پیش‌بینی رفتار زنبور عسل در مواجهه با سموم شیمیایی مزارع با استفاده از تکنیک‌های داده‌کاوی

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چکیده

سمپاشی‌های صورت گرفته در مزارع جهت مبارزه با آفات از جمله مشکلاتی است که زندگی زنبورهای عسل و عملکرد آن‌ها را تهدید می‌کند. بنابراین در پژوهش حاضر شرایط درونی کندو با استفاده از تجهیز آن به حسگرهای ارتعاش، دما، رطوبت و دی اکسیدکربن طی مدت ۷۲ ساعت از زمان سم‌پاشی مزارع بررسی شد. با توجه به آنالیز ضرائب مل، آفت-کش سبب افزایش ۱۰۰ واحدی شدت در محدوده فرکانسی ۱۸۰۰ تا ۲۲۰۰ هرتز گردید. به علاوه با توجه به اطلاعات بدست آمده از دیگر حسگرها، دما تحت شرایط نامساعد (وجود آفتکش در فضا) نسبت به شرایط نرمال از ۳۵ به ۳۹ درجه سلسیوس، میزان دی اکسید کربن از ۴۵۰ به ۵۳۰ و رطوبت حدود ۱۰ درصد افزایش یافت. به منظور طبقه‌بندی داده‌ها ابتدا با استفاده از آنالیز مولفه اصلی انتخاب ویژگی صورت پذیرفت و ۵ مولفه با حداقل خطای میانگین مربعات ۰/۰۷۸ انتخاب شدند. پس از انتخاب ویژگی‌ها، طبقه‌بندی ویژگی‌های منتخب با استفاده از ماشین بردار پشتیبان با کرنل‌های مختلف (RBF، خطی، چندجمله‌ای، کوادراتیک، سیگموئید) انجام که کرنل RBF دو شرایط محیطی نرمال و آلوده به آفت‌کش را به ترتیب با ۱۰۰٪ و ۹۰٪ دقت تشخیص داد.

کلمات کلیدی: *سامانه کندوی هوشمند، سم‌پاشی مزارع، ماشین بردار پشتیبان، آنالیز مولفه اصلی، ضریب کپستروم مل فرکانس*

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Prediction of honey bee behavior under the terms of farm pesticide using data mining techniques

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Abstract

Honeybees play an important role in pollination. However, there are many problems that threaten the life of them. For example, the production of food in agro-ecosystems often involves the application of insecticides which may harm the many insect species providing pollination services to agriculture. Pollinators can be exposed to insecticides during their application, by contact with residues, or from the ingestion of pollen, nectar or guttation fluid containing insecticide. The increasing use of neonicotinoids means there is a greater potential for pollinators to be exposed over longer periods as systemic insecticides can be found in the pollen and nectar of plants throughout their blooming period (Ellis, 2010). Exposure to insecticides may have lethal or sub-lethal behavioral or physiological effects. The impact of imidacloprid on homing flight was evaluated in field with a 500-m-distance between feeder and hive (Bortolotti et al. 2003). At the concentration of 100 lg kg-1 foragers fed with imidacloprid-added syrup returned to the hive, but this treatment caused a temporary inhibition of the foraging activity, lasting more than 5 h. Foragers fed with 500 and 1000 lg kg-1 of imidacloprid were seen neither at the hive nor at the feeding site, for the 24 h after the treatment (Bortolotti et al. 2003). Yang et al. (2008) also showed that when bees were orally treated with imidacloprid-added syrup higher than 1.2 ***l***g.l^{-1} (about 1 ***l***g.kg^{-1}), they delayed their return visit to the feeding site and the lowest effective concentration for inducing this effect was found to be 50 ***l***g.kg^{-1}. In other study, Decourtye et al (2011) have shown how the RFID device can be used to study the effects of pesticides on both the behavioral traits and the lifespan of bees. In this context, they have developed a method under tunnel to automatically record the displacements of foragers individualized with RFID tags and to detect the alteration of the flight pattern between an artificial feeder and the hive. Fipronil was selected as test substance due to the lack of information on the effects of this insecticide on the foraging behavior of free-flying bees. They showed that oral treatment of 0.3 ng of fipronil per bee (LD50/20) reduced the number of foraging trips. Therefore, the aim of this study was to monitoring and determination honeybee's behavior in exposure to pesticide using data mining techniques. Three smart beehive systems developed to monitoring of hive internal conditions. Therefore, each beehive equipped with temperature and humidity (HDC1080, China), vibration (MPU6050, China), and CO_2 (CCS811, China) sensors. Data was collected during spraying time for 48 hours and different features of vibration signal in two time-frequency and frequency domains were extracted by MFCC (Mel-Frequency Cepstral Coefficient) algorithm. After that, the most significant features were selected using PCA (Principle Component Analysis) which has been used specifically for extracting information from correlation matrices. Since the spectral data forms the array of correlated variables containing overlapped information, this approach makes it possible to extract useful information from high-dimensional data. To choose the number of components the cross-validation method was used. The extracted principal components were used as the input variables for the classification model. In this paper, support vector machine with different kernel function including linear, polynomial, MLP, RBF, and quadratic was applied for performing classification. according to the MFCC of internal vibration results, there were dramatic changes in the range of 1800 to 2200 Hz in the time of spraying; besides, humidity (8 to 18 %) , the amount of CO_2 (450 to 530 ppm) and temperature (35 to 39 C) increased during this time**.** To reduce the dimensionality of data five PCs with minimum estimated mean squared prediction error (0.078) were selected based on Monte Carlo method and used in classifier. Among the five kernels, RBF could recognize normal and infected colony with identification rate of 100% and 90%, respectively. according to the results temperature, humidity, CO_2, and vibration sensors can recognize internal condition of bee hive. Vibration features of honeybees movements was extracted using MFCC followed by PCA in frequency-time domain. Five PCs was selected by cross-validation method and RBF kernel was the best kernel with identification rate of 100% and 90% for normal and infected beehive, respectively.

Keywords: Smart beehive, Farm spraying, Support Vector Machine, Principle Component Analysis, Mel-Frequency Cepstral Coefficient

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