [redacted] [redacted].

9.4. gestures_config.json

[redacted]; [redacted] UTF-8; [redacted] [redacted] [redacted] `config=None`, [redacted] [redacted].

---

10. [redacted]

10.1. [redacted] [redacted] ([redacted])

[redacted]	[redacted]	[redacted] [redacted] [redacted]

1	`pip install -r requirements.txt`	[redacted]	
2	`python main.py`	[redacted], [redacted] [redacted]	
3	[redacted], 5 [redacted]	[redacted] `r: 5 f`, ACTIVE	
4	[redacted] (5 [redacted])	volumeup ([redacted] [redacted])	
5	[redacted]	volumedown	
6	4 [redacted], [redacted]/[redacted]	prevtrack / nexttrack	
7	[redacted], 2 [redacted], [redacted]	alt+tab	
8	[redacted]	INACTIVE, [redacted] [redacted]	
9	`q`	[redacted]	
10	`python gui_app.py` → Start tracking	[redacted] [redacted] Qt-[redacted]	
11	Edit config → Add gesture → Save	[redacted] [redacted] JSON	
12	[redacted] [redacted] [redacted] [redacted]	[redacted] [redacted]	

10.2. [redacted] (**[redacted]**)

1. [redacted] `main.py`, [redacted] [redacted] [redacted] — [redacted] [redacted].
2. [redacted] [redacted] [redacted] [redacted] 2.5 — [redacted] [redacted] [redacted].
3. [redacted] `q` — [redacted] [redacted].

---

11. [redacted] [redacted] [redacted]

11.1. [redacted] [redacted]

- [redacted] 1–2 [redacted], 4 [redacted], [redacted] [redacted].
- [redacted] [redacted]: OpenCV [redacted] PyQt6.
- [redacted] [redacted] [redacted] [redacted].

11.2. [redacted]

- [redacted] `ret=False` [redacted]; GUI-[redacted] [redacted] `continue`.
- [redacted] JSON [redacted] [redacted] [redacted] — [redacted] [redacted] [redacted].
- [redacted] [redacted] [redacted] [redacted] [redacted] (**[redacted]** [redacted] [redacted] [redacted] [redacted]).

11.3. [redacted]

- [redacted] Windows 10/11 ([redacted] [redacted]).
- [redacted]-[redacted] USB ([redacted] 0).
- [redacted] [redacted] ≥ 1280×720 [redacted] GUI.

11.4. [redacted]

- Python 3.12+.
- MediaPipe 0.10.21.
- [redacted]: JSON UTF-8.
- [redacted] [redacted] [redacted] PyAutoGUI ([redacted]).

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12. [redacted]

[redacted]:

1. [redacted] `DOCUMENTATION.md`.
2. [redacted]-[redacted] PNG [redacted] `doc/diagrams/`.
3. [redacted] [redacted] [redacted] `generate_diagrams.py`.
4. [redacted] `requirements.txt` [redacted] [redacted] `README.md` [redacted].

---

13. [redacted]-[redacted]

[redacted]	[redacted]
[redacted]	[redacted] (3 [redacted] Python + JSON)
[redacted]	0 ([redacted])

[redacted]	[redacted] + [redacted]
[redacted]	[redacted] [redacted]/[redacted] [redacted] [redacted] [redacted]

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14. [redacted] [redacted] [redacted]

[redacted]	[redacted]	[redacted]
1	[redacted], [redacted] MediaPipe	[redacted] [redacted]
2	`gestures.py`, [redacted] A0–A2	[redacted]
3	`main.py`, [redacted]	[redacted] [redacted]
4	`gestures_config.json`	[redacted] [redacted]
5	`gui_app.py`	GUI [redacted] [redacted]
6	[redacted], [redacted]-[redacted]	[redacted] `doc/`

---

15. [redacted] [redacted] [redacted] [redacted]

1. [redacted] [redacted] [redacted] [redacted].
2. [redacted] [redacted] [redacted]. 10.2.
3. [redacted] [redacted]-[redacted] [redacted] [redacted] [redacted].
4. [redacted] [redacted] JSON [redacted] [redacted] [redacted].
5. [redacted] [redacted] [redacted] ([redacted] [redacted] [redacted] [redacted]).

---

16. [redacted] [redacted] [redacted]

```
cd "gesture-control final" python -m venv .venv .venv\Scripts\activate pip install -r
requirements.txt pip install opencv-python PyQt6 python gui_app.py
```

[redacted]:

- PyAutoGUI [redacted] Windows [redacted] [redacted] [redacted] [redacted] [redacted] [redacted] [redacted] [redacted] [redacted] [redacted].

- [redacted] `movement_threshold` [redacted] [redacted] `GestureController(...)` [redacted] `create_default_gesture_controller()`.
- [redacted]: `cv2.flip(image, 1)` — [redacted] «[redacted]/[redacted]» [redacted] [redacted] `detect_movement`.

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17. [redacted]

[redacted]	[redacted]
`diagrams/01_structural_overview.png`	§ 3.1 [redacted]
`diagrams/02_module_interaction.png`	§ 3.2 [redacted] [redacted]
`diagrams/03_main_loop.png`	[redacted] `main.py`
`diagrams/04_automaton_A0.png`	[redacted]
`diagrams/05_automaton_A1.png`	[redacted]
`diagrams/06_automaton_A2.png`	[redacted]
`diagrams/07_process_hands.png`	`process_hands()`
`diagrams/08_gui_architecture.png`	[redacted] GUI

[redacted]: `python doc/generate_diagrams.py`

[redacted] [redacted]. [redacted] [redacted] [redacted] PyAutoGUI ([redacted])

`win`, `d`, `alt`, `shift`, `tab`, `volumeup`, `volumedown`, `nexttrack`, `prevtrack`, `playpause`, `pause`, `ctrl`, `enter`, `esc`, `space`, `f1`–`f12`, [redacted] `up`/`down`/`left`/`right` [redacted]. — [redacted] [redacted] [redacted]. [redacted] PyAutoGUI (`pyautogui.KEYBOARD_KEYS`).

[redacted] [redacted]. [redacted] landmarks [redacted] MediaPipe

[redacted]	[redacted]
0	[redacted]
4	[redacted] [redacted]
8,12,16,20	[redacted] [redacted]

3,6,10,14,18	PIP [redacted]
9	MCP [redacted]

[redacted] *gesture-control.* [redacted]*: 1.0.*