Jammer Localization Method using Degradation of GPS C/No Measurements

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***Abstract*— In this paper, we present the Global Positioning System (GPS) jammer localization method using the carrier-to-noise density (C/No) measurements of the commercial GPS receivers, which are already installed nationwide in Korea. The jamming power directly affects the C/No measurements of GPS signals. Accordingly, we precisely make the C/No profiles of the GPS receivers correspond to the jamming power under jamming test environment. Then, the Received Signal Strength (RSS) of the jamming can be estimated by comparing the degraded C/No measurements and the corresponding C/No profile of the respective station. Finally, we determine the jammer location by using the RSS of the respective station and the propagation prediction model of the jamming signal.**

Keywords- GPS; Jammer; Localization; C/No.

I. INTRODUCTION

Even though GPS signals are normally robust to jamming due to spreading gain using the code division access scheme, it can be disturbed and can malfunction if the jamming exceeds the spreading gain [1][2]. In particular, the jamming is very critical threat to the unmanned autonomous applications using GPS navigation [3]. The direction finding system is generally used to locate the jammer source, but it is highly costly and should be deployed in the specific station [4]. Therefore, in this paper, we present a GPS jammer localization method using the C/No measurements of the commercial GPS receivers, which are already installed nationwide in Korea. The simulation demonstrates that the proposed method estimate GPS jammer location by using the C/No measurements. The paper is organized so that Section II describes the block diagram and localization algorithm. In Section III, we present the simulation results of the proposed method. Finally, the conclusion is drawn in Section IV.

II. PROPOSED METHOD

A. Block diagram

Figure 1 shows the block diagram of the proposed scheme. The jamming power can be estimated by the C/No measurements of GPS signals because they are directly affected by the degree of jamming. Accordingly, we previously make the C/No profiles of the GPS receivers correspond to the jamming power through the precise jamming test. If we detect the degradation of the C/No measurements of the GPS receivers installed and operated in various stations, we estimate the RSS of the jamming by utilizing the corresponding C/No profile of the respective station. Then, we configure the candidate area including the jammed stations and divide it into the small cells. The cell size is defined as the resolution of the jammer location. We calculate the average value and variance of the transmitted power at all cells within the candidate areas by using the RSS of the respective station and the propagation prediction model of the jamming signal. Finally, we determine the location of the GPS jammer as the cell position within the candidate areas having the minimum variance of the transmitted (TX) power.

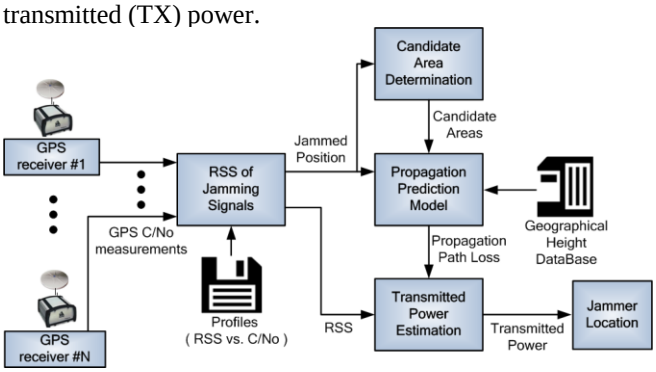

Figure 1. Block diagram of the proposed method.

B. Localization Algorithm

Figure 2 illustrates the algorithm to determine the jammer location. There are many propagation path loss values between the number of jammed positions and the cell position. Then, we can estimate the number of TX powers

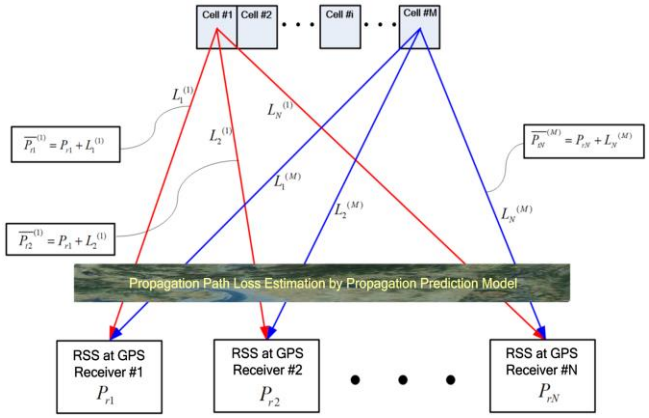

Figure 2. Localization algorithm of the proposed method

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corresponding to the number of jammed positions at each cell. Therefore, the cell having the minimum variance of the estimated TX powers means the estimated optimum location of the jammer within the candidate area including the jammed stations. In this paper, the propagation prediction by the Longley-Rice model is used to estimate the propagation path loss [5].

III. Simulation Results

Firstly, we make the C/No profiles of the GPS receivers corresponding to the RSS of the jamming, as shown in Figure 3. Although the C/No values measured from the GPS receiver are various, we use the average value (green color) of C/No values having about 50 dB-Hz (light-green color) for comparing the degraded C/No from the jammed receiver.

C/No PRN#28	C/No PRN#5	C/No PRN#13	C/No PRN#18	C/No PRN#20	C/No PRN#24	C/No PRN#21	C/No PRN#15	C/No AVR	RSS [dBm]
30.83	43.00	45.00	48.00	49.67	50.00	50.50	51.67	50.06	-107
30.33	44.00	46.00	48.00	49.67	50.00	50.00	51.50	49.89	-106
28.50	44.00	45.67	48.00	49.33	50.00	49.83	52.00	49.72	-105
29.17	44.00	46.00	48.50	49.50	50.00	51.00	52.00	50.17	-104
●	●	●	●	●	●	●	●	●	●
20.17	26.67	35.83	34.83	29.00	37.00	39.00	40.00	35.00	-64
20.50	26.83	36.00	34.00	29.17	36.17	37.00	39.50	34.11	-63
0.00	27.00	35.67	33.17	28.67	35.83	35.83	39.00	33.44	-62
0.00	27.83	34.00	33.00	28.67	35.00	34.50	38.00	32.72	-61
0.00	28.67	32.83	32.33	29.17	34.33	34.17	37.67	32.56	-60
6.83	28.67	30.67	32.00	28.67	33.83	33.83	33.67	32.11	-59
0.00	28.33	29.17	31.67	21.50	33.33	33.00	34.67	29.28	-58
0.00	28.50	29.67	31.17	28.67	33.33	34.00	31.00	32.00	-57
6.83	28.17	29.67	30.17	28.67	33.83	32.50	29.50	31.67	-56
0.00	28.00	29.50	30.00	29.17	33.83	31.00	27.33	31.33	-55
6.83	20.50	27.83	30.00	28.67	33.33	30.33	29.17	30.78	-54

Figure 3. C/No profiles of the GPS receivers corresponding to the RSS

It is assumed that 11 receivers are jammed by the jamming of 1KW effective isotropically radiated power (EIRP) via 1575.42MHz at the position (LLH : 36.8499° / 127.2257° / 560m) near Chonan city in Korea. The RSS values at the stations installed in the commercial GPS receivers are displayed in Figure 4.

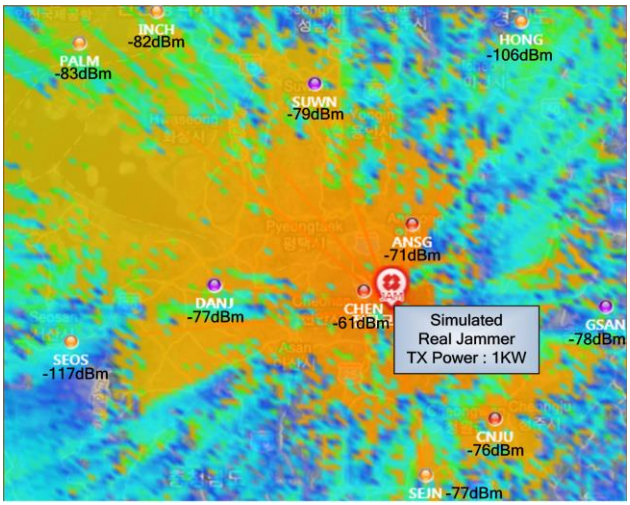

Figure 4. Simulated RSS by simulated jammer power

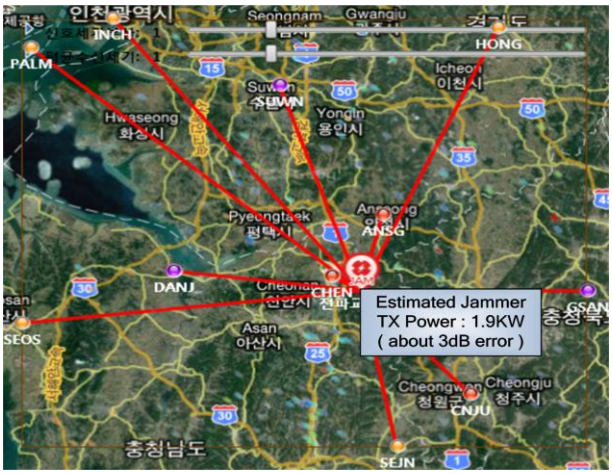

Figure 5. Estimated jammer location and power

Figure 5 shows that the proposed method estimates 1.9 KW power with about 3 dB error at the jammer location using the RSS of the respective station and the propagation prediction of the Longley-Rice model, on the assumption that the RSS are accurately estimated.

IV. Conclusion and Future Work

In this paper, we presented the GPS jammer localization method by using the degradation of C/No measurements of the GPS receivers already installed nationwide in Korea. The simulation showed that the proposed method estimates the GPS jammer location under the condition that the RSS values are accurately estimated by the degraded C/No. This result showed that this method could be used effectively to locate the jammer. Furthermore, future studies will be aimed at improving the reliability of the proposed method by performing experiments under a realistic environment.

Acknowledgment

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