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# Estimation Methods of the Visual Flight Rules Planned Route for Sharing Preflight Information with Urban Air Mobility

Daichi Toratani,[1)†] and Hiroko Hirabayashi[1)]

[1)]*Air Traffic Management Department, Electronic Navigation Research Institute*
*National Institute of Maritime, Port and Aviation Technology, Japan*
[†]*email: toratani-d@mpat.go.jp*

With the emerging urban air mobility, there is a concern that urban air mobility operations affect existing aircraft operations, especially operations of visual flight rules aircraft. Preflight information sharing between urban air mobility and visual flight rules aircraft is a promising approach to establish collaborative operational environment including urban air mobilities. With preflight information, such as planned route, it can be expected that potential conflict is detected before flights and resolved through traffic management system. The authors developed three estimation methods of the visual flight rules planned routes from the visual flight rules flight plan, which is not mandatory to submit to the local air navigation service provider in most countries but mandatory in Japan. Estimation results are compared with the actual track data to evaluate the estimation performance. Based on the comparison results of three estimation methods, discussion is provided regarding the trade-off of the estimation performance and implementation effort from the perspective of sharing preflight information.

**Key Words:** Urban Air Mobility, Visual Flight Rules, Flight Plan, Information Sharing

## 1. Introduction

Various companies are promoting research and development into urban air mobility (UAM), which is expected to provide point-to-point transportation within urban areas on demand. However, there is a concern at UAM flights affecting existing aircraft operations, particularly aircraft in terminal airspace and flying with visual flight rules (VFR) such as general aviation, because it is assumed that the UAM flies at a relatively low altitude. To ensure a safe and efficient UAM operational environment while minimizing the impact on existing aircraft operations, various means have been proposed[1)]. Within a terminal airspace, one promising approach is a UAM corridor, which segregates UAM flights from existing air traffic. It is also considered effective to share flight information between VFR aircraft and UAM.

## 2. Estimation Methods of Visual Flight Rules Planned Route

In Japan, it is mandatory to submit flight plans, even for VFR flights, for all flight distances beyond 9 km[2)], although this is not mandatory for VFR flights in most countries. If the planned VFR flight route can be estimated from the flight plan, the estimated planned route will be useful for preflight conflict detection and resolution with UAM. However, this route is not described in terms of geographic coordinates (i.e. latitude and longitude) but text (i.e. place name) instead. To estimate the VFR planned route from such limited information, we have developed three methods with different required information as shown in Table 1[3, 4)].

Table 1. Required information for estimating the planned route.

| | Required information |
|---|---|
| Method 1 | ● Departure/destination aerodrome<br>● Total estimated elapsed time<br>● Cruising speed |
| Method 2 | ● Departure/destination aerodrome<br>● Route |
| Method 3 | ● Departure/destination aerodrome<br>● Route<br>● Past flight plan/track data |

Figure 1 shows the example of the estimation results for a helicopter flight obtained using Methods 1 to 3. The estimation results are compared with the actual track obtained by Flightradar24[5)]. Method 1 estimates a possible flight region as an ellipse with departure and destination points as the foci of the ellipse. Note that the possible flight region as shown in Fig. 1 is the circle, because the departure and destination points match in this case. Method 2 estimates the planned route by using the route information provided by the VFR flight plan. The geocoding provided by the Geospatial Information Authority of Japan[6)] is used to convert the text-based route information to the route in the geographic coordinate systems. Method 3 also estimates the planned route based on the route information converted by the geocoding in a similar way to Method 2 but updates the waypoints by using the past flight plan/track data. The estimation result obtained from Method 3 as shown in Fig. 1 is depicted as the green area considering the estimation variation in the waypoint updates.

The estimation results are compared to evaluate the developed three methods. The comparison results show that Method 3 has the highest estimation performance, followed in order by Methods 2 and 1. However, Method 3

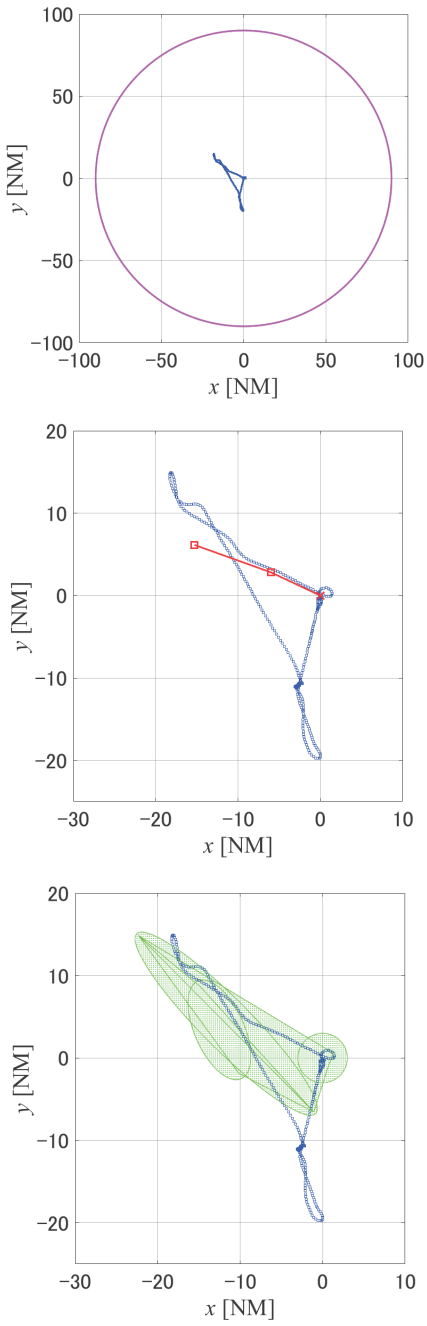


Fig. 1. Example of estimation results.
(top: Method 1, middle: Method 2, bottom: Method 3)
(blue: actual track, magenta: possible flight region, red: estimated planned route, green: estimated flight region)

requires the most effort to implement the estimation method to the information management system, followed by Methods 2 and 1. Accordingly, there is a trade-off relationship between the estimation performance and implementation effort.

## 3. Conclusion

Toward the information sharing with urban air mobility and VFR aircraft, we developed the estimation methods of the VFR planned routes from the VFR flight plan. Example results are shown and compared with the actual track data. The evaluation results show that the estimation methods has a trade-off between the estimation performance and implementation effort. It is expected that the results support the decision maker to introduce the information sharing system between UAM and VFR aircraft.

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