Interference with frequency hopping spread spectrum

Degree programme: BSc in Electrical Engineering and Information Technology | Specialisation: Communication Technologies
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FHSS is widely used as a wireless method to transmit radio signals. With the increasing number of communication devices, the necessity for interference resistance arises. The aim of this work was to investigate the effects of the simultaneous operation of multiple devices of given systems in the same area and at the same time.

Baseline

Since the invention of wireless communication systems, the number of devices which use the electromagnetic spectrum has exponentiated. Technical solutions such as frequency hopping spread spectrum have since been developed to accomodate this progression.
FHSS uses multiple carrier frequencies, between which transmitter and receiver synchronously hop with short intervals (see **figure 1**). This method not only decreases the risk of narrowband interference which includes possible jamming, but also impedes eavesdropping measures. Common applications for FHSS are Bluetooth, control systems for unmanned aerial vehicles (UAV) and military handheld radiotelephones.
The range of these systems is a crucial operational parameter that depends on multiple factors such as refraction, diffraction, reflection and absorption. These are given by topographic and atmoshperic conditions, which can hardly be simulated.

Task

The aim of this Bachelor Thesis was to investigate, how multiple devices of the same type interfere with each other while operating in the same area and at the same time.

For six precisely defined operation scenarios, the goal was to give recommendations for a minimum operating distance. This work extends the previous work of M. Akbari and N. Takagawa, which had the same task but did not include FHSS.

Methods

For the fundamental path loss calculation, common models such as FSPL, Okumura-Hata and others were used, according to the conditions given by the scenarios.
To gain information on specific FHSS sequences, a classified system provided by the client was measured in the field with a high-resolution signal and spectrum analyzer (see **figure 2**). Concluding calculations were made with Matlab & Simulink.

Results

Following the measurement, interesting conclusions on hopping sequences and interference behaviour could be drawn and included in the simulations to improve the recommendations accuracy.
Due to military service, this Bachelor Thesis has been postponed and is still undergoing as of the date of this publication. Therefore, no further results can be presented yet. For an update, feel free to contact the author.

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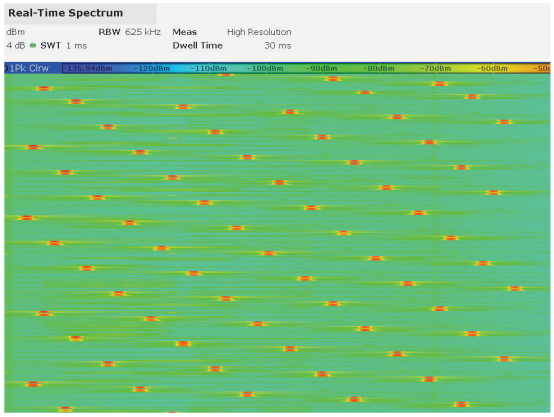

Figure 1: FHSS as measured on a consumer drone (horizontal: frequency, vertical: time, color: power)

Figure 2: Measurement setup in the field