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Traffic enforcement police drone

SRS

Authors:

Pe'er Fikhman 204683650

Yovel Gavrieli 207230343

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1. Introduction

FlyCop provides an innovative solution for traffic enforcement. By using an autonomic drone FlyCop is monitoring the roads and alerting about traffic violations. FlyCop is providing the law enforcement with a sophisticated tool making the roads safe for drivers.

1.1. Overview

One of the most discussed about topics on the daily agenda is the danger on the roads. The Traffic Police, whose job is making the roads safe for drivers, is facing a great deal of challenges. First, the police officers patrolling the roads have human limitations, their sight is limited to their eye view only and many traffic violations avoids the guardians' eye. Nevertheless, after long shifts the policeman might get tired and lose focus. The second big problem is the shortage of manpower, having a police officer on every junction is impossible. Sending a police officer to patrol the roads comes at the expense of other important task he or she might be doing. At last, the technology made available for the police is old fashioned and inaccurate, can deal with one task at a time and requires a policeman that would operate it. Meaning that this tools cost manpower to operate and provide weak evidence against traffic offenders.

FlyCop is a traffic enforcement system based on an autonomic drone. FlyCop is equipped with a wide range sophisticated camera that can cover a great amount of area. Using image processing technology, FlyCop scans the vehicles on the road and recognizes when a traffic violation occurs: if a driver is over speeding, driving carelessly or using his or her cell phone, FlyCop can capture the suspected activity and indicates the police hotline center about the violation in real time. All of FlyCop activity is monitored and uploaded to the drive providing strong evidence against traffic offenders. Using FlyCop, the traffic police can channel manpower from the field to higher priority tasks.

Our Vision at FlyCop is making the roads safe for all drivers by increasing the deterrence among traffic offenders, thus reducing the number of car accidents and traffic violations and saving people lives.

1.2. Problem Description and Motivation

1.2.1. The policemen governing the roads are bound to human limitations: their sight is limited, they might get tired or lose focus. High number of traffic offences that police lose sight of weakens the deterrence resulting in a greater number of accidents that are risking people lives.

1.2.2. The traffic police is limited in manpower- there are many roads to watch and it is an impossible task to have most of them covered.

1.2.3. The technology made available for the police to fight traffic offenders is old-fashioned and inaccurate, providing weak evidence against traffic offenders.

1.3. Goals

1.3.1. By increasing the deterrence among traffic offenders. FlyCop elite Goal is reducing the number of car accidents across the county and saving people lives.

1.3.2. FlyCop is providing a substitution to the traffic police officer on field, providing the police with the ability to channel manpower for better alternative purposes.

1.3.3. FlyCop is renovating the technology made available for the traffic police with sophisticated accurate tools that provide strong evidence against traffic offenders.

1.4. Scope

Law enforcements, traffic.

1.5. Glossary

1.5.1. Autonomous drones: Unmanned aerial vehicles (UAVs) that operate using Artificial Intelligence (AI)-powered navigation and operational software, and do not require a human pilot.

1.5.2. Traffic offence/violation: unlawful activities that occur while an individual is operating a motor vehicle. In this document will refer to violations that can be caught from above view using the drone such as speeding, illegal bypassing, running stop signs or red lights and so on.

1.5.3. field police officer: policemen situated on field. in this document concerns traffic police officers who's job is vising in person the roads.

1.5.4. Hotline center: An emergency center of the police communicating between all policemen in field.

1.5.5. Patrol vehicle terminal: computers installed on the police vehicles connected to the police network.

2. General Description

In this section FlyCop's main stakeholder will be presented. In addition few users study cases will be discussed, from end users to secondary users, showing how the introduction of FlyCop to their daily lives had brought a dramatic change of their management and working routines.

2.1. User Characteristics

2.1.1. FlyCop's clients' characteristics are traffic law enforcement agencies. Therefore, FlyCop main costumer is Israel Police.

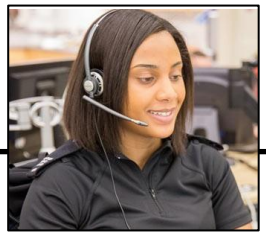
2.2. End-Users:

2.2.1. **Field traffic police officer:** uses the system to get a wider sight of the road.

Haim, 40 years old, field traffic officer.

Haim works at the traffic police at the southern district of Israel for 15 years. Everyday Haim gets on the patrol vehicle, according to the orders he visits different sections of the highroads which are known for having a lot of traffic violations. Haim has no other choice but visiting each section he assigned to at the time. Equipped only with a speedometer and a camera installed on his patrol vehicle, Haim's job is to catch all kinds of traffic offenders while documenting the incident. Lately Haim's department was introduced with FlyCop, the system provides Haim with a wider vision of what is happening on the road. FlyCop recognizes traffic violations and informs Haim in real time. Once the system captures a suspected vehicle, Haim is given GPS navigation to the vehicle. The system had documented the vehicle's violation at the time of the occurrence. Instead of waiting for offenders to come across him, Haim is informed once the offence happens and confronts with it driver directly.

2.2.2. **Police receptionist at hotline center:** uses the system to see live video of the road.



Efrat, 35 years old, working for 3 years as a police hotline receptionist.

Efrat works at the police as hotline receptionist, once an emergency happens all the information about the incident is passed to her by the reports of the police officers on field. Efrat has no sight of what is happening on the road, making it a difficult task for her to grasp on the complete image.
After FlyCop came to use in Efrat's department, Efrat is provided with full visualization of the occurrence in field. When the drone detects a traffic violation a notification is send to Efrat's hotline center, and a live footage of the suspected vehicle is shown on screen with exact GPS coordinates. Now Efrat can easily maneuver the forces on field giving an immediate response to any traffic incident.

2.3. Secondary User:

2.3.1. **lawyers of the State Attorney:** uses the system to watch playback of the offences.

Yosef, 29 years old, lawyer at the State Attorney office.

Yosef works at the state attorney office, as a lawyer Yosef's job is bringing traffic offenders to justice. The evidence against traffic offenders relay mostly on the reports given by the field police officers. The tools in use by the police are old fashioned and don't supply a solid proof against offenders in court.
FlyCop records every traffic offence and uploads the footage to the data base. Since FlyCop has been in use throughout the traffic police departments, Yosef now has footage of what has happened during the suspected incident, providing him with strong evidence against the traffic offenders.

2.4. System Perspective

In the coming section different properties of the system will be discussed including in greater detail five different processes of the system.

2.4.1. **Software**

The Code: Autonomic navigation system, communication system between the drone and the different police terminals, recognition of traffic violations using image processing.

2.4.2. **Hardware**

A computer for running and operating the system, drone, camera, servers, communications infrastructure, GPS sensor, speed sensor, monitor screen.

2.4.3. **Data and Information**

Traffic violation recognition, positioning information about centers with high frequency of traffic violations, data base of the traffic violations caught by the drone, data base of license plates (might be connected to external service).

2.4.4. **Processes**

Process name	Sending the drone for patrol
Participating actors	Traffic police officer.
Flow of Events	**1.** A map is displayed on screen **2.** The user indicates on the map, by circling the area, where the drone should patrol. **3.** The drone takes off and starts to patrol the given area. **4.** The drone recognizes roads. **5.** The drone prioritizing the sections of roads by frequency of traffic violations.

Process name	Real time notification
Participating actors	Traffic police officer, Hotline receptionists.
Flow of Events	**1.** The drone detects traffic violation or careless driving that might result in such. **2.** A notification pops up on the different terminals (at the hotline center and at patrol vehicles nearby). **3.** Provide the user with the option to watch live footage of the suspected vehicle or rewind for the captured incident. **4.** Provide user with GPS coordinates of the suspected vehicle. **5.** Provide user with the option for vehicle surveillance (explained below).

Process name	Semi- autonomous Mode
Participating actors	Hotline receptionists.
Flow of Events	**1.** The drone detects traffic occurrence that might be a violation. **2.** Informs hotline center with vehicle details **3.** Provide the user with the option to watch live footage of the suspected vehicle or rewind for the captured incident. **4.** User enters violation properties such as: User (hotline center receptionist) is given the following options: ▪ Scale the severity of violation. ▪ Enter text describing the violation. ▪ Integrate vehicle details with violation file. ▪ Upload violation to data base. **5.** User is given the option of dealing with violation: ▪ Ignore. ▪ Save to database without informing. ▪ informing field police officer of the violation and uploading to database.

Process name	Documentation of Violations
Participating actors	All actors.
Flow of Events	**1.** The drone detects a traffic violation. **2.** The drone records on camera the violation and uploads to the cloud. **3.** A list of all violations captured by the drone is provided to the user. **4.** List can be sorted by date, saved incidents or the severity of the violation. **5.** Violation can be searched using plate number. **6.** Access to watch the documentation of the incident, location, time etc. **7.** Access for filling a report about the violation.

Process name	License plate recognition
Participating actors	Traffic police officer, hotline center receptionist.
Flow of Events	**1.** The user enters a license plate number. **2.** The user indicates on map, by circling the area, where the drone should look for the vehicle. **3.** The drone takes off starting to patrol the given area. **4.** The drone scans all license plates it encounters. **5.** Once the requested license plate is located the system alerts the hotline center.

Process name	Vehicle surveillance
Participating actors	Traffic police officer, Hotline center receptionists.
Flow of Events	**1.** The drone takes off for a patrol. **2.** The drone zeros in on a vehicle, either by capturing a violation or by user's choice. **3.** The user turns on surveillance mode. **4.** The drone follows up the vehicle. **5.** Live footage is being screened at the different monitors and recorded to data base.

2.4.5.**People**

- Traffic police officers.
- Police hotline receptionists.
- Secondary user: Lawyers at the Attorney office.

2.5. Market Survey

- Elbit Systems

Elbit System is an international high technology company engaged primarily in the defense and homeland security arenas.

Among other products Elbit develops unidentified aerial system including autonomous drones such as the MAGNI which is designed to deliver real-time Intelligence to maneuvering forces.

Another drone manufactured by Elbit is the THOR which is designed for a wide range of surveillance and reconnaissance missions.

- Percepto

Percepto is developing different robotics including autonomous drone in-a-box for holistic inspection and monitorization of industrial sites and critical infrastructure while collecting aggregating and analyzing visual data. By drawing upon tens of thousands of hours collected by autonomous drone missions at industrial facilities Percepto using AI technology to come up with reports tailored for the costumer about assess risk, minimize downtime, drive efficiency, increase safety, and reduce operational costs.

Although different companies are providing similar technology to that of FlyCop, no other company had utilized this technology in order to fight against traffic offenders. FlyCop is the first autonomous drone designed to study the public roads and recognize traffic violations.

2.6. The Approach

The system features a drone equipped with sophisticate camera and different sensors, such as speed and positioning. Using these tools, the system collects data by advanced data processing: recognize vehicles, roads and traffic violations (such as speeding, illegal bypassing, running stop signs or red lights and so on). The system prioritizes the sections of the road by violations frequency giving a closer care and sending the drone more often to high frequency centers. The system is installed on the police servers, using it's network of communication, interfacing with all of existing terminals such as those in the hotline center and the ones on the patrol vehicles.

The user determines the area for the drone to patrol by indicating on map. Once the drone detects a traffic violation, all the different users are informed, switching the system into emergency mode providing the user with features such as coordinates of the suspected vehicle or putting it under surveillance. All of the violations detected by the drone are uploaded to the database.

2.7. Constraints

- The drone should preform in different weather conditions such as bright sunlight, rain or fog.
- The drone must recognize unexpected Obstacles that might encounter it such as birds or other aircrafts and avoiding collision.
- The police should provide a strong enough server computer to support system requirements.
- The drone is bound to areas supported with the police communication network.

2.8. Assumptions and Dependencies

- The system must be interfaced with different police systems such as vehicle registration plate database, a system allowing to issue a report and the police different terminals and computers.

3. Functional Requirements

In this section the system functional requirements will be presented with priority classification by the MoSCoW analysis. FlyCop's system main process is sending the drone for a patrol, therefore this process is situated at the center. All requirements will be described relatively by the order: prior, during and following the process of the patrol.

Prior to the patrol

- **[M]** login: all users must login with a valid permission.
  - in case of failure to login, a corresponding message will show on screen describing the reason of failure.
- **[M]** Selecting a mission: the system currently supports two missions one is detecting traffic violations and the other is locating a vehicle by register plate number.
  - Traffic violation detection settings: selecting the first mission a menu will show on screen allowing the user to set the following:
    - Time and date of the mission: allowing the user to schedule mission later.
    - Duration of mission.
    - Time and date: allowing the user to schedule mission later.
    - Height of the flight.
    - Choice between flying at a specific point or patrol a wider area.
  - Locating a vehicle settings: selecting the second mission a menu will show on screen allowing the user to set the following
    - Entering a vehicle license number: after entering the number the screen will show the vehicle's details such as color, model, name of owner etc.
    - Time and date: allowing the user to schedule mission later.
    - Duration of mission.
    - Height of the flight.
    - Choice between flying at a specific point or patrol a wider area.

- **[M]** Indicating patrol area on map: After setting the mission properties the user is led to a map
  - If specific point was chosen in settings allowing the user to choose only a point on screen. Otherwise if a wider area for patrol was chosen in settings allowing the user to draw a circle on map.
  - if the point/area is outside of communication network boundaries an error message will display.
  - If the settings entered previously are not compatible with the selected area a message will show on screen advising the user to change settings accordingly.

During the patrol

- **[S]** If the drone doesn't detect violations :
  - Advice the officer to change location of patrol.
- **[M]** If the drone detects a violation
  - Start recording
  - Send notification to hotline center.
    - Send description of the violation.
    - Send plate number.
    - Send live location of the drone.
    - Send link to live video.
  - An option to start surveillance mode on the vehicle is given.
  - The hotline center can send officer to the violation place
    - Sends the most close officer to the violation.
    - Sends the plate number.
    - Sends live location of the drone.
- **[C]** Semi-autonomous mode
  - Drone detects an occurrence that might be a violation.
  - Informs hotline center about the occurrence.
    - including all vehicle information as mentioned above.
  - User (hotline center receptionist) is given the following options:
    - Scale the severity of violation.
    - Enter text describing the violation.
    - Integrate vehicle details with violation file.
    - Upload violation to data base.
  - User is given the option of dealing with violation:
    - Ignore.
    - Save to database without informing.
    - informing field police officer of the violation and uploading to database.
- **[S]** See live image of the drone.
  - Map with all operating drones in the area.
  - Clicking on a drone
    - Send current location.
    - Send link to live video.
    - Send the status of the road.

After the patrol

- **[M]** The system process data collected during the patrol:
  - Successful violation detection and categorization by severity.
  - Road recognition with prioritization by frequency of violations.
  - Mission properties set before patrol are compatible with the area and the success of detecting traffic violations.
- **[M]** The drone uploading videos of detected violations to the cloud:
  - Drone connects to police server
  - Drone uploads video to cloud.
  - the system organizes videos by sort options (explained below).

- **[M]** The user can watch violations detected by the drone:
  - Search engine allowing the user to search by: plate number, date and time, location by district.
  - Filter the list of violations by: severity, location, date and time (past day, week, month etc.).
- **[M]** User can fill a report about the violation
  - Connecting to external system allowing police officer to issue a report.

4. Non Functional Requirements

The following section will describe the non-functional requirements, meaning requirements that the system must meet out the scope of the users' interface and functional algorithmics.

- Since the system is connected to police servers a critical issue of information security arises:
  - The system should meet the police information security standards: information shall be encrypted and secured.
  - Information will be displayed to user according to permissions.
- Following the need to operate in real time with the occurrence on the roads, the system shall not perform with no delays.
- The system should work simultaneously in full corporation among different terminals, therefore adaptation to each terminal is needed.
- Since most of the system users are naïve and don't have advanced technical knowledge, the system should be user friendly and easy to operate.
- The system should hold an accurate location of the drone.
- Because the need for accurate data of the vehicles on the road in different weather conditions, the drone shall be equipped with infrared camera as well.

5. System Flows

Always start with a few sentences before the first sub section.

6. System Screen Specifications

Always start with a few sentences before the first sub section.

7. Non Goals

In this section explanation about general requirements outside the scope of the system will be brought:

- The system is not designed for insurance purposes, data collected by the system will not serve insurance corporations for any reason.
- Taking control over the drone is not supported by the system, the drone should be completely autonomous.

- The drone is not designed to interact with civilian drivers.
- The system is not compatible with civilian devices.
- The system doesn't deal with hazards caused to road infrastructure.

8. Open Issues

This section will discuss open issues of the system, meaning issues which are not yet to be solved.

- Not all traffic violations are yet to be supported by the system. With time and advance of technology the system will be able to detect more violations.
- Drone can't fly at any weather condition, the system should feature a connection to weather service that would update the drone if flying is possible.

9. References

10. Appendix – A: Risk Analysis

- Information Security: The system is connected to police servers containing all sort of vulnerable information, may attract crooks trying to break into police servers .
  - Solution approach: Using high level of encryption that stands to police security standards.
- Crash of the drone: The drone may be tackled during flight and crash.
  - Solution approach: positioning device will be contained in a Blackbox with it's own battery, signaling emergency location when down.
- Vehicle owner trying to hide plate number: drivers trying to avoid the drone may hide vehicle's plate number
  - Solution approach: The system will recognize defects in registration plate and informing.