

OOI Implementation

10팀

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Table of Contents

Refinements 02

Sequence Diagram

Class Diagram

Coding 14

Pair Programming and Code Review

Unit test using Google Test

System Test 37

System Test List

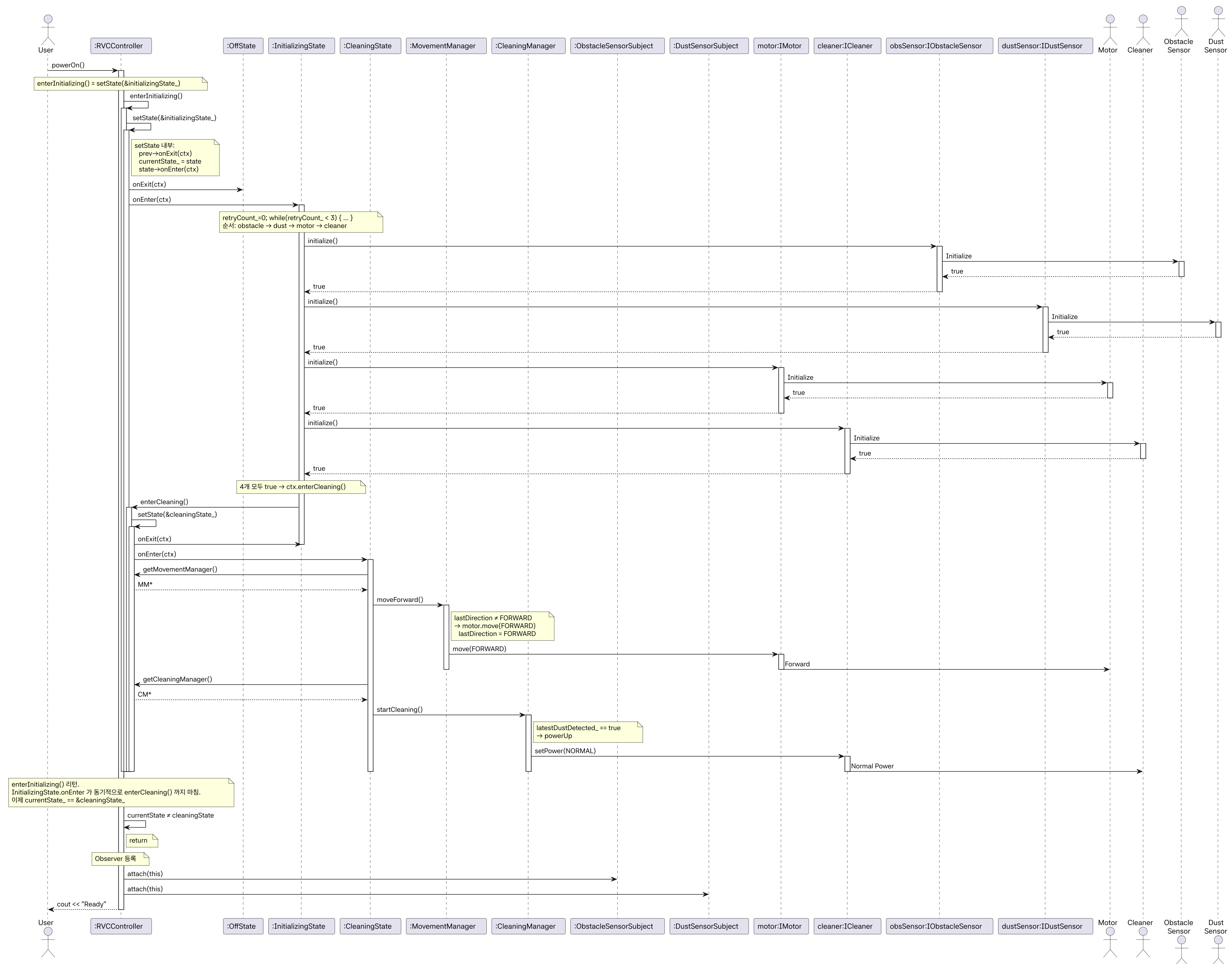
System Test Result

Simulator

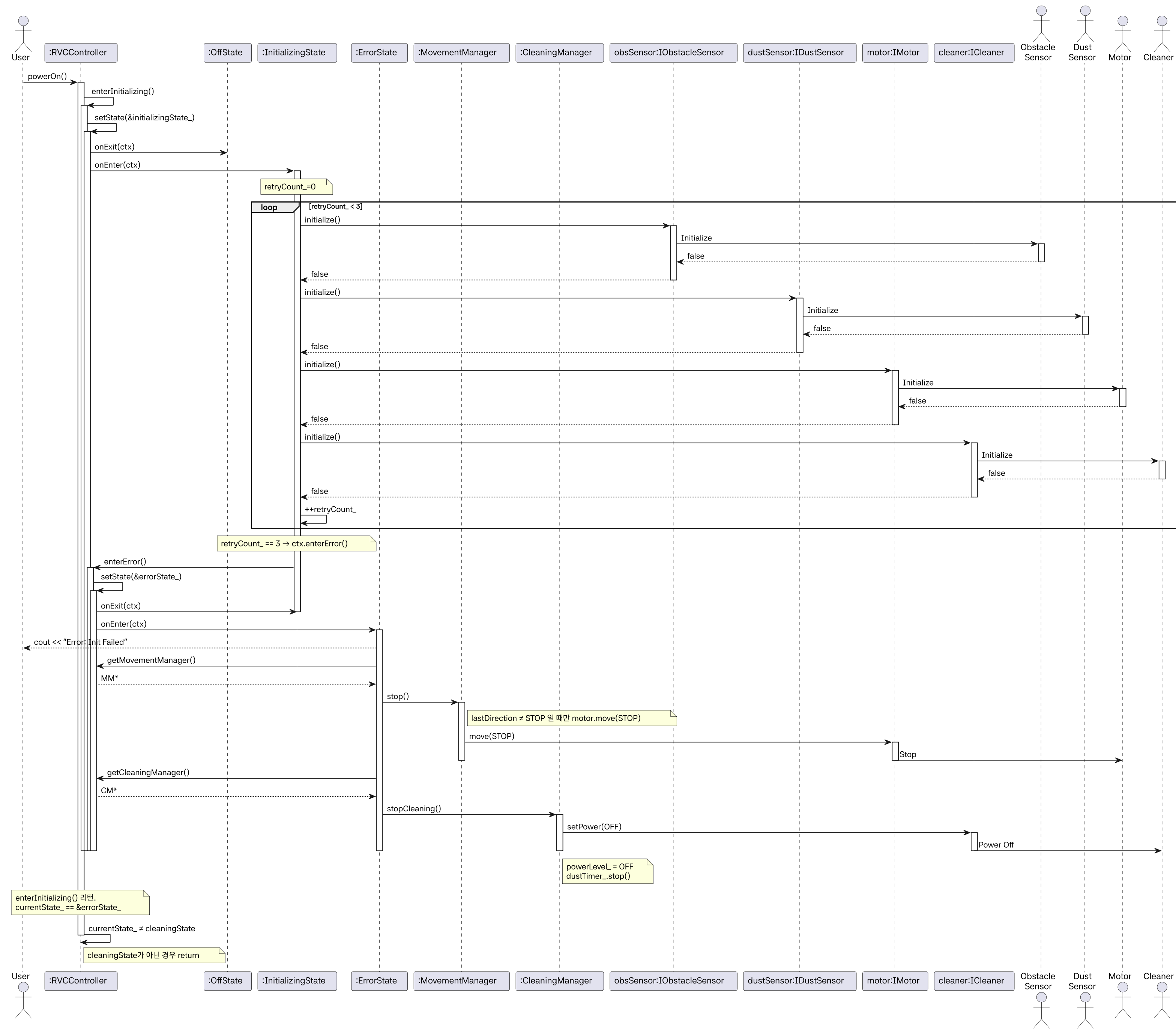
Refinements

Refined Sequence Diagram

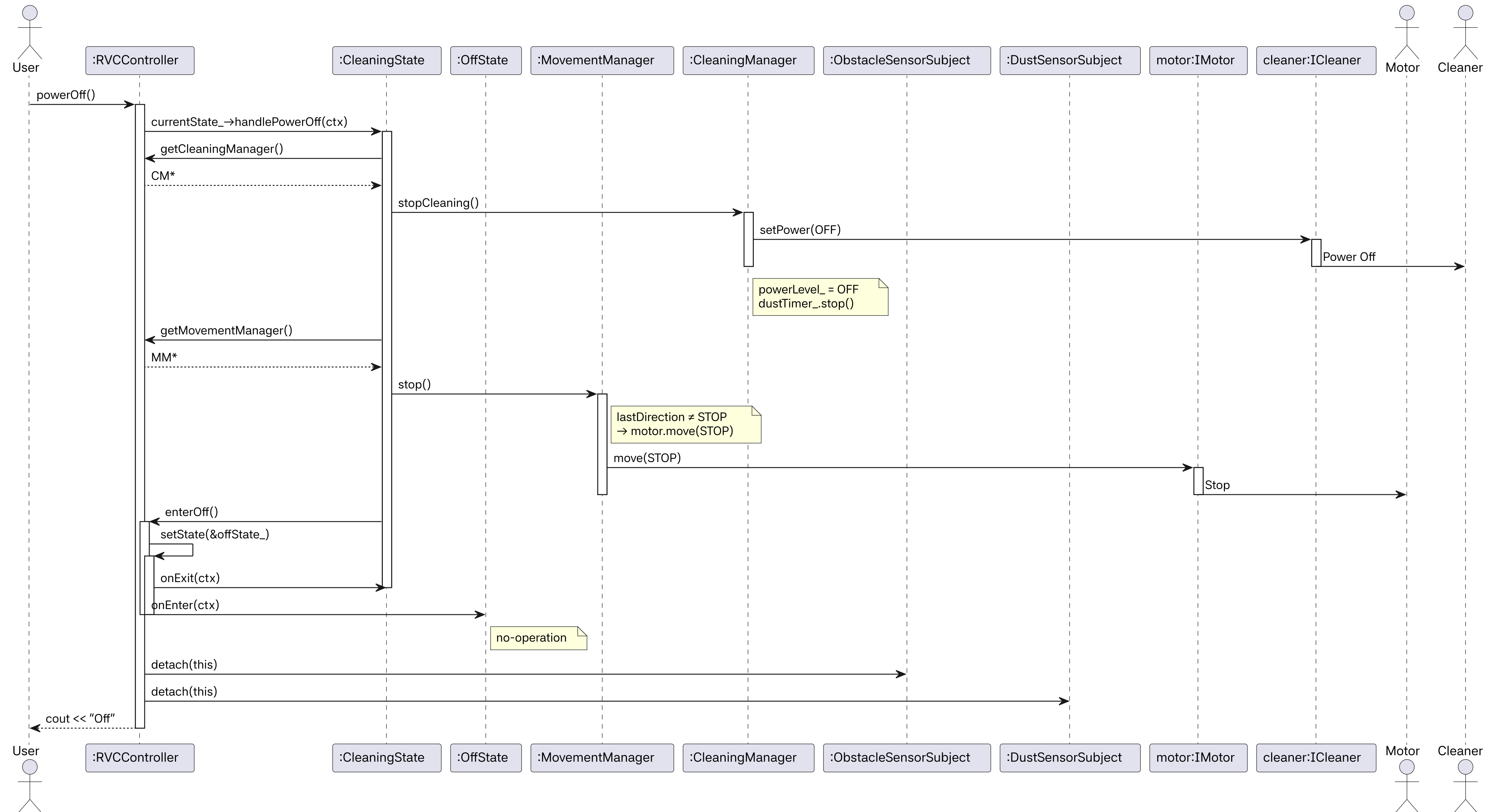
SD-01 - Success



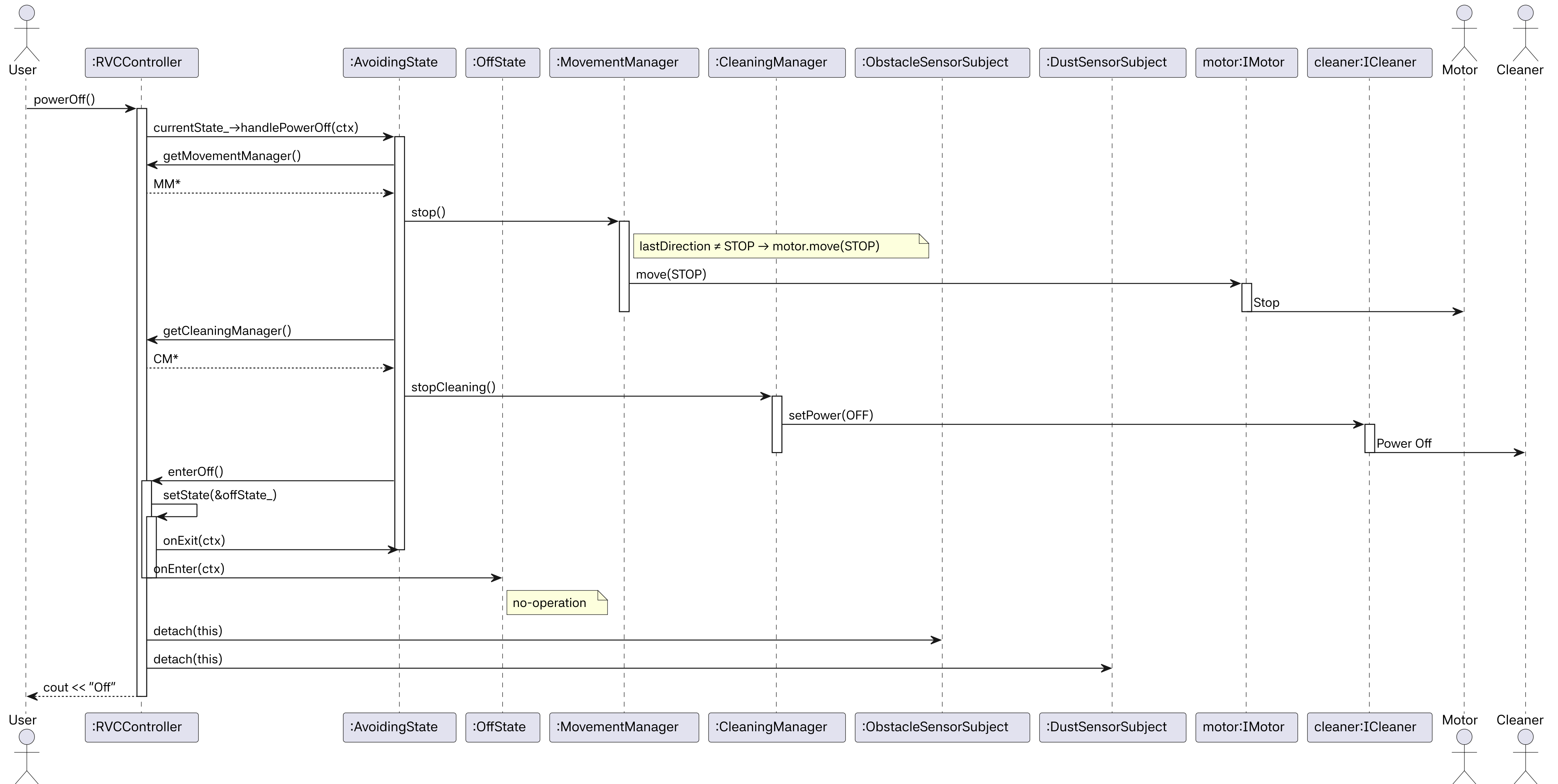
SD-01 - Fail



SD-02 – CleaningState



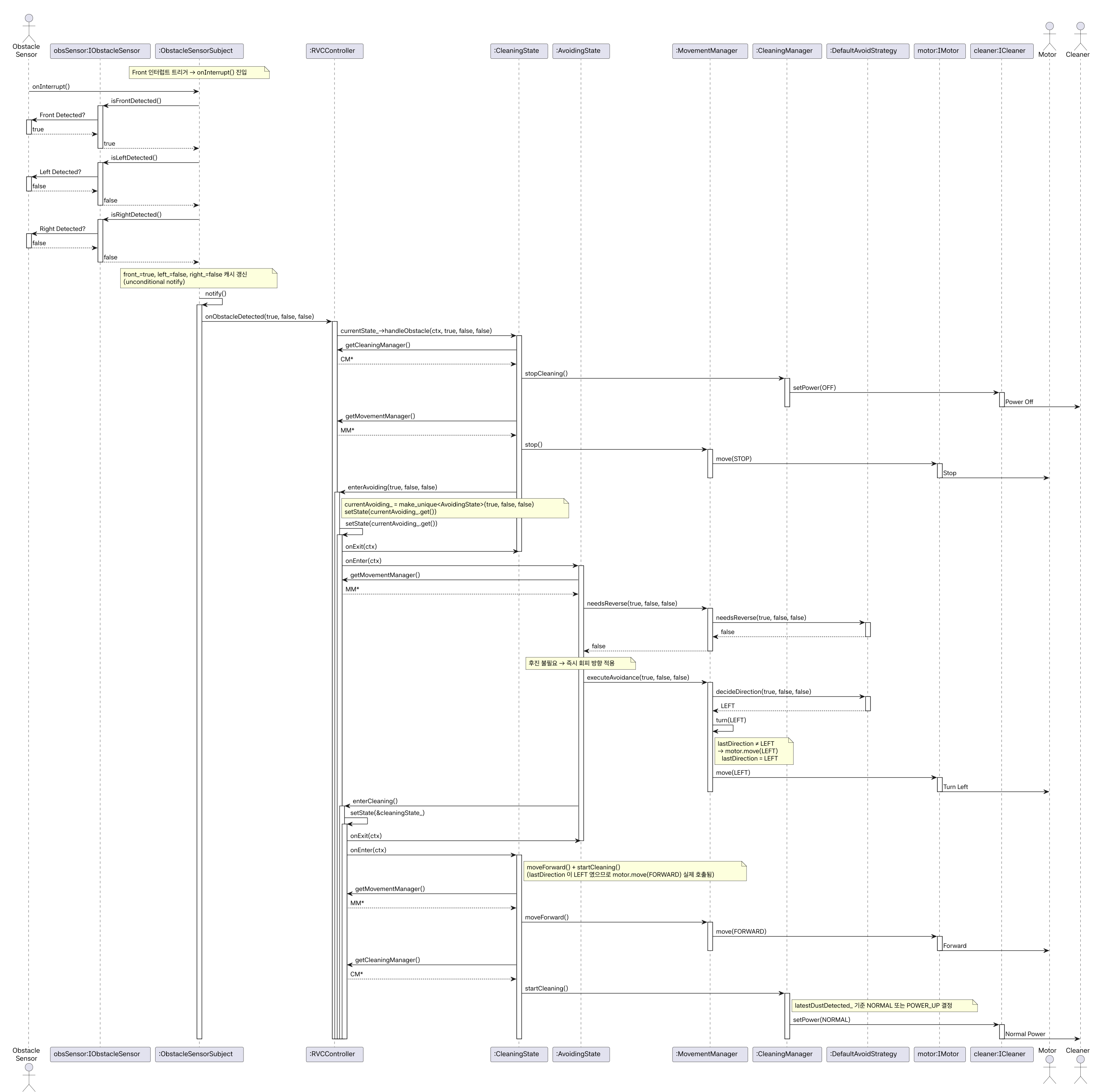
SD-02 – AvoidingState



SD-03

Front Blocked

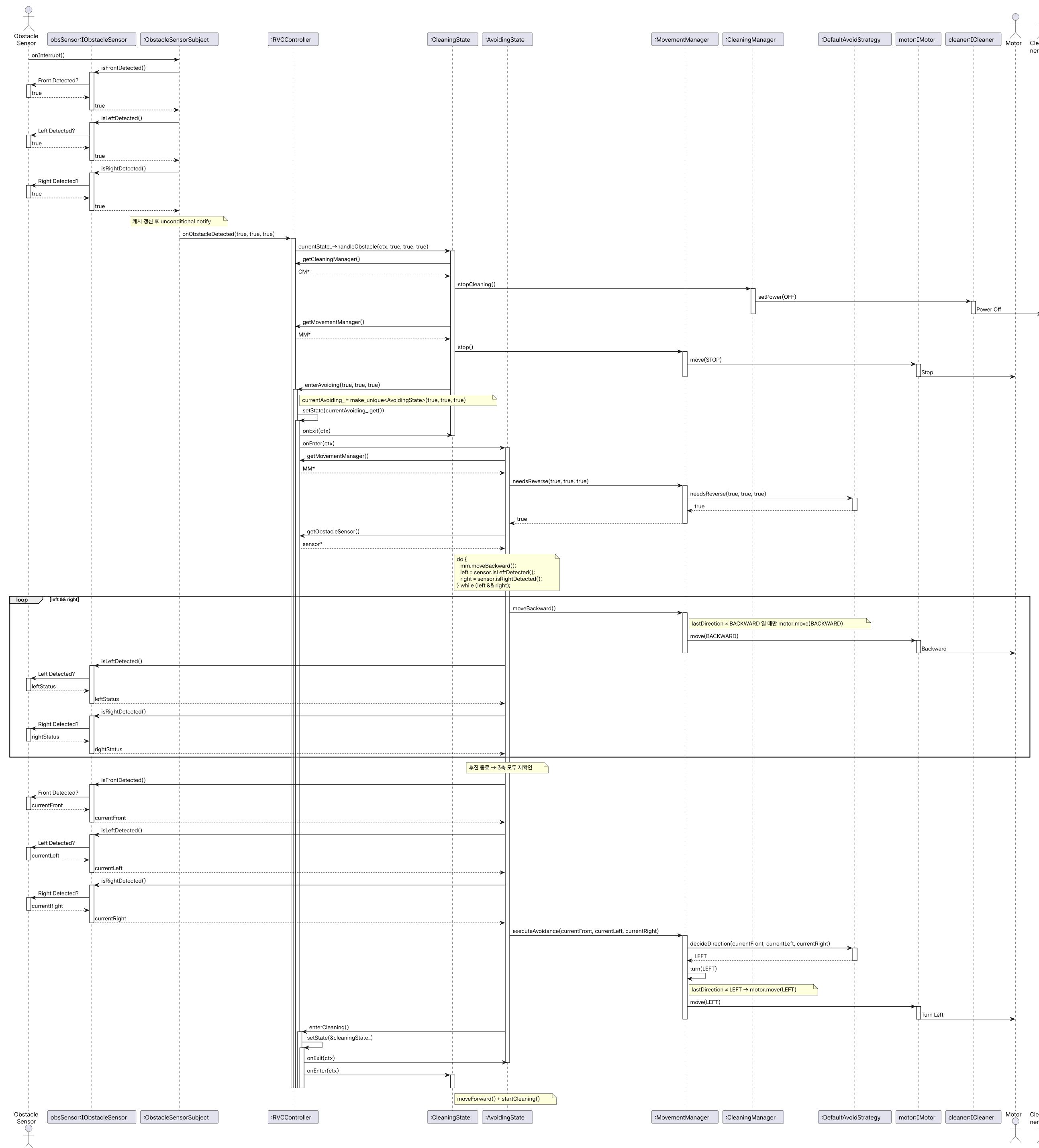
(Front = true, left = false, right = false)



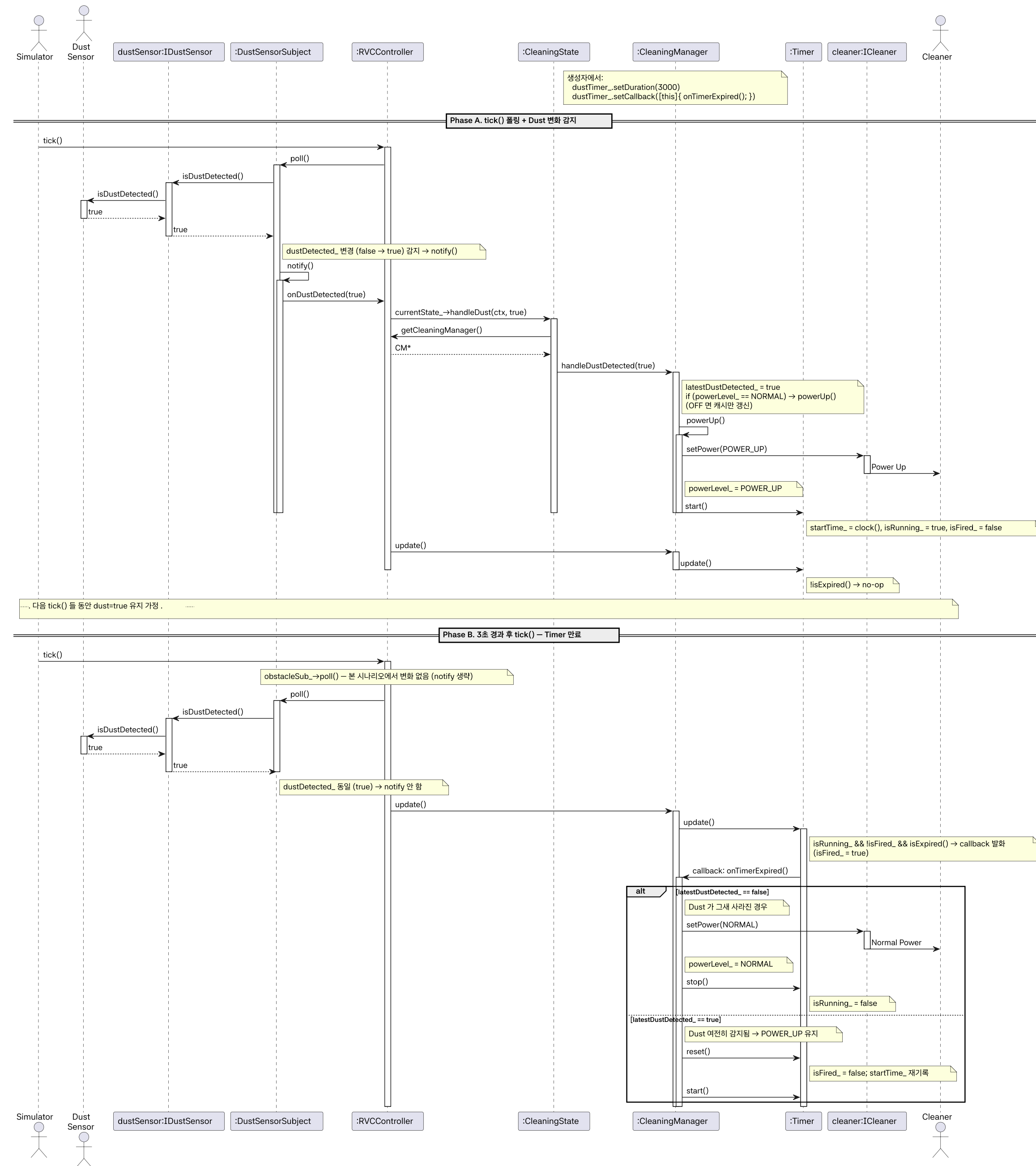
SD-03

All Blocked

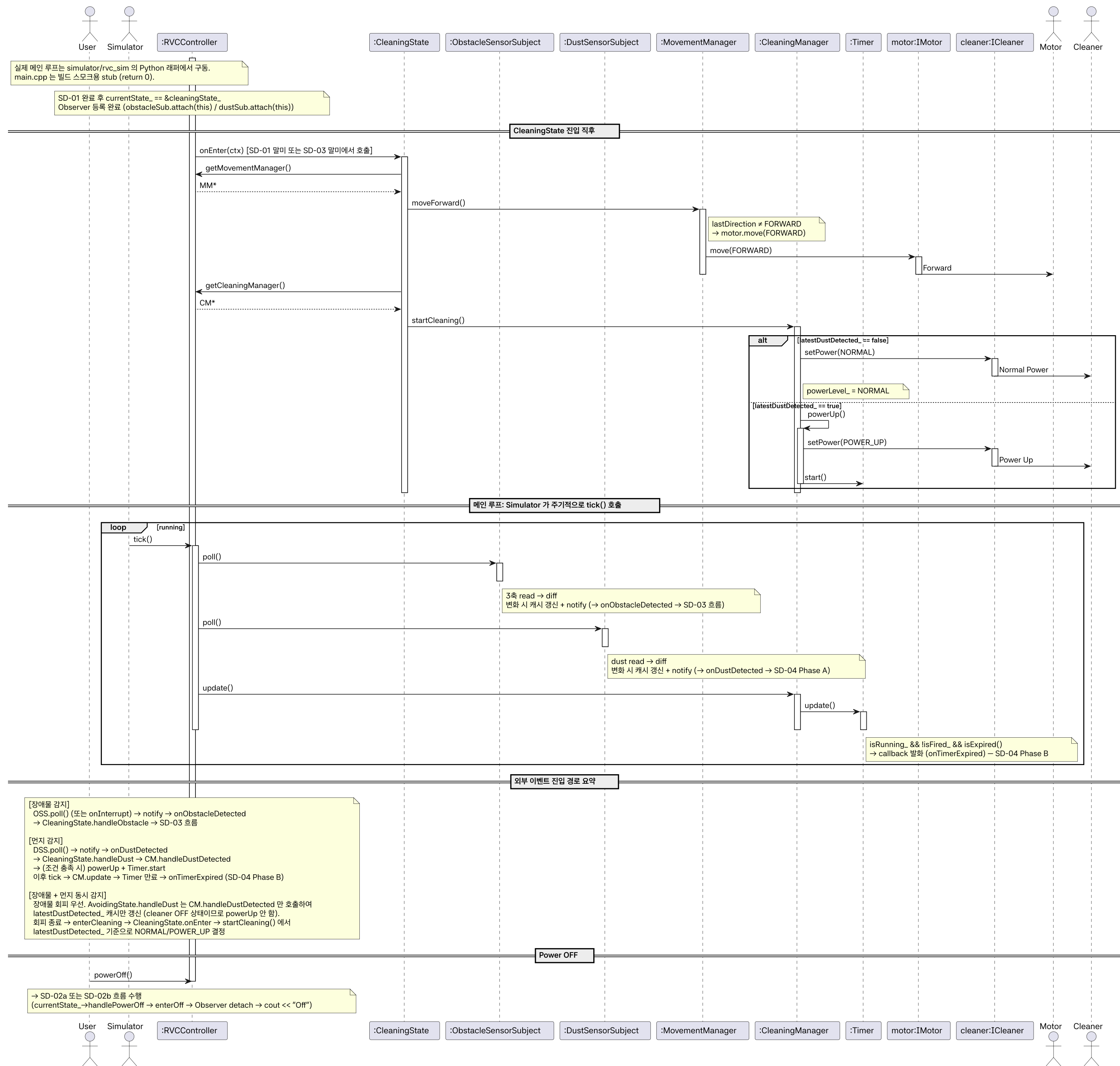
(Front = true, left = true, right = true)



SD-04

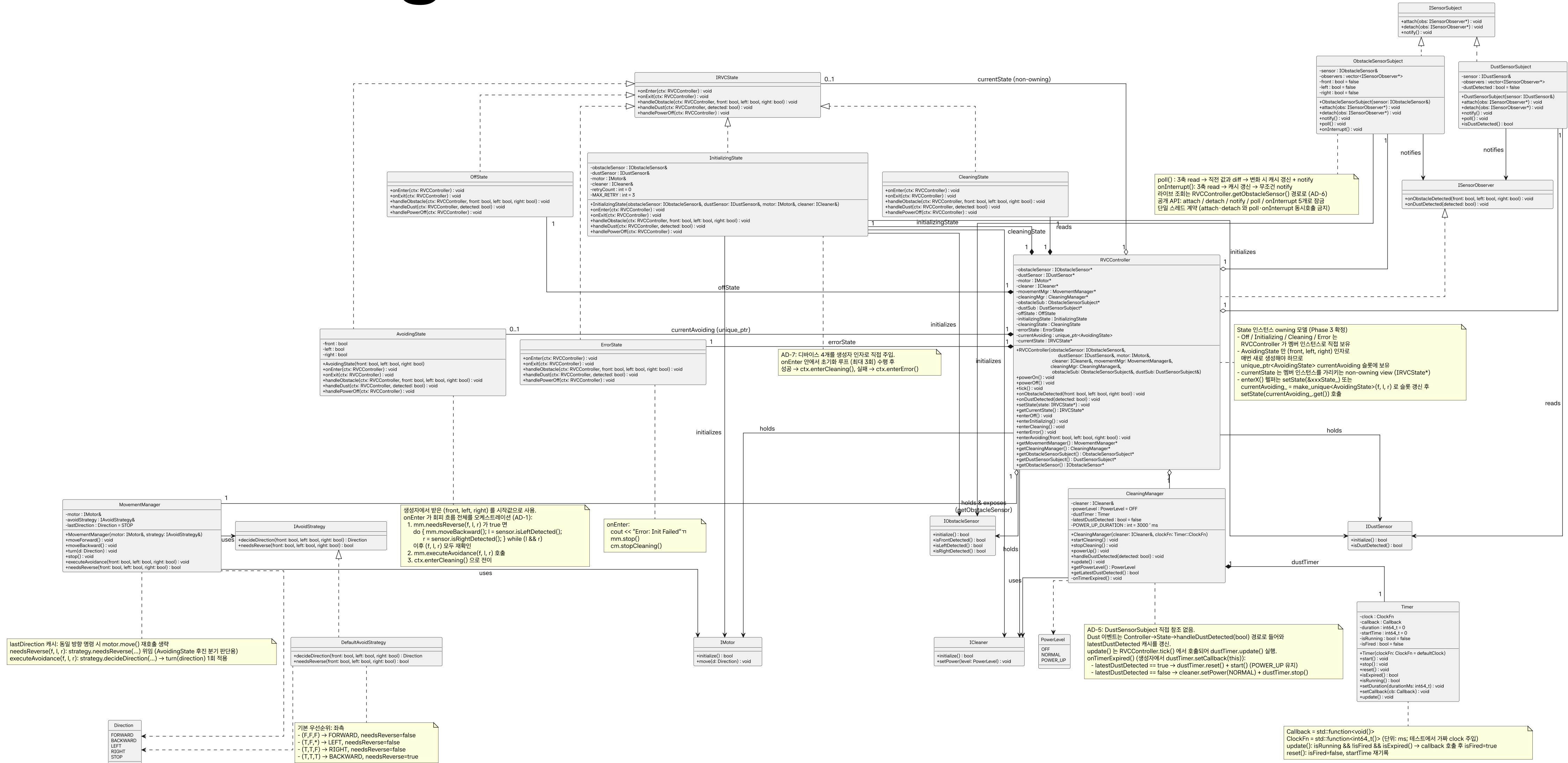


SD-05



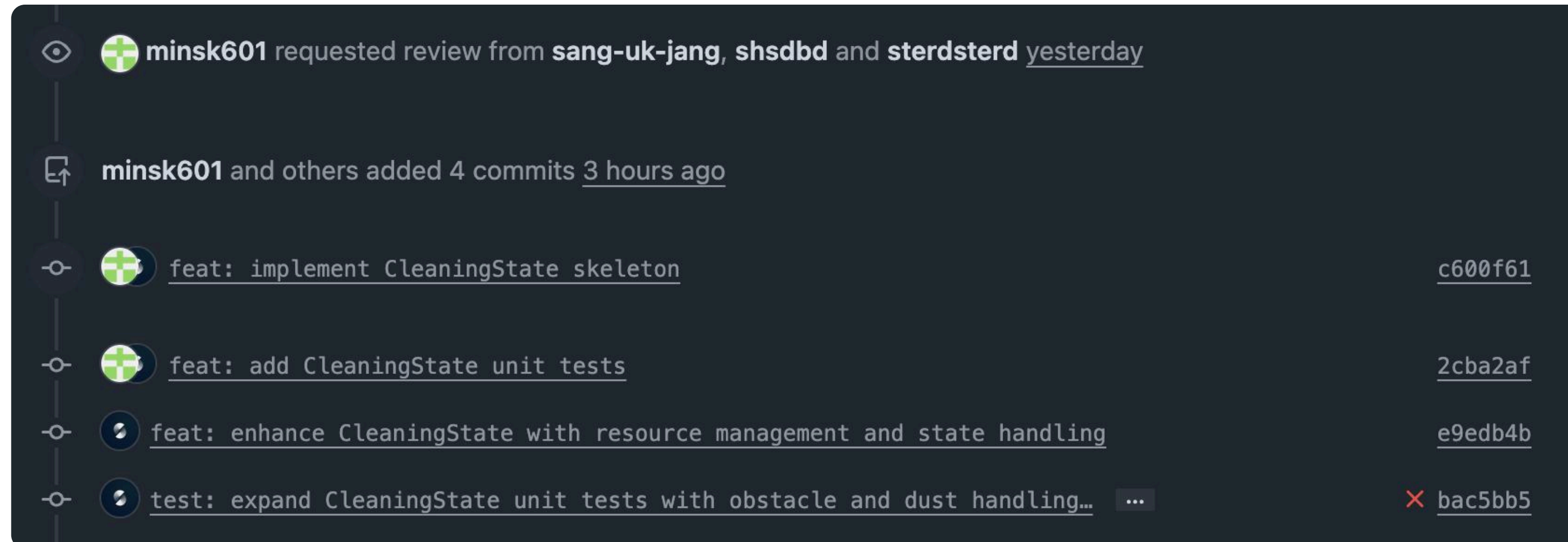
Refined Class Diagram

Class Diagram



Coding

Pair Programming



- Git based pair programming

Pair Programming

CI ci.yml Filter workflow runs

78 workflow runs Event Status Branch Actor

✔ feat: InitializingState & ErrorState 구현 CI #78: Pull request #24 synchronize by sterdsterd	feat/initializing-state-v2	📅 Today at 12:00 PM 🕒 2m 45s	...
✖ feat: InitializingState & ErrorState 구현 CI #77: Pull request #24 opened by sterdsterd	feat/initializing-state-v2	📅 Today at 11:54 AM 🕒 2m 45s	...
✔ feat: implement CleaningState (#19) CI #76: Commit 2b05274 pushed by sang-uk-jang	develop	📅 Today at 11:35 AM 🕒 2m 35s	...
✔ feat: implement CleaningState CI #75: Pull request #19 synchronize by sterdsterd	feat/cleaningState	📅 Today at 10:07 AM 🕒 2m 38s	...
✖ Feat/initializing state CI #74: Pull request #21 synchronize by minsk601	feat/initializing-state	📅 Today at 10:02 AM 🕒 2m 29s	...
✖ Feat/initializing state CI #73: Pull request #21 synchronize by minsk601	feat/initializing-state	📅 Today at 9:52 AM 🕒 2m 44s	...
✔ feat: implement CleaningState CI #72: Pull request #19 synchronize by sterdsterd	feat/cleaningState	📅 Today at 9:25 AM 🕒 2m 42s	...
✔ feat: implemented AvoidingState skeleton code (#20) CI #71: Commit 553bcee pushed by sang-uk-jang	develop	📅 Today at 9:19 AM 🕒 2m 23s	...
✔ feat: implement CleaningState CI #70: Pull request #19 synchronize by sterdsterd	feat/cleaningState	📅 Today at 9:18 AM 🕒 2m 36s	...

Code Review

The screenshot shows a GitHub pull request interface. At the top, a comment from user 'minsk601' is visible, dated '3 days ago'. Below the comment is a 'Warning' section with two bullet points: 'PR feat: DustSensorSubject class #10 merge 전에는 이 PR을 merge하지 마세요.' and 'PR feat: DustSensorSubject class #10 merge 이후 base branch를 develop 으로 변경해야 합니다.'.

The main content area is titled '변경 사항' (Changes) and describes updates to the 'CleaningManager' class. It lists three changes: 'startCleaning() , stopCleaning() 을 통한 RVC 상태 및 전원 레벨(PowerLevel) 관리', '먼지가 감지되면(handleDustDetected) POWER_UP 레벨로 전환하고 타이머를 가동합니다.', and '타이머가 만료되었을 때(onTimerExpried), 먼지 상태에 따라 타이머 연장 혹은 NORMAL 모드로 복귀합니다.'.

Below the changes is an 'Important' section with a sub-section '[추가 사항]' (Additional changes) listing: '마지막으로 저장된 dustDetected 여부를 저장하는 latestDustDetected_ 변수가 추가되었습니다', 'getLatestDustDetected() 메서드가 추가되었습니다.', and 'PowerUP 타이머 콜백 함수 onTimerExpired() 메서드가 추가되었습니다.'.

Another sub-section '[수정 사항]' (Revisions) lists: 'dustSub_ 변수가 제거되었습니다. DustSensorSubject 의존성을 제거했습니다.' and 'lastestDustDetected_ 값을 토대로 startCleaning() 에서 전원 레벨을 유동적으로 처리하도록 수정하였습니다.'.

At the bottom left, there is a section for '변경 유형' (Change type).

The right sidebar contains several sections: 'Reviewers' with users 'sang-uk-jang', 'sterdsterd', and 'shsdbd'; 'Assignees' with 'minsk601'; 'Labels' (None yet); 'Projects' (None yet); 'Milestone' (No milestone); 'Development' with a note 'Successfully merging this pull request may close these issues.'; and 'Notifications' with an 'Unsubscribe' button and a note 'You're receiving notifications because you authored the thread.'

- Pull Request Template

Code Review

The screenshot displays a GitHub pull request interface with the following elements:

- Reviewers:**
 - sang-uk-jang** reviewed 3 days ago. A link to "View reviewed changes" is present.
 - sterdsterd** requested changes yesterday. A link to "View reviewed changes" is present.
- Code Files:**
 - include/rvc/cleaning_manager.hpp (Outdated) with a "Show resolved" link.
 - src/cleaning_manager.cpp (Outdated) with a "Show resolved" link.
 - src/cleaning_manager.cpp (Outdated) with a "Show resolved" link.
 - include/rvc/cleaning_manager.hpp (Outdated) with a "Show resolved" link.
 - src/cleaning_manager.cpp (Outdated) with a "Show resolved" link.
- Commits:**
 - minsk601** added 4 commits 8 hours ago.
 - feat: refactor CleaningManager to use references for cleaner and dust... (7997a4f)
 - feat: add [[nodiscard]] attribute to getPowerLevel and isDustDetected... (44704df)
 - feat: refactor CleaningManager to remove DustSensorSubject and start ... (d6c4455)
 - test: refactor CleaningManagerTest to remove DustSensorSubject (2830f8e)
- Branch Change:**
 - sterdsterd** changed the base branch from feat/SensorSubject to develop 6 hours ago.

- Peer Code Review
- Code Refactoring

Code Review

Review required
At least 1 approving review is required by reviewers with write access.

3 pending reviews >

Some checks were not successful
1 failing, 5 successful checks

1 failing check ▾

- CI / cppcheck (pull_request)** Failing after 39s **Required** ⋮

5 successful checks ▾

- CI / build-and-test (pull_request)** Successful in 58s **Required** ⋮
- CI / clang-tidy (pull_request)** Successful in 1m **Required** ⋮
- CI / format-check (pull_request)** Successful in 18s **Required** ⋮
- CI / sonarcloud (pull_request)** Successful in 1m **Required** ⋮
- SonarCloud Code Analysis** Successful in 27s — Quality Gate passed **Required** ⋮

Merging is blocked
At least 1 approving review is required by reviewers with write access.


Merge pull request ▾ You can also merge this with the command line. [View command line instructions.](#)

- Review Required for merging
- CI 통과 시에만 Merging 가능


Code Review


src/error_state.cpp

```
19 + }
20 +
21 + void ErrorState::handlePowerOff(RVCController& ctx) {
22 +     IRVCState* offState = nullptr; // 추후 변경 예정
```

 **sterdsterd** 2 hours ago Member ...

어떻게 변경 예정인지요?



 **minsk601** 1 hour ago Member Author ...


OffState merge 이후에

Suggested change

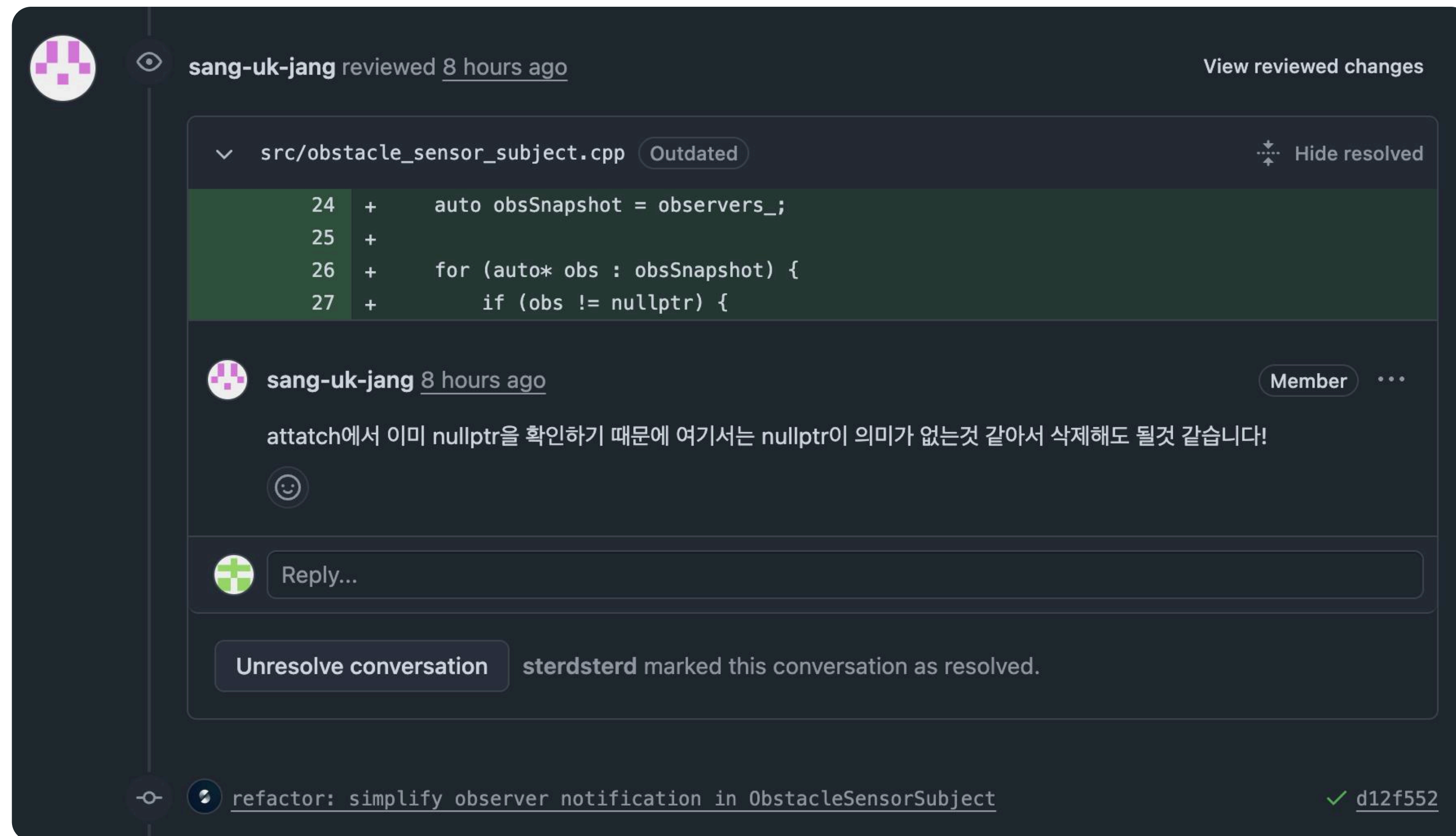
```
22 -     IRVCState* offState = nullptr; // 추후 변경 예정
22 +     ctx.setState(OffState);
```

Commit suggestion ▼

로 변경 예정입니다!



Code Review



The screenshot shows a code review interface. At the top, a user profile icon is followed by the text "sang-uk-jang reviewed 8 hours ago" and a link "View reviewed changes". Below this, a file path "src/obstacle_sensor_subject.cpp" is shown with a status "Outdated" and a "Hide resolved" button. The code snippet is as follows:

```
24 + auto obsSnapshot = observers_;
25 +
26 + for (auto* obs : obsSnapshot) {
27 +     if (obs != nullptr) {
```

Below the code, a comment from "sang-uk-jang" (8 hours ago) is displayed. The comment text is: "attatch에서 이미 nullptr을 확인하기 때문에 여기서는 nullptr이 의미가 없는것 같아서 삭제해도 될것 같습니다!". There is a smiley face emoji below the text. A "Reply..." input field is visible below the comment. At the bottom of the comment section, there is a button "Unresolve conversation" and a notification: "sterdsterd marked this conversation as resolved.". At the very bottom of the interface, a commit message "refactor: simplify observer notification in ObstacleSensorSubject" is shown with a checkmark and the commit hash "d12f552".

Code Review

The screenshot shows a GitHub code review interface. At the top, it indicates that user **sterdsterd** requested changes yesterday. The code being reviewed is in the file `src/dust_sensor_subject.cpp`, specifically lines +23 to +28. The code snippet is as follows:

```
23 + void DustSensorSubject::notify() {
24 +     for (auto* obs : observers_) {
25 +         if (obs != nullptr) {
26 +             obs->onDustDetected(dustDetected_);
27 +         }
28 +     }
```

Below the code, there is a discussion. User **sterdsterd** (Member) commented yesterday:

notify() 가 observers_ 를 직접 순회하고 있는데, callback 안에서 observer가 detach되거나 power off flow랑 섞여서 subject에서 detach가 발생하면 vector erase 때문에 iterator가 invalidate 될 수도 있을 것 같아요

지금 flow에서 터질 가능성은 낮은 한데, snapshot을 떠서 iteration을 돌리거나 notification 중 변경을 delay 시키는 편이 낫지 않을까 싶습니다

User **minsk601** (Member, Author) responded 12 hours ago:

RVC Controller 에서는 옵저버 개수가 그리 많지 않아 벡터 복사로 인한 성능 저하도 크지 않다고 생각이 들어서, snapshot 생성 후 iteration 돌리는 방식으로 바로 수정하겠습니다!

At the bottom, there is a button to "Unresolve conversation" and a notification that "minsk601 marked this conversation as resolved."

Code Review

The screenshot displays a GitHub pull request interface. At the top, it indicates that user **sterdsterd** requested changes yesterday. The file being reviewed is `src/dust_sensor_subject.cpp`. A diff view shows changes to `include/rvc/dust_sensor_subject.hpp`, which is marked as 'Outdated'. The diff shows five lines of added code (lines 3-7) for including headers: `rvc/i_sensor_observer.hpp`, `<vector>`, `i_dust_sensor.hpp`, and `i_sensor_observer.hpp`. Below the diff, there are two comments. The first comment from **sterdsterd** (yesterday) asks to remove a line and replace it with `#include "rvc/i_sensor_observer.hpp"`. The second comment from **minsk601** (12 hours ago) responds that the fix will be pushed. At the bottom, there is a 'Reply...' input field and a status bar showing 'Unresolve conversation' and a notification that 'minsk601 marked this conversation as resolved.'

sterdsterd requested changes yesterday View reviewed changes

> `src/dust_sensor_subject.cpp` Show resolved

▼ `include/rvc/dust_sensor_subject.hpp` Outdated Hide resolved

Comment on lines **+3** to **+7**

```
3 + // #include "rvc/i_sensor_observer.hpp"
4 + #include <vector>
5 +
6 + #include "i_dust_sensor.hpp"
7 + #include "i_sensor_observer.hpp"
```

sterdsterd yesterday Member ...

요거 주석 지우고 `#include "rvc/i_dust_sensor.hpp"` 랑 `#include "rvc/i_sensor_observer.hpp"` 로 바꾸시저

minsk601 12 hours ago Member Author ...

헉 수정해서 올리겠습니다!

Reply...

Unresolve conversation minsk601 marked this conversation as resolved.

Code Review

src/dust_sensor_subject.cpp Outdated Hide resolved

Comment on lines +32 to +34

```
32 +   if (sensor_ == nullptr) {
33 +       return;
34 +   }
```

sterdsterd yesterday Member ...

좀 더 생각해보니까, 지금 구조에서는 object 만들 때 `DustSensorSubject subject{nullptr};` 처럼 써도 정상적으로 object가 생성되고, 여기서 `poll()` 도 early return 되버려서 아무 일 없이 지나갈 것 같은데, 이렇게 되면 `isDustDetected()` 가 계속 `false` 만 뱉어서 먼지가 감지가 안된건지 센서가 연결이 안 된건지 파악이 어려울 것 같아요.

`IDustSensor` 는 필수니까 아래처럼 생성자쪽에서 reference로 받아 null 상태 자체를 표현할 수 없도록 하는 것도 좋을 것 같네요.

```
explicit DustSensorSubject(IDustSensor& sensor);
IDustSensor& sensor_;
```

minsk601 12 hours ago Member Author ...

네! reference로 받는 방법으로 변경하고, `poll()` 메서드도 변경된 부분에 맞게 수정하겠습니다!

Reply...

Unresolve conversation minsk601 marked this conversation as resolved.

Code Review

The screenshot displays a GitHub pull request interface. At the top, a comment from 'sonarqubecloud' (Bot) is shown, stating 'Quality Gate passed'. Below this, the 'Issues' section reports '0 New issues' and '0 Accepted issues'. The 'Measures' section lists '0 Security Hotspots', '93.8% Coverage on New Code', and '0.0% Duplication on New Code'. A link to 'See analysis details on SonarQube Cloud' is provided. Below the comment, three review entries are visible: two from 'sang-uk-jang' and one from 'sterdsterd', all with green checkmarks and 'View reviewed changes' links. At the bottom, a merge commit by 'sang-uk-jang' is shown, indicating '6 checks passed' and including 'View details' and 'Revert' buttons.

sonarqubecloud Bot commented 11 hours ago

✔ Quality Gate passed

Issues

- ✔ 0 New issues
- ✔ 0 Accepted issues

Measures

- ✔ 0 Security Hotspots
- ✔ 93.8% Coverage on New Code
- ✔ 0.0% Duplication on New Code

[See analysis details on SonarQube Cloud](#)

👤 sang-uk-jang ✔ sang-uk-jang approved these changes 10 hours ago [View reviewed changes](#)

👤 sang-uk-jang ✔ sang-uk-jang approved these changes 10 hours ago [View reviewed changes](#)

👤 sterdsterd ✔ sterdsterd approved these changes 10 hours ago [View reviewed changes](#)

👤 sang-uk-jang merged commit 45841fc into develop 10 hours ago [View details](#) [Revert](#)
6 checks passed

Code Review

The screenshot shows a GitHub code review interface. At the top, a user profile for 'minsk601' is shown with the text 'minsk601 reviewed 4 days ago' and a link to 'View reviewed changes'. Below this, the file path 'src/timer.cpp' is displayed with a status of 'Outdated' and a 'Hide resolved' option. The code snippet shows lines 37 to 40, with a green checkmark on line 37. A suggested change is shown below the code, with a red minus sign indicating the original code and a green plus sign indicating the suggested change. The suggested change is 'return isRunning_ && ((clock_() - startTime_) >= duration_);'. Below the suggested change, there is a 'Commit suggestion' button. A comment from 'minsk601' asks '삼항연산자 대신해서 이렇게 사용하는건 어떨까요?' (How about using it like this instead of the ternary operator?). A reply from 'sterdsterd' says '넵 좋아요' (Yes, I like it). At the bottom, there is a 'Reply...' input field and a button to 'Unresolve conversation'. A notification at the bottom right says 'sterdsterd marked this conversation as resolved.'

minsk601 reviewed 4 days ago [View reviewed changes](#)

src/timer.cpp Outdated Hide resolved

```
37 + }
38 +
39 + bool Timer::isExpired() const {
40 +     return !isRunning_ ? false : (clock_() - startTime_) >= duration_;
```

minsk601 4 days ago Member ...

Suggested change

```
- return !isRunning_ ? false : (clock_() - startTime_) >= duration_;
+ return isRunning_ && ((clock_() - startTime_) >= duration_);
```

[Commit suggestion](#)

삼항연산자 대신해서 이렇게 사용하는건 어떨까요?

😊

sterdsterd 4 days ago Member Author ...

넵 좋아요

😊

+ Reply...

[Unresolve conversation](#) sterdsterd marked this conversation as resolved.

Code Review

The screenshot displays a GitHub code review for the file `tests/test_pattern_interfaces.cpp`. The code change is marked as "Outdated" and shows lines 39 to 42 with additions (+). The code snippet is:

```
39 +   }  
40 +  
41 +   void detach(rvc::ISensorObserver* obs) override {  
42 +       observers_.erase(std::remove(observers_.begin(), observers_.end(), obs), observers_.end());
```

The review conversation includes:

- A comment from **minsk601** (4 days ago) asking: `std::erase(observers_, obs);` 은 어떨까요? C++ 20 환경이라 괜찮지 않을까 싶습니다!
- A response from **sterdsterd** (3 days ago) stating: 넵 수정할게용

The conversation is currently resolved, as indicated by the "Unresolve conversation" button and the message "sterdsterd marked this conversation as resolved."

Below the conversation, a commit history is shown:

- sterdsterd** changed the base branch from `feat/device-interfaces` to `develop` 3 days ago
- sterdsterd** added 4 commits 3 days ago
- feat: add interface classes for IAVoidStrategy, IRVCState, and sensor... (8380b70)
- test: add unit tests for pattern interfaces and update CMakeLists to ... (332deaa)
- refactor: simplify observer detachment in test_pattern_interfaces by ... (a9a12fc)

Code Review

The screenshot shows a GitHub pull request interface. At the top, it says "sterdsterd requested changes yesterday" and "View reviewed changes". Below that, the file path "src/cleaning_manager.cpp" is shown with a "Hide resolved" button. The code review is for lines +14 to +31. The code is as follows:

```
14 + void CleaningManager::startCleaning() {
15 +     if (cleaner_ == nullptr) {
16 +         return;
17 +     }
18 +
19 +     cleaner_>setPower(PowerLevel::NORMAL);
20 +     powerLevel_ = PowerLevel::NORMAL;
21 + }
22 +
23 + void CleaningManager::stopCleaning() {
24 +     if (cleaner_ == nullptr) {
25 +         return;
26 +     }
27 +
28 +     cleaner_>setPower(PowerLevel::OFF);
29 +     powerLevel_ = PowerLevel::OFF;
30 +     dustTimer_.stop();
31 + }
```

Below the code, a comment from "sterdsterd yesterday" (Member) is visible:

stop / start 사이에 dust 상태가 남으면 POWER_UP 재진입이 누락될 수 있을 것 같아용

현재 구조 상 stopCleaning() 은 dustTimer_ 만 멈추고 dustDetected_ 를 그대로 두고 있는데, startCleaning() 은 항상 NORMAL 로만 바꾸는데, 예를 들어 먼지가 감지된 상태에서 장애물 회피로 stopCleaning() 후 다시 CleaningState 에 들어오면 startCleaning() 이 NORMAL 로 만들지만, DustSensorSubject 는 값이 안변하면 다시 notify 를 안 해서 다시 POWER_UP 으로 돌아갈 trigger가 사라질 수도 있을 것 같네요. stop 시에 dust 상태를 초기화할지, 아니면 start 시 기존 dust 상태랑 subject를 확인할지 한 번 논의해봐야 할 것 같아요


At the bottom, there is a "Reply..." input field.

Code Review

src/cleaning_manager.cpp Hide resolved


Comment on lines +62 to +67


```
62 + void CleaningManager::onTimerExpired() {
63 +     if (dustDetected_) { // POWER-UP 유지
64 +         dustTimer_.reset();
65 +         dustTimer_.start();
66 +         return;
67 +     }
```

 **sterdsterd** yesterday Member ...

`dustSub` 안 쓰는게 마음에 걸려서 정책 다시 한 번 잡아봐야 할 것 같아요

현재처럼 구현하면 `handleDustDetected()` 가 마지막으로 저장한 `dustDetected_` 값만 봐서 timer update 직전에 dust 관련 이벤트가 전달이 안될 경우에 stale한 상태를 참조해서 `POWER_UP` 이 연장될 수도 있어서 그 부분을 중점으로 한 번 논의해보면 좋을 것 같긴 합니다



 Reply...

Unresolve conversation sterdsterd marked this conversation as resolved.

Code Review

The screenshot displays a GitHub code review interface. At the top, a user profile for 'minsk601' is shown with the text 'minsk601 reviewed 2 days ago' and a 'View reviewed changes' link. Below this, a file path 'include/rvc/MovementManager.hpp' is listed with an 'Outdated' status. The code editor shows lines 9 through 12, all marked with a '+' sign, indicating additions. The code defines a 'MovementManager' class with a public constructor. A 'Suggested change' box highlights a modification to the constructor signature, removing the underscore from the parameter names 'motor_', 'strategy_', and 'obstacleSensor_'. Below the suggestion is a 'Commit suggestion' button. A comment from 'minsk601' asks '매개변수는 _ 없이 사용하는게 어떨까요?' (How about not using underscores for parameters?). A response from 'sang-uk-jang' says '좋습니다' (That's good). At the bottom, there is a 'Reply...' input field and a status bar indicating 'Unresolve conversation' and 'sang-uk-jang marked this conversation as resolved.'

minsk601 reviewed 2 days ago View reviewed changes

include/rvc/MovementManager.hpp Outdated Hide resolved

```
9 +
10 + class MovementManager {
11 + public:
12 +     MovementManager(IMotor* motor_, IAvoidStrategy* strategy_, IObstacleSensor* obstacleSensor_);
```

minsk601 2 days ago Member ...

Suggested change

```
-     MovementManager(IMotor* motor_, IAvoidStrategy* strategy_, IObstacleSensor*
+     MovementManager(IMotor* motor, IAvoidStrategy* strategy, IObstacleSensor*
obstacleSensor_);
obstacleSensor);
```

Commit suggestion ▼

매개변수는 _ 없이 사용하는게 어떨까요?

😊

sang-uk-jang 2 days ago Member Author ...

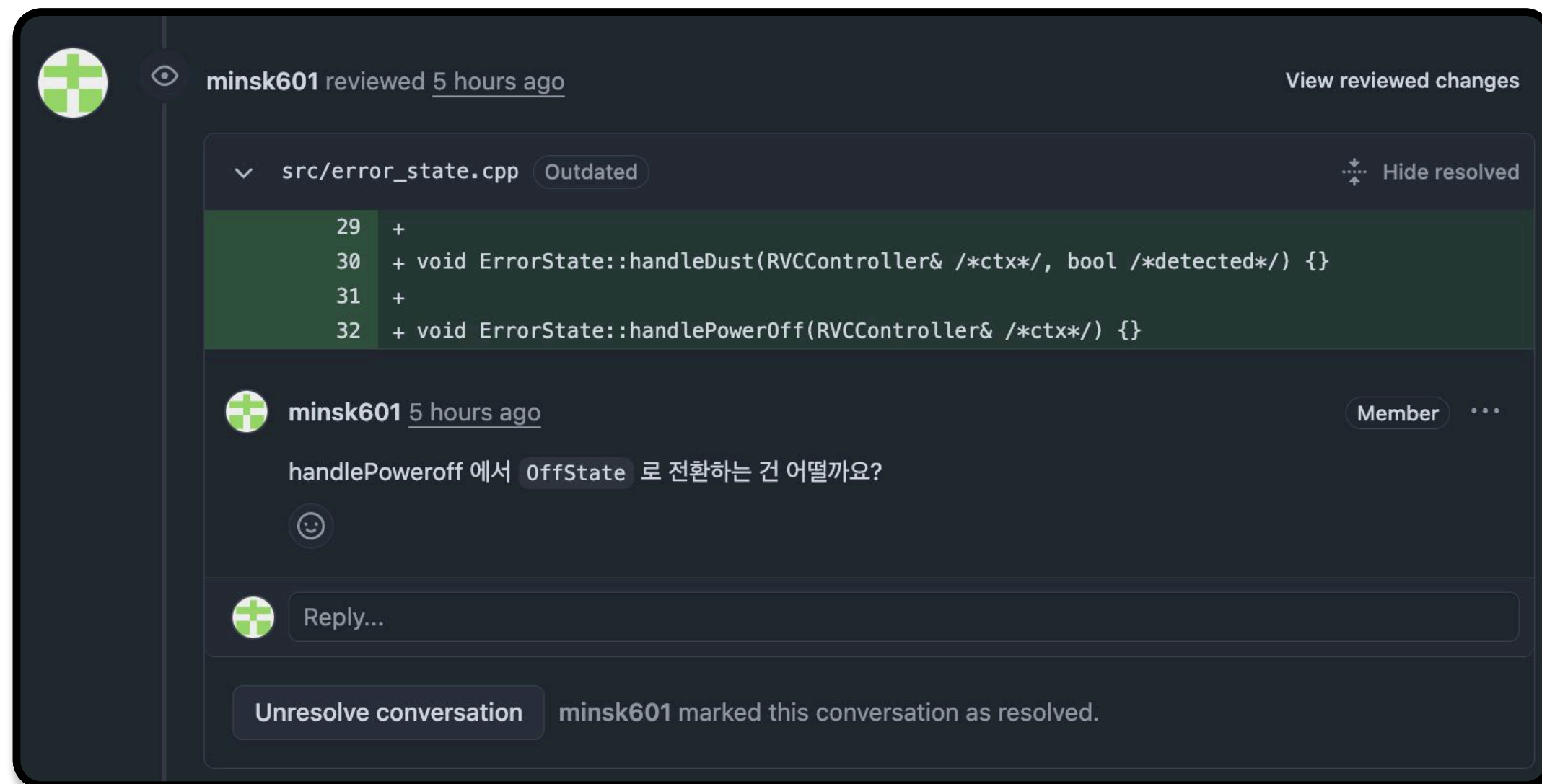
좋습니다

😊

Reply...

Unresolve conversation sang-uk-jang marked this conversation as resolved.

Code Review



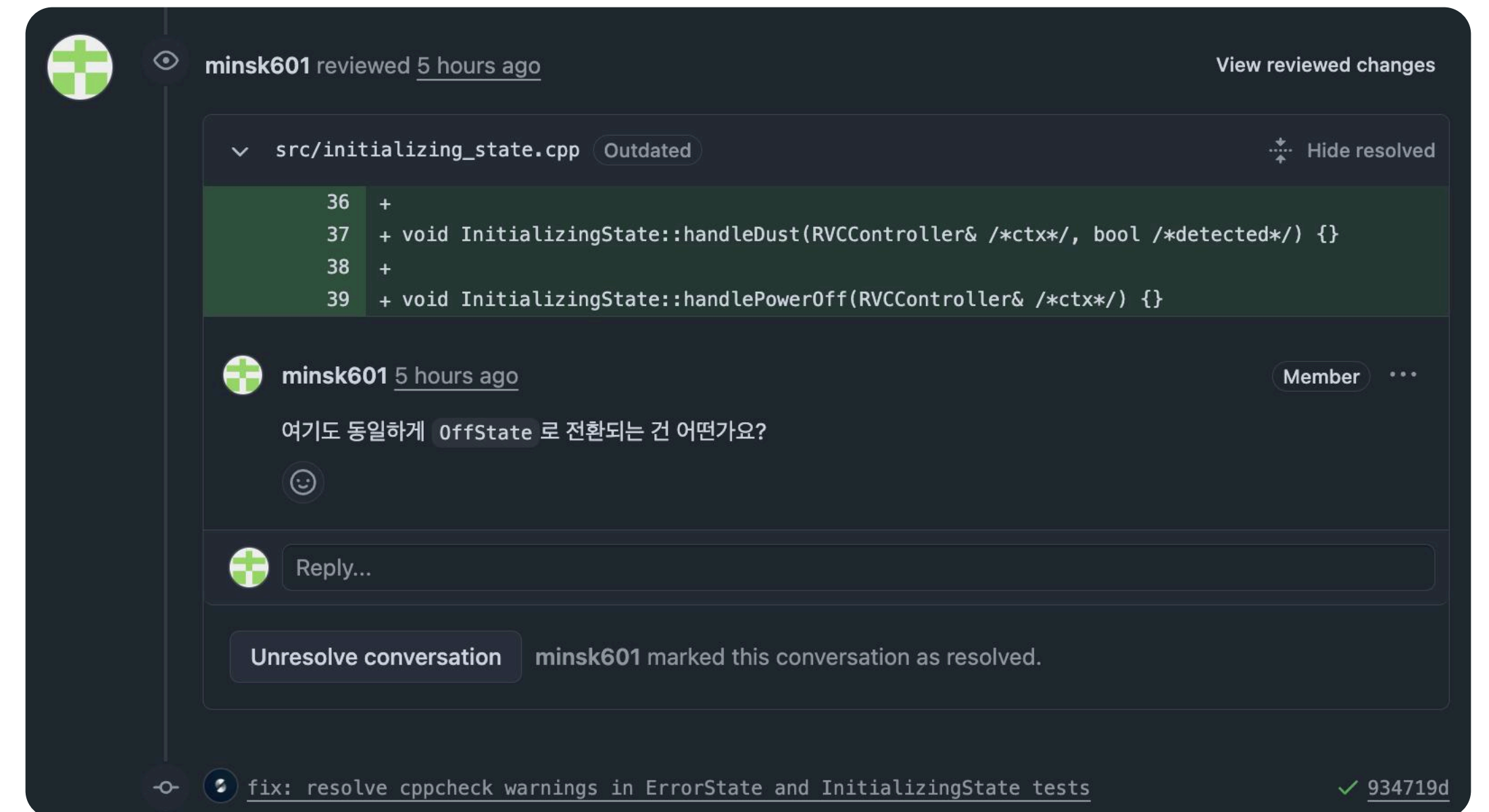
This screenshot shows a code review interface for the file `src/error_state.cpp`. The code is marked as "Outdated". The reviewed code includes two methods: `handleDust` and `handlePowerOff`. A comment from user `minsk601`, posted 5 hours ago, asks a question about the `OffState` transition in the `handlePoweroff` method. The comment is currently unresolved.

```
29 +
30 + void ErrorState::handleDust(RVController& /*ctx*/, bool /*detected*/) {}
31 +
32 + void ErrorState::handlePowerOff(RVController& /*ctx*/) {}
```

`minsk601` 5 hours ago
handlePoweroff 에서 OffState 로 전환하는 건 어떨까요?

Reply...

Unresolve conversation minsk601 marked this conversation as resolved.



This screenshot shows a code review interface for the file `src/initializing_state.cpp`. The code is marked as "Outdated". The reviewed code includes two methods: `handleDust` and `handlePowerOff`. A comment from user `minsk601`, posted 5 hours ago, asks a question about the `OffState` transition in the `handlePowerOff` method. The comment is currently unresolved.

```
36 +
37 + void InitializingState::handleDust(RVController& /*ctx*/, bool /*detected*/) {}
38 +
39 + void InitializingState::handlePowerOff(RVController& /*ctx*/) {}
```

`minsk601` 5 hours ago
여기도 동일하게 OffState 로 전환되는 건 어떤가요?

Reply...

Unresolve conversation minsk601 marked this conversation as resolved.

fix: resolve cppcheck warnings in ErrorState and InitializingState tests 934719d

Code Review

The screenshot shows a code review interface. At the top, a user profile icon (a green cross) is next to the text "minsk601 reviewed 5 hours ago". To the right is a link "View reviewed changes". Below this is a file path "src/error_state.cpp" with a "Hide resolved" button. A comment is shown on lines +14 to +22. The code diff shows two if-statements: one for MovementManager and one for CleaningManager. Below the code, a comment from minsk601 says "state 진입점에서 motor 및 cleaner를 정지하는 부분이 좋아보입니다!". There is a "Reply..." input field and an "Unresolve conversation" button with a message "minsk601 marked this conversation as resolved.". At the bottom, a commit list shows two commits: "feat: add handlePowerOff OffState transition to ErrorState and Initia..." with hash e2973bf, and "refactor: improve initialization logic in InitializingState for bette..." with hash 7619b54 and a green checkmark.

minsk601 reviewed 5 hours ago [View reviewed changes](#)

src/error_state.cpp [Hide resolved](#)

Comment on lines +14 to +22

```
14 + MovementManager* movementMgr = ctx.getMovementManager();
15 + if (movementMgr != nullptr) {
16 +     movementMgr->stop();
17 + }
18 +
19 + CleaningManager* cleaningMgr = ctx.getCleaningManager();
20 + if (cleaningMgr != nullptr) {
21 +     cleaningMgr->stopCleaning();
22 + }
```

minsk601 5 hours ago Member ...

state 진입점에서 motor 및 cleaner를 정지하는 부분이 좋아보입니다!

☺

Reply...

[Unresolve conversation](#) minsk601 marked this conversation as resolved.

sterdsterd added 2 commits 5 hours ago

- feat: add handlePowerOff OffState transition to ErrorState and Initia... ... e2973bf
- refactor: improve initialization logic in InitializingState for bette... ... ✓ 7619b54

Code Review

The screenshot shows a GitHub code review for the file `include/rvc/off_state.hpp`. The code being reviewed is a C++ class `OffState` that inherits from `IRVCState`. The class has a default constructor, a destructor, and several member functions: `onEnter`, `onExit`, `handleObstacle`, `handleDust`, and `handlePowerOff`. All these functions are currently marked as `override = default`.

The review discussion includes the following comments:

- sterdsterd** (2 days ago): C++ class의 default access modifier가 private이라서 현재 구현상 constructor랑 destructor 등등 모두 private이 되어 버립니다. CD상 모두 public이니까 `public:` 추가해주시고 `copy`랑 `move` 삭제도 넣어주세요.
- sang-uk-jang** (20 hours ago): 수정했습니다!

At the bottom, there is a button to "Unresolve conversation" and a notification that "sang-uk-jang marked this conversation as resolved."

Code Review

The screenshot displays a code review interface. At the top, a file named `src/off_state.cpp` is shown as `Outdated`. The code snippet is as follows:

```
7 + namespace rvc {  
8 +  
9 + void OffState::onEnter(RVController& ctx) {  
10 +     std::cout << "off" << std::endl;
```

Below the code, a comment from user `sterdsterd` (2 days ago) is visible. The comment discusses the flow of control and the output of the `display("Off")` function, suggesting that the `OffState` object is not the subject of the output, but rather the `RVController` object, which outputs after the `OffState.onEnter` method is called. The user suggests that the current flow might be confusing and that it would be better to have the `OffState` object directly output the "off" message, as this would be clearer and more consistent with the state machine's logic.

A response from user `sang-uk-jang` (20 hours ago) is also shown, stating "네 수정했습니다" (Yes, I fixed it). The conversation is marked as resolved, with a button labeled "Unresolve conversation" and a note indicating that `sang-uk-jang` marked the conversation as resolved.

Unit Test

```
111/121 Test #111: CleaningManagerTest.StopCleaningSetsPowerOff ..... Passed 0.01 sec
      Start 112: CleaningManagerTest.PowerUpSetsPowerUpLevel
112/121 Test #112: CleaningManagerTest.PowerUpSetsPowerUpLevel ..... Passed 0.01 sec
      Start 113: CleaningManagerTest.HandleDustDetectedTriggersPowerUp
113/121 Test #113: CleaningManagerTest.HandleDustDetectedTriggersPowerUp ..... Passed 0.01 sec
      Start 114: CleaningManagerTest.HandleDustDetectedDoesNotPowerUpIfAlreadyPowerUp
114/121 Test #114: CleaningManagerTest.HandleDustDetectedDoesNotPowerUpIfAlreadyPowerUp ..... Passed 0.01 sec
      Start 115: CleaningManagerTest.HandleDustClearedJustUpdatesState
115/121 Test #115: CleaningManagerTest.HandleDustClearedJustUpdatesState ..... Passed 0.01 sec
      Start 116: CleaningManagerTest.TimerExpiresAndReturnsToNormalIfNoDust
116/121 Test #116: CleaningManagerTest.TimerExpiresAndReturnsToNormalIfNoDust ..... Passed 0.00 sec
      Start 117: CleaningManagerTest.TimerResetsIfDustStillDetected
117/121 Test #117: CleaningManagerTest.TimerResetsIfDustStillDetected ..... Passed 0.00 sec
      Start 118: CleaningManagerTest.StopCleaningStopsTimer
118/121 Test #118: CleaningManagerTest.StopCleaningStopsTimer ..... Passed 0.01 sec
      Start 119: CleaningManagerTest.IsDustDetectedReportsCorrectState
119/121 Test #119: CleaningManagerTest.IsDustDetectedReportsCorrectState ..... Passed 0.01 sec
      Start 120: CleaningManagerTest.OffStateDustDetectedUnchanged
120/121 Test #120: CleaningManagerTest.OffStateDustDetectedUnchanged ..... Passed 0.00 sec
      Start 121: CleaningManagerTest.StartCleaningWithPowerUpLevel
121/121 Test #121: CleaningManagerTest.StartCleaningWithPowerUpLevel ..... Passed 0.01 sec

100% tests passed, 0 tests failed out of 121

Total Test time (real) = 0.71 sec
```

로컬 환경 Unit Test

Unit Test

build-and-test

succeeded 3 hours ago in 58s

Search logs

- > ✓ Set up job
- > ✓ Run actions/checkout@v4
- > ✓ Install dependencies
- > ✓ Configure (dev)
- > ✓ Build (dev)
- > ✓ Run tests
- > ✓ Configure (coverage)
- > ✓ Build (coverage)
- > ✓ Run tests with profiling
- > ✓ Generate coverage report
- > ✓ Upload coverage artifact
- > ✓ Post Run actions/checkout@v4
- > ✓ Complete job

Run tests with profiling

```
368
369 [-----] 7 tests from ErrorStateTest
370 [ RUN    ] ErrorStateTest.OnEnterPrintsErrorMessage
371 [      OK ] ErrorStateTest.OnEnterPrintsErrorMessage (0 ms)
372 [ RUN    ] ErrorStateTest.OnEnterStopsMotor
373 [      OK ] ErrorStateTest.OnEnterStopsMotor (0 ms)
374 [ RUN    ] ErrorStateTest.OnEnterStopsCleaning
375 [      OK ] ErrorStateTest.OnEnterStopsCleaning (0 ms)
376 [ RUN    ] ErrorStateTest.HandleObstacleIsNoop
377 [      OK ] ErrorStateTest.HandleObstacleIsNoop (0 ms)
378 [ RUN    ] ErrorStateTest.HandleDustIsNoop
379 [      OK ] ErrorStateTest.HandleDustIsNoop (0 ms)
380 [ RUN    ] ErrorStateTest.HandlePowerOffTransitionsToOffState
381 [      OK ] ErrorStateTest.HandlePowerOffTransitionsToOffState (0 ms)
382 [ RUN    ] ErrorStateTest.OnExitIsNoop
383 [      OK ] ErrorStateTest.OnExitIsNoop (0 ms)
384 [-----] 7 tests from ErrorStateTest (0 ms total)
385
386 [-----] 10 tests from InitializingStateTest
387 [ RUN    ] InitializingStateTest.AllDevicesSucceedTransitionsToCleaningState
388 [      OK ] InitializingStateTest.AllDevicesSucceedTransitionsToCleaningState (0 ms)
389 [ RUN    ] InitializingStateTest.AllDevicesInitializedOnceOnSuccess
390 [      OK ] InitializingStateTest.AllDevicesInitializedOnceOnSuccess (0 ms)
391 [ RUN    ] InitializingStateTest.FirstAttemptFailsThenSucceedsTransitionsToCleaningState
392 [      OK ] InitializingStateTest.FirstAttemptFailsThenSucceedsTransitionsToCleaningState (0 ms)
393 [ RUN    ] InitializingStateTest.TwoFailuresThenSuccessTransitionsToCleaningState
394 [      OK ] InitializingStateTest.TwoFailuresThenSuccessTransitionsToCleaningState (0 ms)
395 [ RUN    ] InitializingStateTest.AllAttemptsFailTransitionsToErrorState
396 [      OK ] InitializingStateTest.AllAttemptsFailTransitionsToErrorState (0 ms)
397 [ RUN    ] InitializingStateTest.RetriesExactlyMaxRetryTimes
398 [      OK ] InitializingStateTest.RetriesExactlyMaxRetryTimes (0 ms)
399 [ RUN    ] InitializingStateTest.HandleObstacleIsNoop
400 [      OK ] InitializingStateTest.HandleObstacleIsNoop (0 ms)
401 [ RUN    ] InitializingStateTest.HandleDustIsNoop
402 [      OK ] InitializingStateTest.HandleDustIsNoop (0 ms)
403 [ RUN    ] InitializingStateTest.HandlePowerOffTransitionsToOffState
404 [      OK ] InitializingStateTest.HandlePowerOffTransitionsToOffState (0 ms)
405 [ RUN    ] InitializingStateTest.OnExitIsNoop
406 [      OK ] InitializingStateTest.OnExitIsNoop (0 ms)
407 [-----] 10 tests from InitializingStateTest (0 ms total)
408
409 [-----] Global test environment tear-down
410 [=====] 173 tests from 17 test suites ran. (2 ms total)
411 [ PASSED ] 173 tests.
```

System Test

System Test List

#	시나리오	목표	기대 동작
01	basic_cleaning	powerOn 직후 Off→Initializing→Cleaning 진입과 NORMAL 흡입을 검증한다	첫 tick에 Cleaning 진입, NORMAL 가동, FORWARD 이동, 먼지 ≥2.0 수거, 충돌 0
02	obstacle_front	정면 장애물 회피 진리표 (T,F,*) → LEFT를 검증한다	회피 LEFT 후 FORWARD 재개, 먼지 일부 수거, 충돌 0
03	left_blocked_then_dust	진리표 (T,T,F) → RIGHT 회피 후 새 경로의 먼지를 처리하는지 검증한다	RIGHT 회피, NORMAL 가동, 진입 경로 먼지 ≥1.0 수거, 충돌 0
04	right_blocked_then_off	진리표 (T,F,T) → LEFT 회피 직후 powerOff가 깨끗하게 Off로 복귀하는지 검증한다	LEFT 회피, 종료 상태 Off, 충돌 0
05	dead_end	3면 막힌 데드엔드에서 (T,T,T) → BACKWARD 후진 루프를 검증한다	BACKWARD 발생, 진입 경로 먼지 ≥0.5 수거
06	backward_avoidance	사방이 막혔을 때 후진 한 칸으로 충돌을 회피하는 (T,T,T) 진리표를 검증한다	BACKWARD 모터 명령, 충돌 0
07	multi_obstacle	진로상 두 장애물을 연속으로 회피하는지 검증한다	LEFT + FORWARD 발생, 먼지 ≥1.0 수거, 월드 영역 내 위치 유지
08	obstacle_event_burst	5틱 연속 인터럽트 처리 시 매 틱 1회 회피만 발생하는지 검증한다	회피 명령 정확히 5회, 충돌 0
09	obstacle_dust_simultaneous	같은 틱에서 장애물·먼지가 동시 발생할 때 회피 우선·POWER_UP 후속을 검증한다	LEFT 회피 후 새 경로에서 POWER_UP, 충돌 0
10	power_off_during_avoid	회피 중 powerOff가 들어와도 안전하게 Off로 복귀하는지 검증한다	종료 상태 Off, 청소기 OFF 기록, 충돌 0
11	power_off_mid_cleaning	Cleaning 중 powerOff가 STOP+OFF 시퀀스를 거쳐 Off로 가는지 검증한다	종료 Off, 모터 STOP, 청소기 OFF
12	init_failure_motor	모터 initialize 3회 실패 시 MAX_RETRY 소진으로 ErrorState 진입을 검증한다	tick 0 Error 진입, 청소기 OFF, 충돌 0
13	init_retry_then_success	두 번 실패 후 세 번째에 성공하면 Cleaning까지 도달하는지 검증한다	tick 0 Cleaning 진입, FORWARD 발생, 충돌 0
14	error_recovery	Error 상태에서 powerOff 호출이 Off 복귀로 정상 처리되는지 검증한다	tick 0 Error → 종료 Off, 청소기 OFF, 충돌 0
15	dust_powerup	먼지 감지 시 POWER_UP 진입과 먼지 소진 후 NORMAL 복귀를 검증한다	POWER_UP·NORMAL 모두 기록, 먼지 ≥1.5 수거, 충돌 0

System Test List

16	dust_sustained_powerup	지속적인 먼지 감지로 3s 타이머가 갱신되어 POWER_UP이 끊기지 않는지 검증한다	clock 200·3500·5000ms 모두 POWER_UP, 충돌 0
17	dust_below_threshold	임계값(0.5) 미만 먼지(0.3)에서 POWER_UP이 발동하지 않는지 검증한다	NORMAL 가동, POWER_UP 0회, 충돌 0
18	dust_timer_expiry_at_power_off	POWER_UP 타이머 만료와 powerOff가 같은 틱에 겹쳐도 안전한지 검증한다	clock 100·3000ms POWER_UP, 종료 Off, OFF 기록, 충돌 0
19	powerup_preserved_through_avoid	회피 직후에도 새 경로에 먼지가 있으면 POWER_UP이 유지되는지 검증한다	회피 1회, clock 500ms POWER_UP, 충돌 0
20	power_off_immediately	powerOn 직후 첫 틱에 powerOff해도 Off로 깨끗하게 가는지 검증한다	종료 Off, 청소기 OFF, POWER_UP 0회, 충돌 0
21	multi_dust_zone	두 먼지 구역 사이 3s 타이머 만료로 POWER_UP↔NORMAL 사이클을 검증한다	clock 200 POWER_UP, 4000 NORMAL, 5100 POWER_UP, 충돌 0
22	dust_at_avoidance_endpoint	RIGHT 회피로 진입한 새 경로의 먼지로 POWER_UP이 발동하는지 검증한다	RIGHT 회피, POWER_UP 기록, 충돌 0
23	observer_silent_after_off	powerOff 이후 늦게 도착한 인터럽트가 Off에서 무시되는지 검증한다	clock 300ms 이후 회피 0회, 종료 Off, 충돌 0
24	sensor_after_error	Error 진입 후 인터럽트가 들어와도 회피 명령이 발생하지 않는지 검증한다	tick 0 Error, 회피 0회, 종료 Off, 충돌 0
25	fast_tick	tick_duration=50ms일 때 거동이 실시간 페이싱과 무관함을 검증한다	FORWARD 발생, 먼지 ≥1.0 수거, 충돌 0
26	interrupt_during_avoid	한 틱 안에 before_poll/after_poll 인터럽트가 둘 다 들어와도 깨지지 않는지 검증한다	회피 정확히 2회, 충돌 0
27	nfr01_front_interrupt	NFR-01: 인터럽트 기반 정면 감지가 1 tick 이내 회피로 이어지는지 검증한다	인터럽트 후 1 tick 안에 회피 명령, 충돌 0
28	nfr02_avoid_500ms	NFR-02: 정면 장애물 트리거 → Avoiding 진입까지 ≤500ms를 검증한다	trigger_tick 1 기준 500ms 이내 회피, 충돌 0
29	nfr03_powerup_3s	NFR-03: POWER_UP 지속 시간이 정확히 3000ms임을 검증한다	clock 100·2900 POWER_UP, 3100 NORMAL, 충돌 0
30	nfr07_long_run_60min	NFR-07: 60분 연속 운행 동안 Error/Off 진입 없이 동작하는지 검증한다	tick 1~35999 동안 Error/Off 미진입, 종료 Off, 충돌 0

System Test Result

GitHub Actions / System Test Results

succeeded 1 minute ago in 1s

29 passed, 0 failed and 1 skipped

tests 29 passed, 1 skipped

✓ [simulator/system-test-results.xml](#)

30 tests were completed in 273ms with 29 passed, 0 failed and 1 skipped.

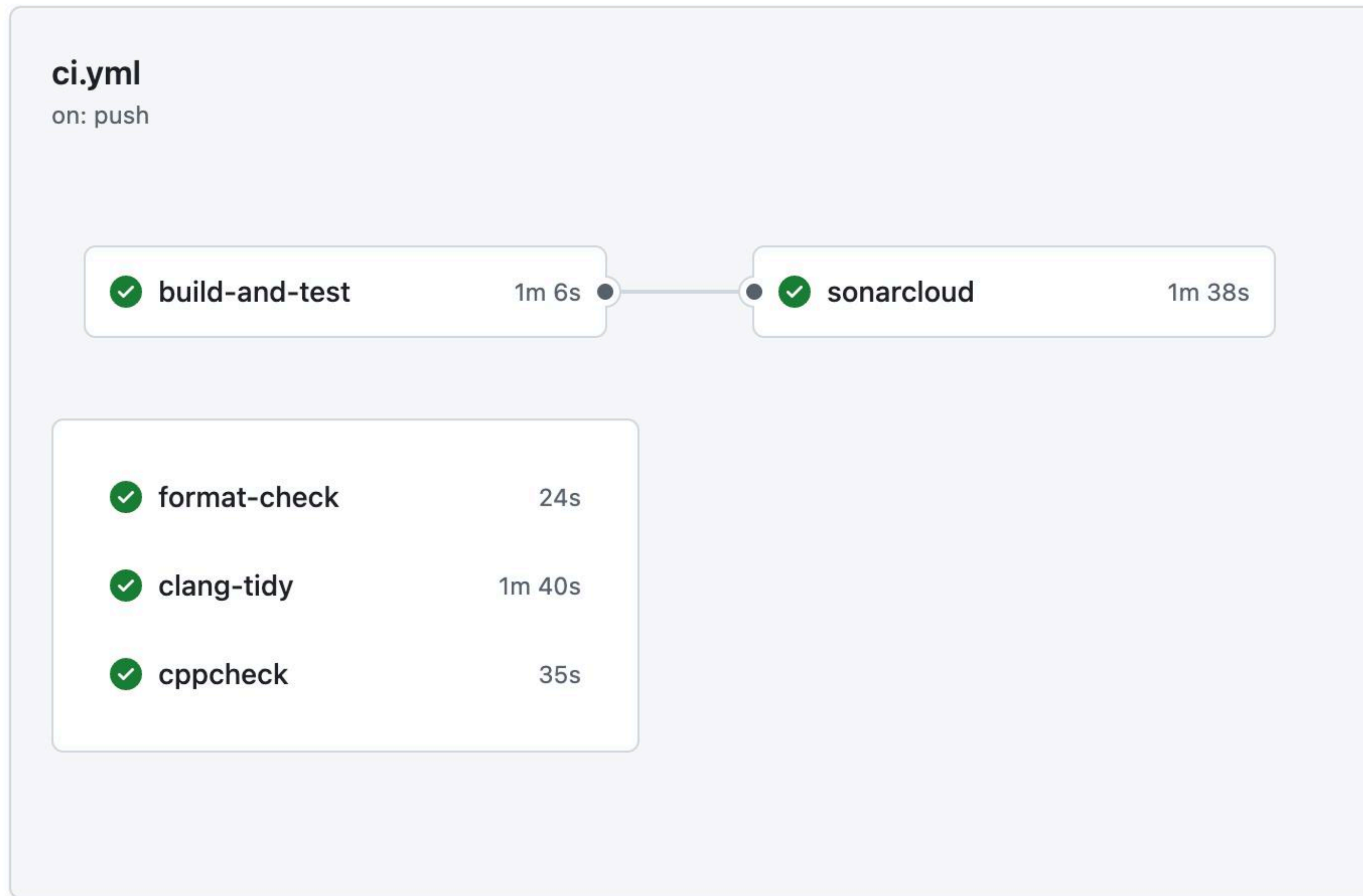
Test suite	Passed	Failed	Skipped	Time
pytest	29 ✓		1 ●	273ms

✓ [pytest](#)

```
tests.test_scenarios
  ✓ test_scenario[01_basic_cleaning]
  ✓ test_scenario[02_obstacle_front]
  ✓ test_scenario[03_left_blocked_then_dust]
  ✓ test_scenario[04_right_blocked_then_off]
  ✓ test_scenario[05_dead_end]
  ✓ test_scenario[06_backward_avoidance]
  ✓ test_scenario[07_multi_obstacle]
```

```
✓ test_scenario[08_obstacle_event_burst]
✓ test_scenario[09_obstacle_dust_simultaneous]
✓ test_scenario[10_power_off_during_avoid]
✓ test_scenario[11_power_off_mid_cleaning]
✓ test_scenario[12_init_failure_motor]
✓ test_scenario[13_init_retry_then_success]
✓ test_scenario[14_error_recovery]
✓ test_scenario[15_dust_powerup]
✓ test_scenario[16_dust_sustained_powerup]
✓ test_scenario[17_dust_below_threshold]
✓ test_scenario[18_dust_timer_expiry_at_power_off]
✓ test_scenario[19_powerup_preserved_through_avoid]
✓ test_scenario[20_power_off_immediately]
✓ test_scenario[21_multi_dust_zone]
✓ test_scenario[22_dust_at_avoidance_endpoint]
✓ test_scenario[23_observer_silent_after_off]
✓ test_scenario[24_sensor_after_error]
✓ test_scenario[25_fast_tick]
✓ test_scenario[26_interrupt_during_avoid]
✓ test_scenario[27_nfr01_front_interrupt]
✓ test_scenario[28_nfr02_avoid_500ms]
✓ test_scenario[29_nfr03_powerup_3s]
● test_scenario[30_nfr07_long_run_60min]
```

Static Code Analysis



Static Code Analysis

build-and-test

succeeded 43 minutes ago in 1m 6s

- Set up job
- Run actions/checkout@v4
- Install dependencies
- Configure (dev)
- Build (dev)
- Run tests
- Configure (coverage)
- Build (coverage)
- Run tests with profiling
- Generate coverage report
- Upload coverage artifact
- Post Run actions/checkout@v4
- Complete job

format-check

succeeded 40 minutes ago in 22s

- Set up job
- Run actions/checkout@v4
- Install clang-format
- Check formatting
 - Run ./scripts/format.sh check
 - Checking formatting...
 - All files formatted correctly.
- Post Run actions/checkout@v4
- Complete job

clang-tidy

succeeded 38 minutes ago in 2m 33s

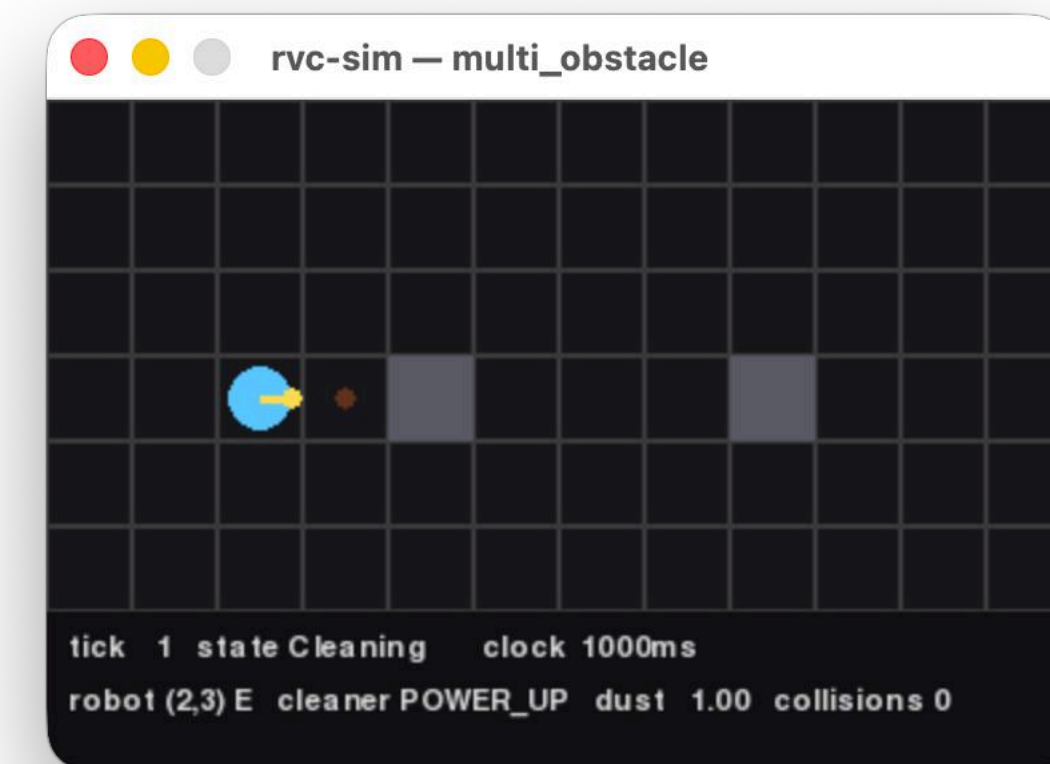
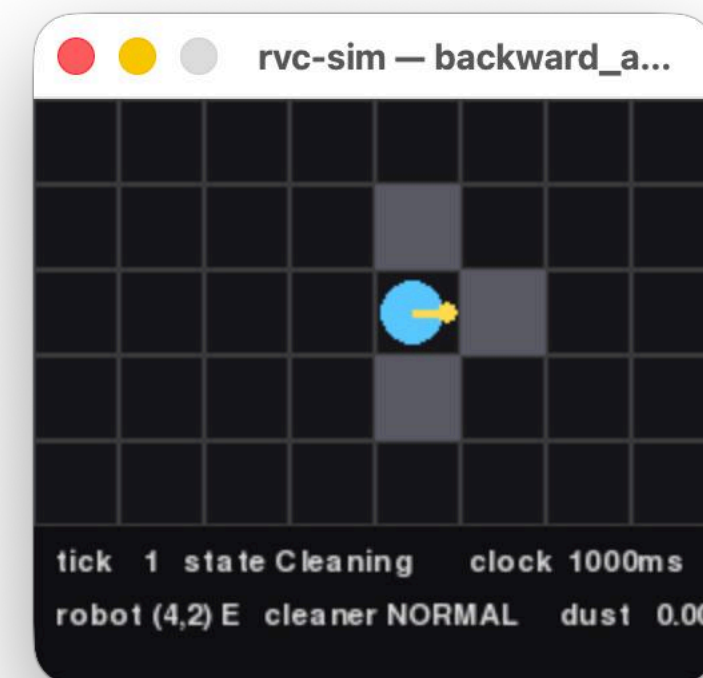
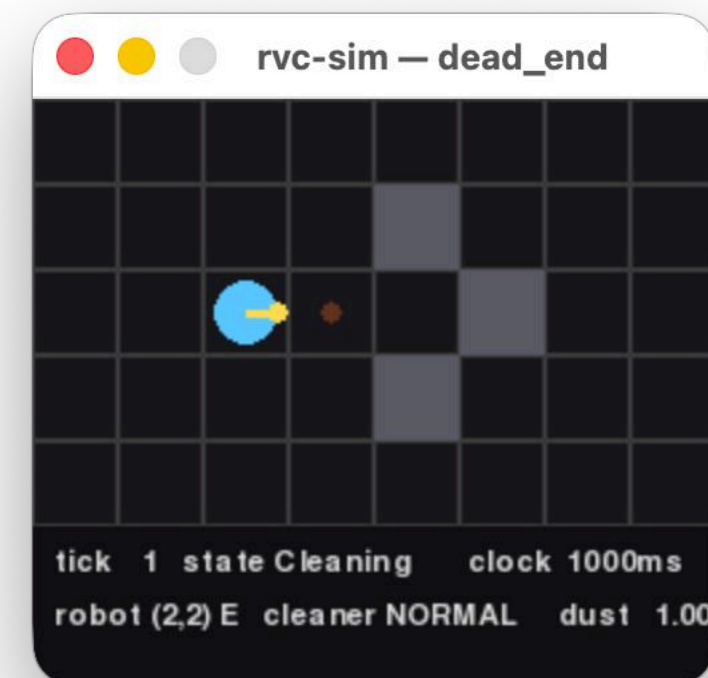
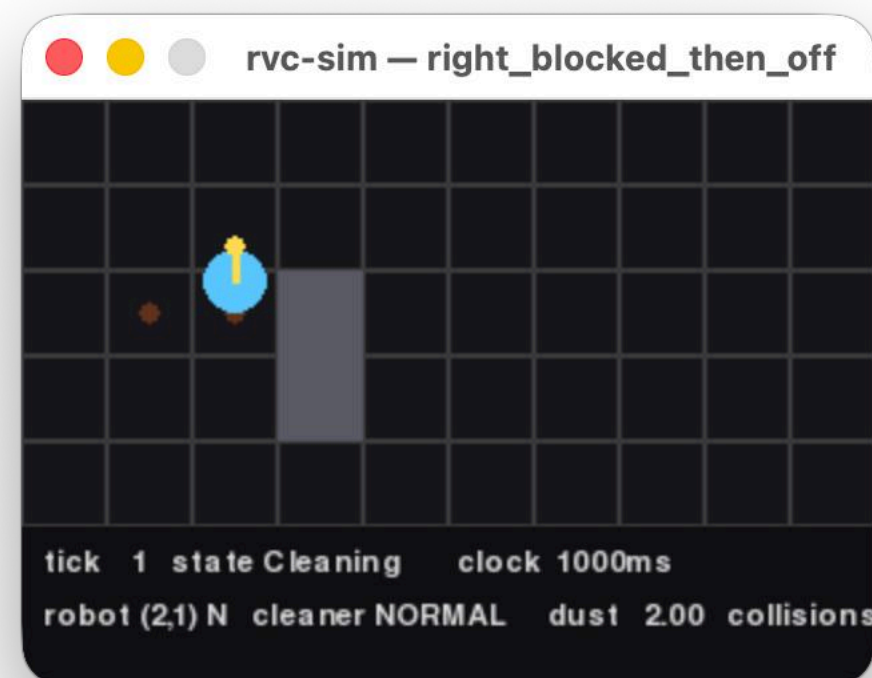
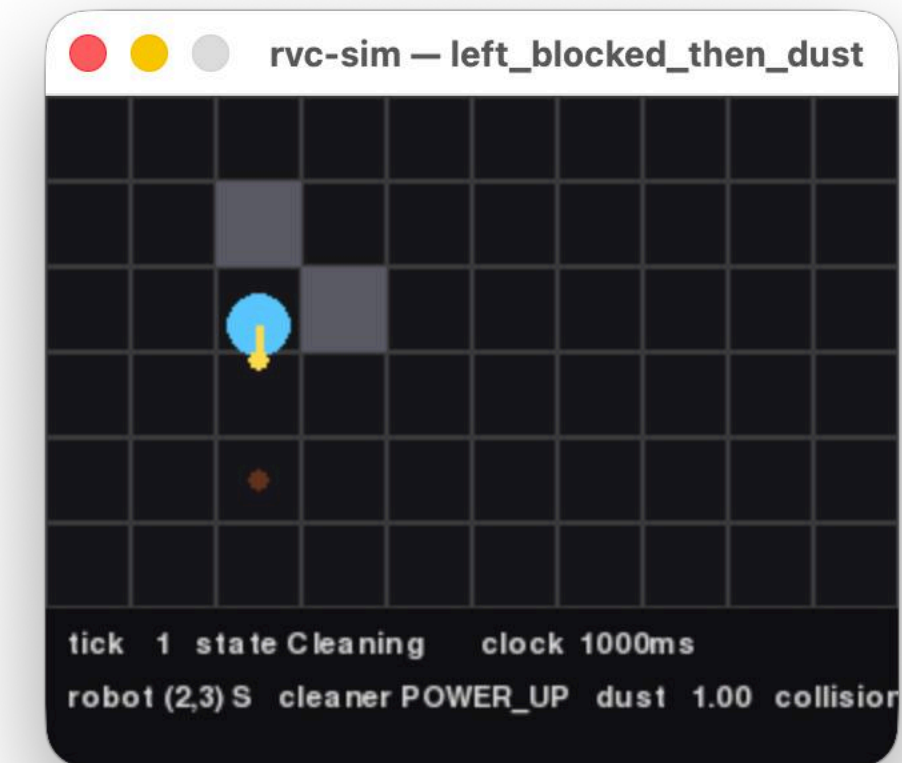
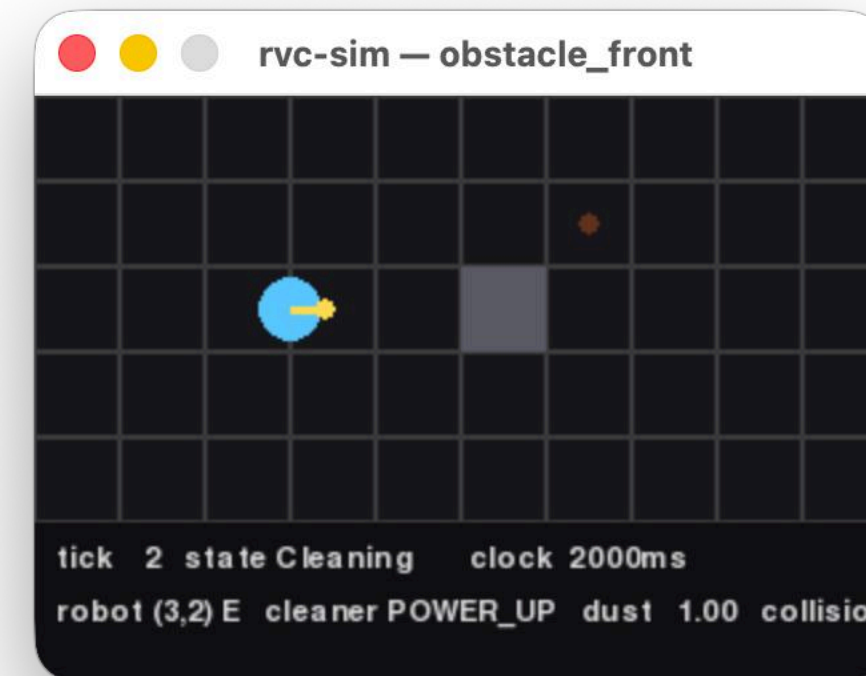
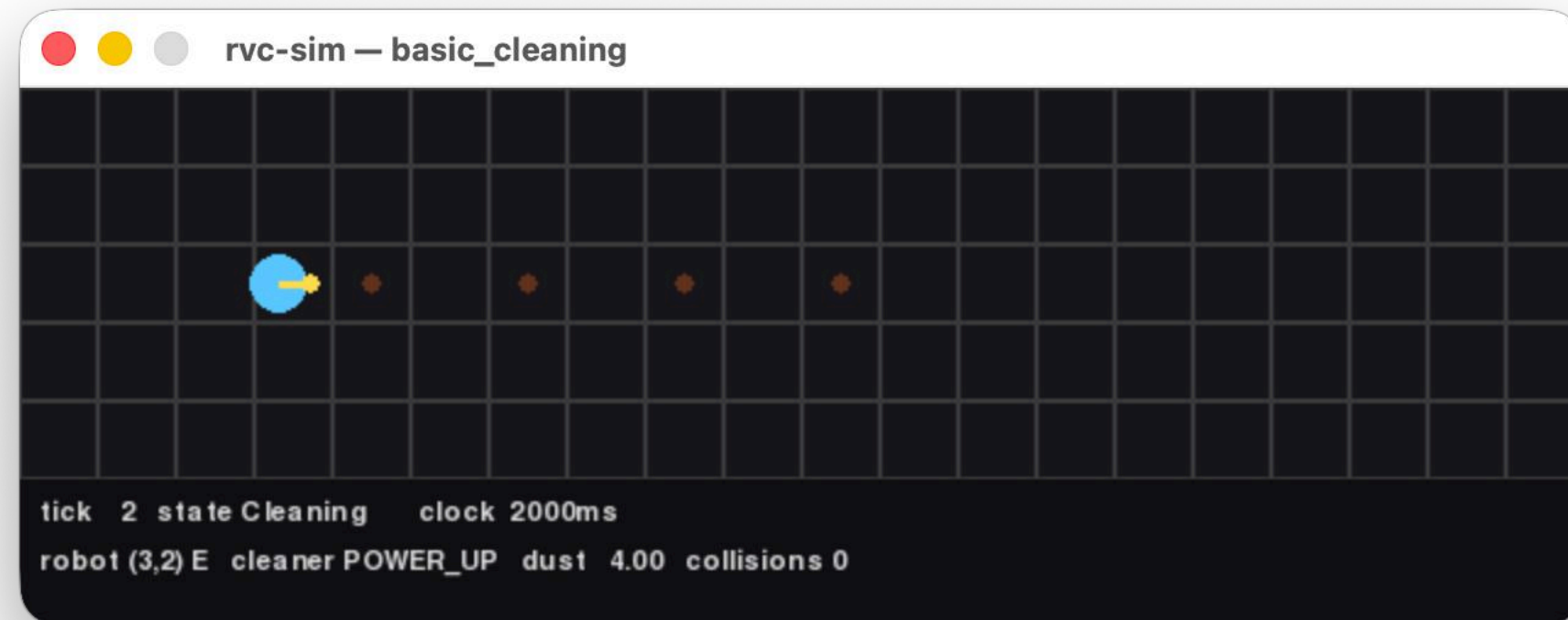
- Set up job
- Run actions/checkout@v4
- Install dependencies
- Configure
- Build (needed for headers)
- Run clang-tidy

```
1 ▶ Run ./scripts/lint.sh build/dev
7 ==> Running clang-tidy...
8 [1/13] Processing file /home/runner/work/rvc-controller/rvc-controller/src/off_state.cpp.
9 28315 warnings generated.
10 [2/13] Processing file /home/runner/work/rvc-controller/rvc-controller/src/obstacle_sensor_subject.cpp.
11 47832 warnings generated.
12 [3/13] Processing file /home/runner/work/rvc-controller/rvc-controller/src/rvc_controller.cpp.
13 82347 warnings generated.
14 [4/13] Processing file /home/runner/work/rvc-controller/rvc-controller/src/cleaning_state.cpp.
15 116232 warnings generated.
16 [5/13] Processing file /home/runner/work/rvc-controller/rvc-controller/src/error_state.cpp.
17 150642 warnings generated.
18 [6/13] Processing file /home/runner/work/rvc-controller/rvc-controller/src/main.cpp.
19 150642 warnings generated.
20 [7/13] Processing file /home/runner/work/rvc-controller/rvc-controller/src/dust_sensor_subject.cpp.
21 170159 warnings generated.
22 [8/13] Processing file /home/runner/work/rvc-controller/rvc-controller/src/cleaning_manager.cpp.
23 188337 warnings generated.
24 [9/13] Processing file /home/runner/work/rvc-controller/rvc-controller/src/timer.cpp.
25 233041 warnings generated.
26 [10/13] Processing file /home/runner/work/rvc-controller/rvc-controller/src/default_avoid_strategy.cpp.
27 234410 warnings generated.
28 [11/13] Processing file /home/runner/work/rvc-controller/rvc-controller/src/initializing_state.cpp.
29 262725 warnings generated.
30 [12/13] Processing file /home/runner/work/rvc-controller/rvc-controller/src/avoiding_state.cpp.
31 296615 warnings generated.
32 [13/13] Processing file /home/runner/work/rvc-controller/rvc-controller/src/movement_manager.cpp.
33 297985 warnings generated.
34 /home/runner/work/rvc-controller/rvc-controller/include/rvc/movement_manager.hpp:24:15: warning: function 'needsReverse' should be marked [[nodiscard]] [modernize-use-nodiscard]
35 24 | bool needsReverse(bool front, bool left, bool right) const;
36 |     ^
37 |     [[nodiscard]]
38 /home/runner/work/rvc-controller/rvc-controller/src/avoiding_state.cpp:15:22: warning: variable name 'mm' is too short, expected at least 3 characters [readability-identifier-length]
39 15 | MovementManager* mm = ctx.getMovementManager();
40 |     ^
41 /home/runner/work/rvc-controller/rvc-controller/src/avoiding_state.cpp:29:9: warning: avoid do-while loops [cppcoreguidelines-avoid-do-while]
42 29 | do {
43 |     ^
44 /home/runner/work/rvc-controller/rvc-controller/src/avoiding_state.cpp:53:22: warning: variable name 'cm' is too short, expected at least 3 characters [readability-identifier-length]
45 53 | CleaningManager* cm = ctx.getCleaningManager();
46 |     ^
47 /home/runner/work/rvc-controller/rvc-controller/src/avoiding_state.cpp:60:22: warning: variable name 'mm' is too short, expected at least 3 characters [readability-identifier-length]
48 60 | MovementManager* mm = ctx.getMovementManager();
49 |     ^
50 /home/runner/work/rvc-controller/rvc-controller/src/avoiding_state.cpp:65:22: warning: variable name 'cm' is too short, expected at least 3 characters [readability-identifier-length]
51 65 | CleaningManager* cm = ctx.getCleaningManager();
52 |     ^
53 Suppressed 297976 warnings (297976 in non-user code).
54 Use -header-filter=.* to display errors from all non-system headers. Use -system-headers to display errors from system headers as well.
55 ==> clang-tidy passed.
```
- Post Run actions/checkout@v4
- Complete job

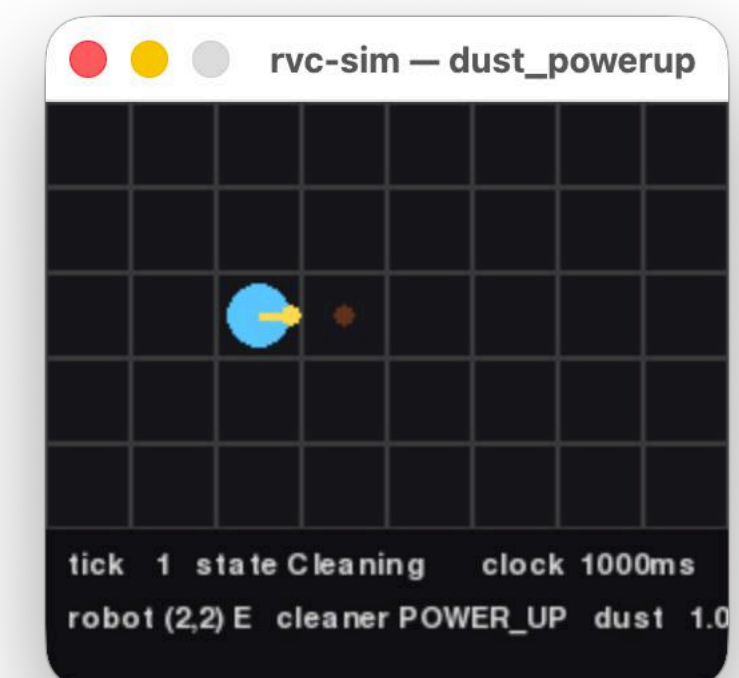
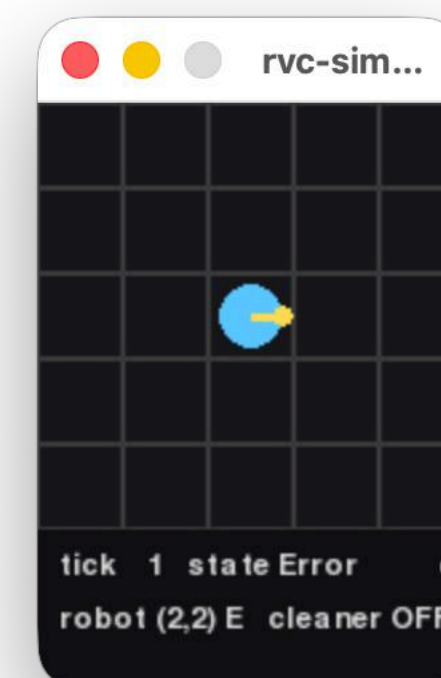
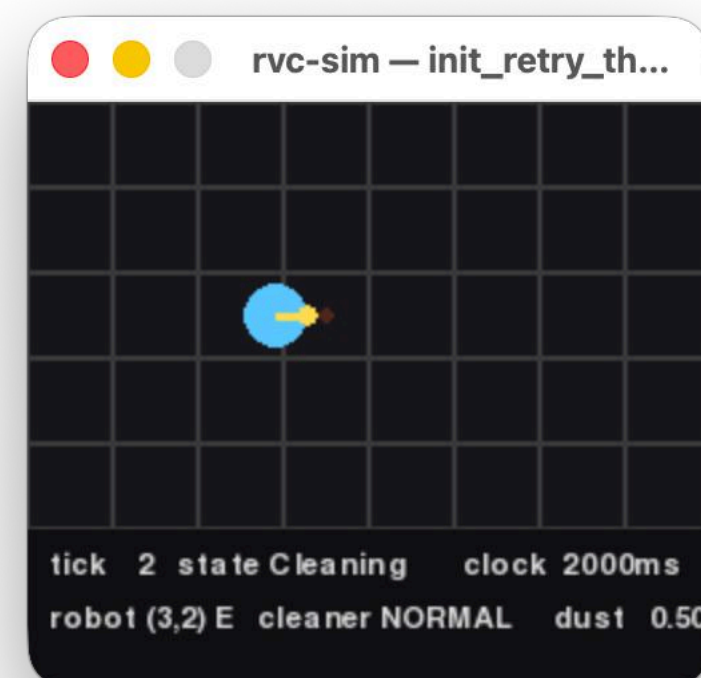
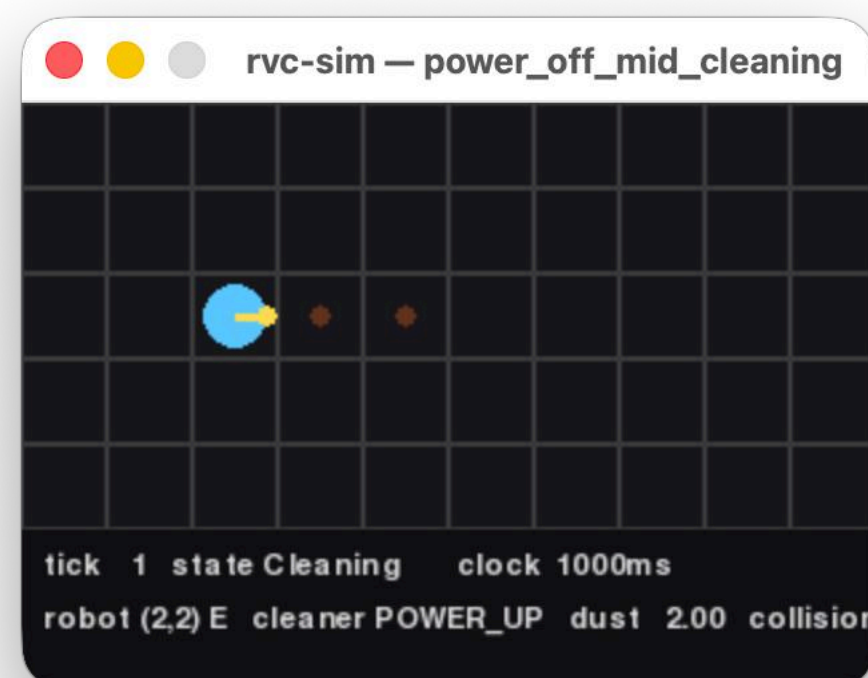
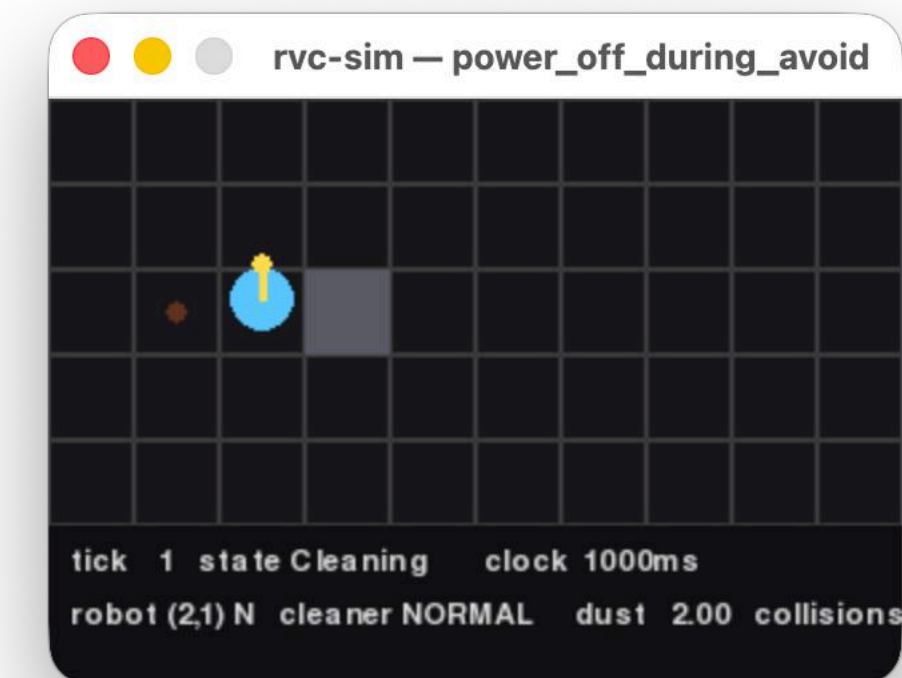
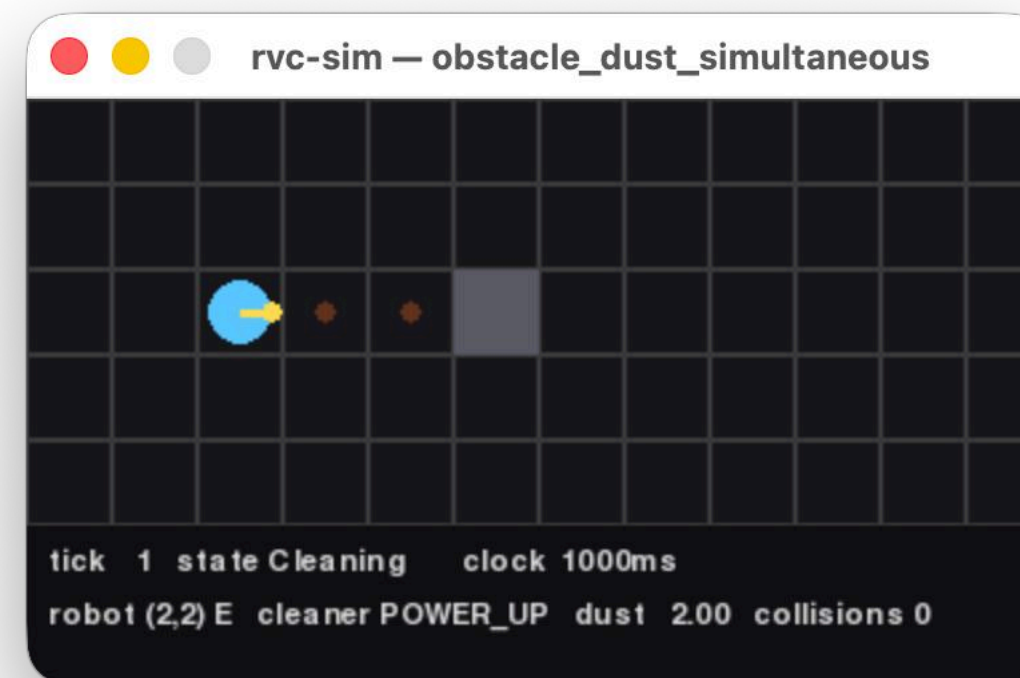
Static Code Analysis

<p>cppcheck succeeded 40 minutes ago in 33s</p> <ul style="list-style-type: none">> <input checked="" type="checkbox"/> Set up job> <input checked="" type="checkbox"/> Run actions/checkout@v4> <input checked="" type="checkbox"/> Install dependencies> <input checked="" type="checkbox"/> Configure<input checked="" type="checkbox"/> Run cppcheck <pre>1 ▶ Run cppcheck \ 16 Checking src/avoiding_state.cpp ... 17 1/27 files checked 1% done 18 Checking src/cleaning_manager.cpp ... 19 2/27 files checked 3% done 20 Checking src/cleaning_state.cpp ... 21 3/27 files checked 4% done 22 Checking src/default_avoid_strategy.cpp ... 23 4/27 files checked 5% done 24 Checking src/dust_sensor_subject.cpp ... 25 5/27 files checked 5% done 26 Checking src/error_state.cpp ... 27 6/27 files checked 6% done 28 Checking src/initializing_state.cpp ... 29 7/27 files checked 8% done 30 Checking src/main.cpp ... 31 8/27 files checked 8% done 32 Checking src/movement_manager.cpp ... 33 9/27 files checked 9% done 34 Checking src/obstacle_sensor_subject.cpp ... 35 10/27 files checked 10% done 36 Checking src/off_state.cpp ... 37 11/27 files checked 11% done 38 Checking src/rvc_controller.cpp ... 39 12/27 files checked 14% done 40 Checking src/timer.cpp ... 41 13/27 files checked 15% done 42 Checking tests/test_avoiding_state.cpp ... 43 14/27 files checked 22% done 44 Checking tests/test_cleaning_manager.cpp ... 45 15/27 files checked 29% done 46 Checking tests/test_cleaning_state.cpp ... 47 16/27 files checked 38% done 48 Checking tests/test_default_avoid_strategy.cpp ...</pre>	<p>sonarcloud succeeded 38 minutes ago in 1m 50s</p> <ul style="list-style-type: none">> <input checked="" type="checkbox"/> Set up job> <input checked="" type="checkbox"/> Run actions/checkout@v4> <input checked="" type="checkbox"/> Install dependencies> <input checked="" type="checkbox"/> Build with compile-commands> <input checked="" type="checkbox"/> Generate coverage> <input checked="" type="checkbox"/> Generate cppcheck report> <input checked="" type="checkbox"/> SonarCloud Scan> <input checked="" type="checkbox"/> Post Run actions/checkout@v4> <input checked="" type="checkbox"/> Complete job
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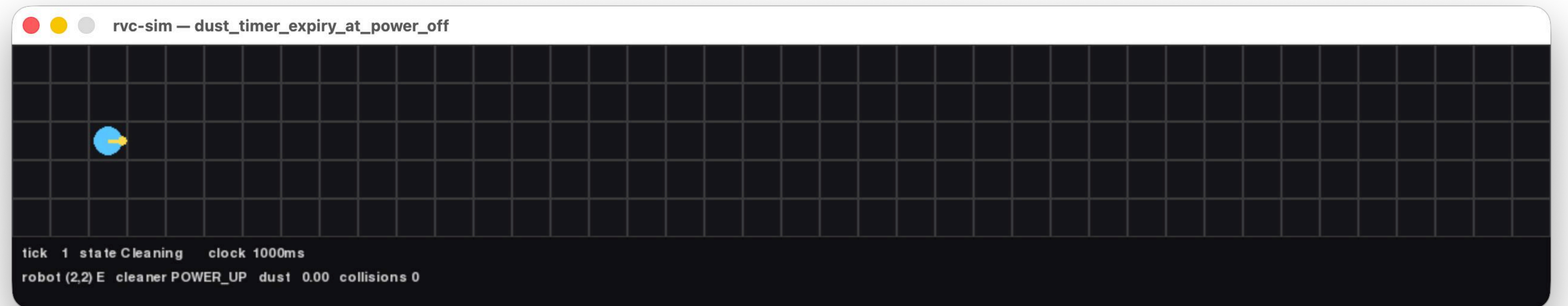
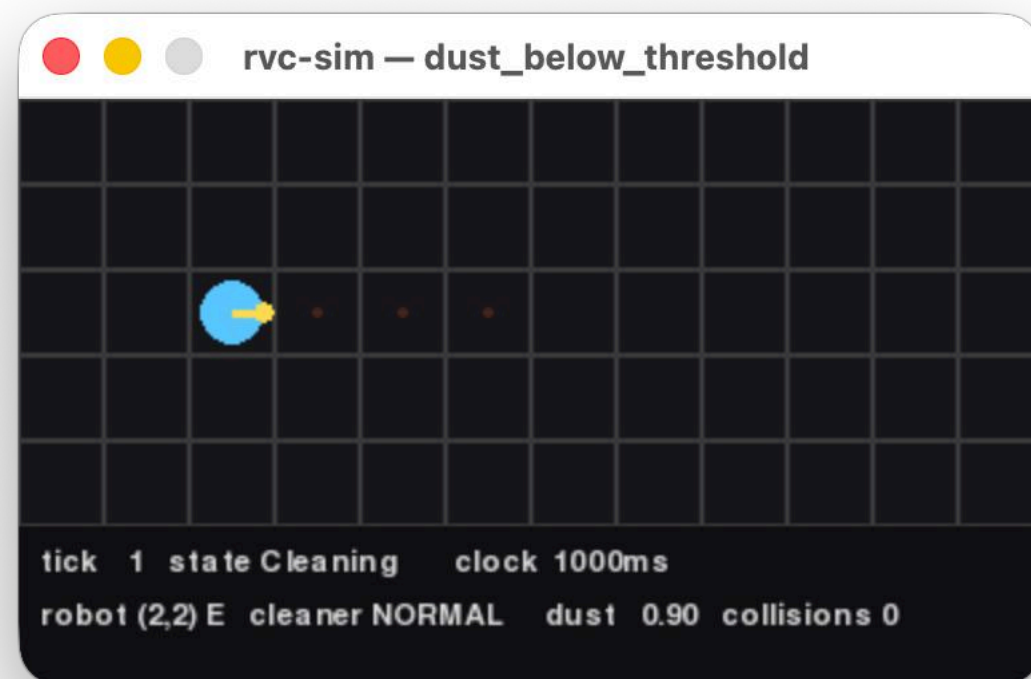
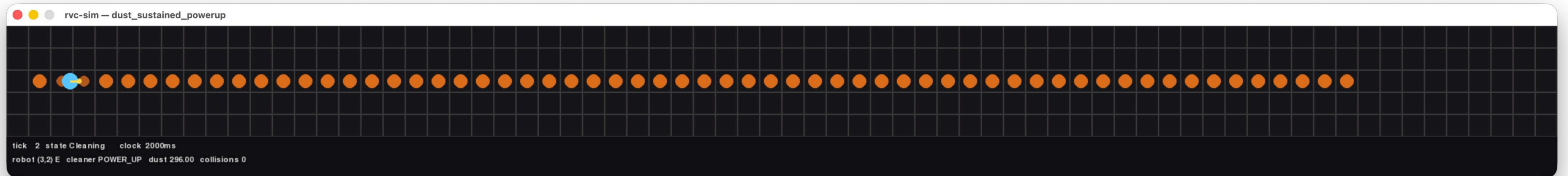
Simulator



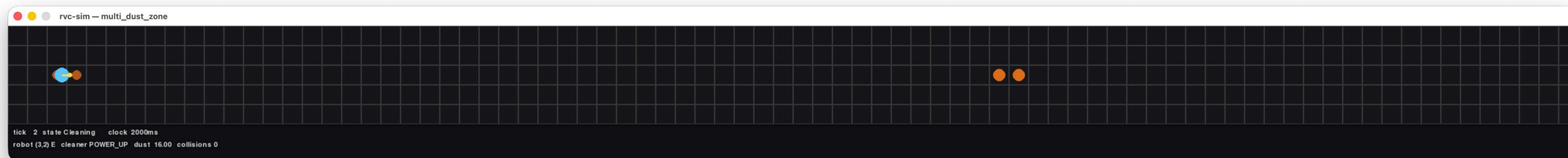
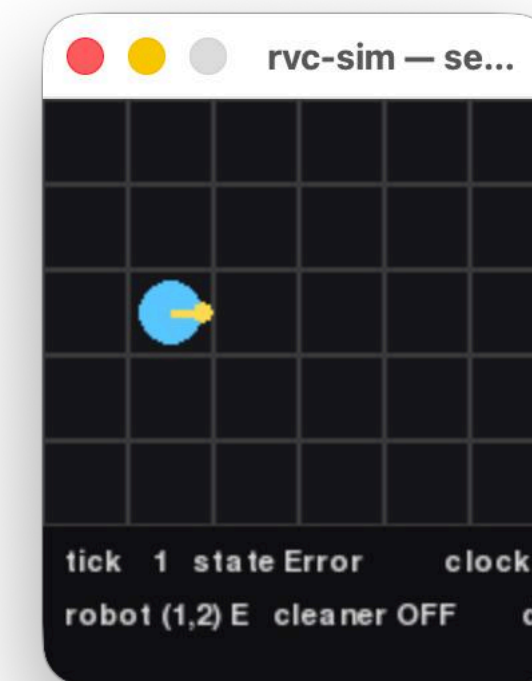
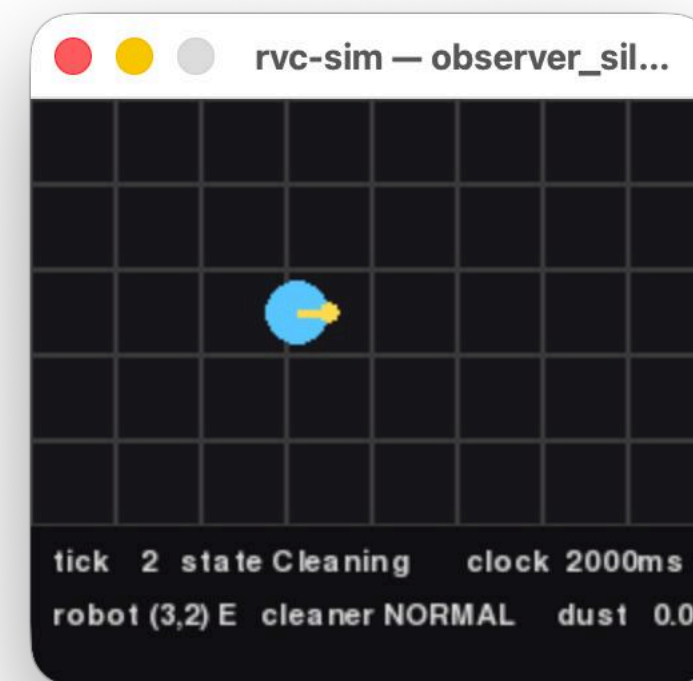
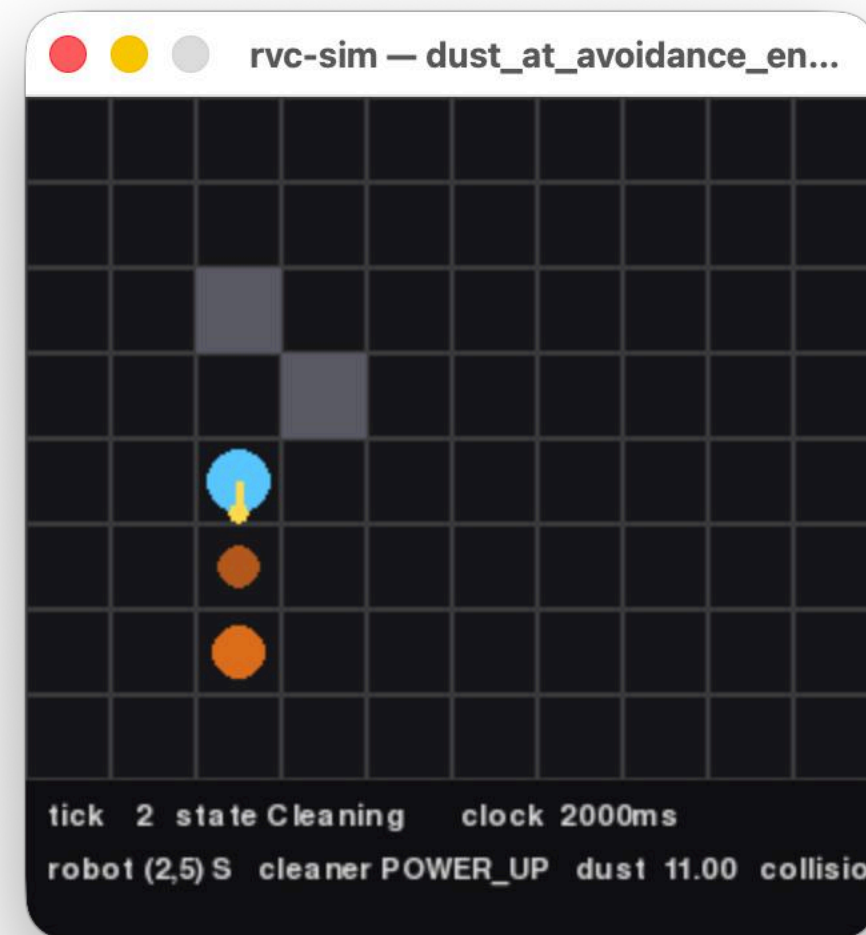
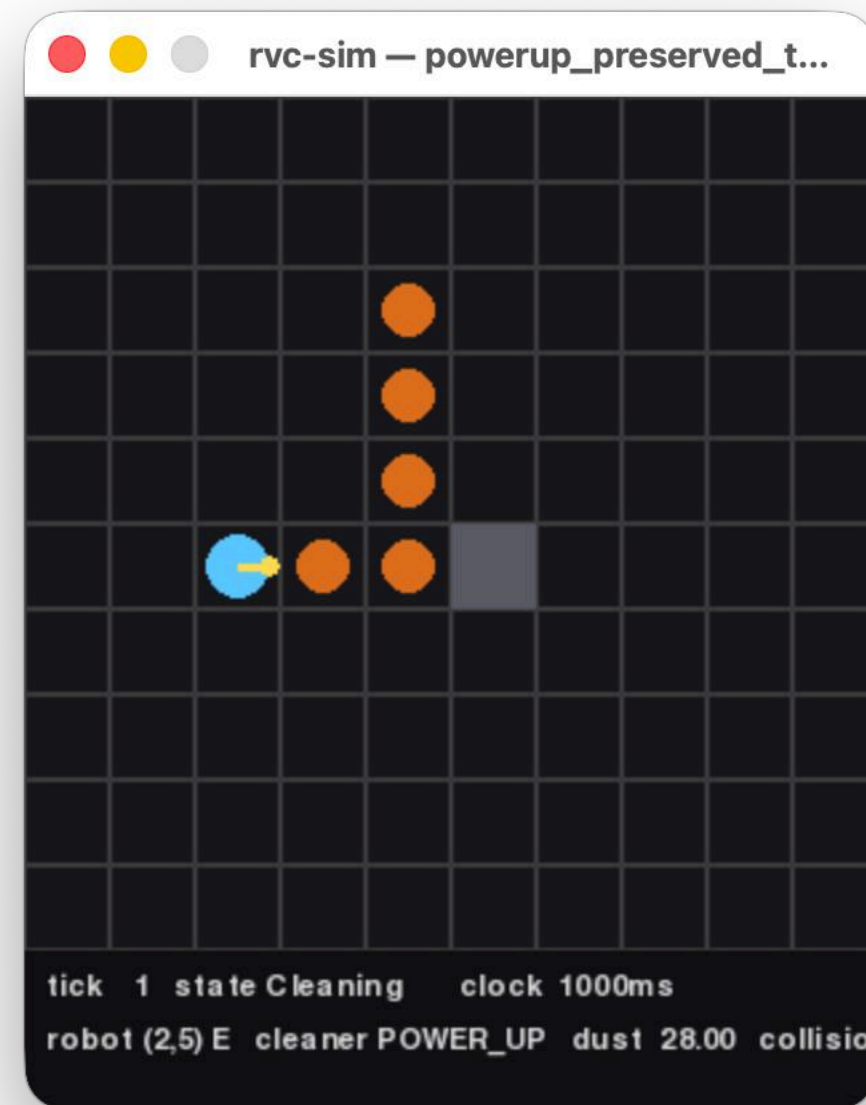
Simulator



Simulator



Simulator



Simulator

