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Review Article

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E-Green Revolution: Intentional Pollination using Intelligent Agent Based Autonomous Drone-Pollinator-Bees

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ABSTRACT

Pollination happens in multifarious ways. Pollen can transfer from one flower to another with or without any external help. Generally, plants rely on insects or the wind to pollinate them. When animals such as bees, butterflies, moths, flies, and birds pollinate plants, it's unintentional. They are not working for purpose of pollination of the plants. They sit on the flowers to feed themselves and the sticky pollen gets stuck to their legs which are later on carried to the stigma of another flower. Most of the times brightly colored flowers having a strong fragrance attract the natural pollinators. Another means of pollination of plants may involve the wind and water. In wind pollination, the wind picks up pollen from one plant and blows it onto another. Similarly, with the water pollination pollens flows from female to male plant. Because of some unknown reason the population of bees has drastically reduced and continue to exterminate, many researchers and scientists are worried about the crop pollination. Artificial pollinators are being thought of as a successful milestone to achieve intentional pollination side by side looking to the solution of bee's demise. This paper focuses on various impediments in the development of drone-pollinator-bees and their working as a farmer friend in absence of natural bees. It also elaborated that, drone bees are capable of reaching aloof areas such as under water, places with less flower population etc. for the intention to attain successful self or cross pollination.

Key words: *Pollination, E-Green Revolution, Drone-Pollinator-Bees*

INTRODUCTION

Pollination is an important part for growth of plants. It supports by creating new seeds in plants at flowering time. Flowers have different parts that play important role in pollination such as male and female parts called stamens and pistil, respectively[1]. Stamen produces sticky material called pollen where as the top of the pistil is called the stigma, and is often sticky. The formation of seeds happens in the ovule at the base of the pistil. For the purpose of pollination, the pollens must transfer from the stamen (male) to the stigma (female). When transfer of pollen happens from a stamen of plant to the stigma of same plant then it is termed as self-pollination[2]. Further, it may be elaborated that the process of self-pollination when pollens are carried to the female part of the same flower then.

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It is called as Autogamy and when pollens are transferred to another flower on the same plant then it is attributed as Geitonogamy. There is third kind of self-pollination called Cleistogamy which happens even before the flower opens. The Cross-pollination occurs between stamen and stigma of different plants of same species which is, technically, called as Allogamy[3].

Honeybees support in pollination of nearly one-third of overall crops and they alone contribute more than $15 billion in value to U.S. agricultural crops each year. The disappearance of natural bees has devastated the crop pollination that occurs naturally. It has brought many crops on the verge of extinction[4]. Without them, many varieties of fruits and vegetables would come to an end. Deaths of bees have been rising with losses and less ability to regenerate. Flying autonomous bee bots has a promising potential importance in crop pollination, as well as climate and environmental monitoring[5]. The goal of the Robo-Bee projects running in several universities and research institutes is to make it full-fledged autonomous, self-decisive, light-weight and small size flying bee-bots for application of artificial pollination.

CROPS, PESTICIDES AND THEIR EFFECT ON BEES

Honey bees are not only responsible for the collection of honey or nectar but they also contribute to the overall yield of the crops. 'Madhusandesh' is one such pilot scheme in which crops like pomegranate, onion, and apple are noted for successful crop production. By placing the honey beehives in farms and fields of crops like pomegranate, rambutan, alfa-alfa, apple, onion and other pollinated crops, 30-70 percent increase in yield can be obtained[6]. The output quality product directly benefits the farmers with the rise in income. Pollination is an important aspect of quality, size, beautification, and production of the crops it has shown 42-45 percent of increment on all previous measures. But the conditions are severely shocking by knowing the fact that the major pollinators like butterfly, bumblebee and especially the honey bees are reducing in population[7]. Use of pesticides in a large amount is the one major reason for the mass extinction of bees. Without pollinators, numerous varieties and diversities of crops, fruits, flowers, and vegetables would cease to exist.

We have two categories in pesticides: Contact pesticides that are sprayed on plants which can kill bees when they sit on the sprayed plants. In this category of pesticides mainly Dust (D), Soluble Powders (SP), Granulars (G) and Wettable Powder (WP) formulations are liable to cause more jeopardy to bees as compared with Solutions (LS) and Emulsifiable Concentrates (EC). The bee may die as it comes in exposure with pesticides during the period of scouring while other bees present at the distant hive are not subjected to the influence. But it may happen that the bee may get infected with the insecticides on pollens and carry it back to the hive either in form of contaminated pollen or honey, causing widespread colony death. The other type of pesticides is Systemic pesticides[8]. They are either mixed with the soil or coated onto seeds getting spread to all parts of the plant and ultimately to the pollens. Further, it may kill soil-dwelling insects, and also honey bees get revealed to infected bare leaves, contaminated fruits, adulterated flowers and pollen of the treated plants.

CAUSE FOR DEMISE OF BEES AND IT'S ALTERNATIVE

The reasons for the extermination of honey bees are still obscure but many researchers are quoting the Colony Collapse Disorder (CCD) and Israeli Acute Paralysis Virus (IAPV) as the main cause for bee's demise. There are other reasons which may include the heavy use of pesticides and because of this, there is a reduction in quality production of the crops. To tackle this critical problem and to enhance the pollination in crops, experts and professionals are enforced to investigate into artificial ways for the survival of plants without the biological bees. Vital crop conservation efforts have been taken under Green Revolution project by banning the use of all those pesticides that deliberately inflicts

the bees and other pollinators and switching towards ecological farming to enhance biodiversity that will help in long run. Quick measures can be taken using Nano Drone Technology (NDT) in combination with Artificial Intelligence (AI)[9]. The one way to go with this is designing of the artificial pollinators, such as drone-bee until the exact reason for the extinction of honeybees become conspicuous and required actions are executed. The drone-pollinator-bee can behave in the same manner as of the biological bee except for the belongingness for each other. A drone-pollinator-bee is helpful in pollination of flowers round the season flying abreast to biological bees to ameliorate overall yield of the crop. Various training sets can be installed within the robo-bees with an automated learning software feature as a part of AI. This will teach and train the robo-bee mobile agents as they move from one flower to other. Heterogeneous Mobile Agent system will help robo-bees to learn, execute and work on dedicated goal taking their own decisions. A mobile agent is the software based autonomous entity that works as directed to achieve the goal in a restricted environment. They are self-governing in decision making, self-contained, automated drawing paths, remembering directions and working in collaboration with biological bees as well as other robo-pollinator-bees[10].

WORKING AND FUNCTIONING OF ROBO BEES

To achieve this, the mechanical and programming parts can be broadly classified into two main software modules and hardware components: the physical body parts and the processing unit. The physical parts body comprises of assembling of various parts like electronic wings and legs, a power source, an integrated circuitry[8]. While functioning of robo-bees will include the installation of different smart sensors for eyes, legs and movable antennas. This will also monitor the flight of an electronic bee, underneath it is responsible for bee's motion paths, coordination with other bees, recognizing female flower of same species for purpose of pollination, the formation of teams working in proximity of target area, and many more activities. The flying drone-bee of size as small as 10 mm to 15 mm (almost half the size of a paper clip) and weighs in grams, can work in same way as a worker bee to help flowers pollinate[11]. This adoption of drone-bees cannot only help in obtaining healthy and beautified crops but will also help in curbing the fear of crops getting scarce because of less pollination. A visual identification system developed within the drone-pollinator-bees will support in fixing the object vision detection camera. This will further help robo-pollinator-bees in recognition of male or female flowers on their own. The artificial wings and other muscles may expand and contract as when required controlled from the discharge of a certain amount voltage. Various brush-legs installed in robo-bees will spit less-adhesive solvent (self-adhesive) gel in an appropriate amount so that pollen get stuck and carried forward to a female flower[12]. This way these mechanically animated autonomous micro-robo-bees can be programmed to pollinate the crops for us.

These micro-robo-bees can be designed water-resistant that are fixed with under water visual/image recognition digital camera. Now scientists are into development of aerial cum aquatic micro-bees for both wind and water pollination of flowers[13]. These flowers mostly don't produce sweet fragrances and also they don't have dark colors to attract pollinators like honeybees. They are dependent on natural means for pollination when the light weight pollens flows with water or blown away by the wind. Pollination will happen only when released pollens will land up at the female plant of same species. So the aqua-airy pollinator bees may be used for intentional pollination encouraging it to happen in both an open air as well as in under water plants[14].

CONCLUSION

These tiny bots coming to life will surely make an E-Green revolution but there do persist some challenges in the development of these bots. Some of them may include the availability of continuous power supply which

will be dependent on the life of a battery, sensing the correct species of flowers, balancing in the air, making it fly faster, another major issue is communicating, tracing and controlling the bot-bee wirelessly. Although, researchers and scientists are persistently inquiring about the actual cause of CCD and other reasons for the demise of native honey bees so that they can be brought back to healthy numbers. Having the artificial-pollinators-bees as a backup support tool is not a bad idea for the conservation of crop pollination.

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