HYPERCOMPLEX NUMBER BASED AUTOMATED ROBOTIC VANILLA POLLINATION SYSTEM WITH VISION SENSING

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Vanilla is a spice obtained from the fruit of the vanilla planifolia orchid. As vanilla is one of the most expensive spices, second only to saffron [1], the high demand and labor-intensive production process has led to adulteration of many supplies with toxic artificial flavoring chemical compounds. As early as 1954, the United States Food and Drug Administration banned coumarin, which is still commonly used in Mexico, in light of evidence of its hepatotoxicity [2], [3]. Since toxic substitutes continue to be added to or substituted for true vanilla in some countries, there is a real need for lower-cost production of real vanilla. The requirement for hand-pollination is a major contributing factor to the high cost of production, suggesting that alternative methods be investigated. The purpose of this study is to concentrate on the recognition of the pose and anatomy of vanilla flowers in color images that would be useful for providing robotic assistance in vanilla pollination.

Pure quaternions are extensions of imaginary numbers. Image colors are regarded as pure quaternion numbers, leading to hypercomplex image processing techniques. These color processing techniques consider each color as a single quaternion number rather than the traditional three independent channels. This is done to achieve a holistic approach to color image processing.

A system of robotic cranes is considered which uses these techniques in multiple stages of image processing for vision feedback. One stage in which these techniques are used is the segmentation stage. Segmentation is necessary for isolating the flower in the image from its background. These techniques are also used in analysis of the flower to determine the suitability of the current orientation for a direct trajectory of the pollinating robot. Alternate methods are compared and results are given. From these results, we draw conclusions as to the best method among those analyzed.

The proposed robotic system of cranes ties all of these processing techniques together for vision feedback for coordinating six winches of each six degree of freedom crane in the system to adjust the position of the camera and the pollination tool. In simulation, the flowers on vanilla vines climbing a pipe post are recognized and manipulated for pollination autonomously, and results of the simulation are presented.