GESTURE-BASED FLYING ROBOT FOR PRECISION AGRICULTURE

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Introduction:
In India over 70% of rural households depend on agriculture as their principal means of livelihood and it contributes about 16% of Gross Domestic Product (GDP) and 10% of exports to the Indian economy. As of now there are lots of problems exist in the field of agriculture due the traditional agricultural practices. Traditional agriculture practices include identifying of pests, insects, weeds, animal attacks and crop condition/health monitoring, maintenance of crops in terms of water level, spraying of pesticides and many other tasks. Farmers need to visit fields frequently to look after crop conditions, if the field is wider and far away from residence then farmers needs to hire more people to look after each and every agro task by paying wages. This consumes lots of time and requires more effort and is bit costlier if the land area is more. To overcome this problem the key idea is to use Drone technology to handle many of the agricultural tasks by capturing images through the flying robot’s inbuilt HD camera and there by analyzing the gathered data using precision agricultural software to give appropriate solution to the identified crop condition. The idea is to control the flying robot is by means of natural hand gestures in an easy learnable manner rather than controlling by complex hand held remotes. The operator gives gestures in front of gesture recognition device which can sense gestures and send them to computing device for processing. The processed information serves as a command to control the flying robot. Gesture-Based Flying Robot is an effective solution to the existing problems in the field of agriculture by reducing time consumption, cost and boosting the crop yield.

Objectives:
The goals and objectives of the project is to provide service to farmers by reducing their effort, time consumption and boosting the crop yield using available technologies with some innovation. The project aims at developing gestural interface to control the Flying Robot to reduce the human effort of using hand held remotes in control the Flying Robot. The aim of the project is to overcome many of the problems existing in the field of agriculture using gesture interfaced Flying Robot and motivating farmers to do agriculture which contributes to the economic growth not only at national level but also at global level, increase food production, increase exports of food products at global scale and supports in growth of sectors dependent on agriculture.

Methodology:
**Devices used:** Parrot AR Drone 2.0, Leap Motion Controller, Computing Device.

**Softwares used:** Ubuntu 16.04 OS, Atom IDE.

**Programming Languages used:** Node.js, JavaScript, HTML, CSS.

**System Diagram:**

Fig. 1: High level working model of the proposed system.

The user’s (operator) hand gestures are tracked by the leap motion device which is connected to the computing device via USB connection. The tracked information from leap motion controller is sent to the computing device for processing. Fig. 1 represents the proposed system’s high level working of the system. The hand gestures are processed as commands and translated into control signal which is sent to the flying robot through Wi-Fi. The Fig. 2 shows the connection establishment between leap motion controller and flying robot. The computing device acts as an interface between these two devices. According to the gestures given by the user the flying robot can be controlled with bare hands. The objective is to fully control the flying robot (Drone) movements using a natural controller that is human. The Graphical User Interface (GUI) lets the operator to monitor remotely many parameters of the platform, navigation, altitude of flight, battery level and streaming video from the inbuilt cameras of the flying robot.
The images captured from the flying robot are stored in the computer for further analysis. The collected sets of images are sent for processing. Different precision agricultural software and digital image processing techniques are used to determine the crop condition based on various parameters prescribed by agro scientists. The detailed test results are studied to identify the problems in the crops and appropriate solutions to overcome the problem by prescribing suitable fertilizers, pesticides, insecticides, herbicides etc. are suggested to use in the specified ratio. The guidance related to weather conditions, growing of crops based on soil type and climatic conditions and some other agro information is given along with the documented report. The complete report is preferably made in the regional specific language in an easily understandable manner, and finally the detailed report is handed over to the farmer.

**Control flow of the System:**

The development of gestured interface to control the flying robot uses the concept of machine learning. The proposed approach consists of three steps namely training, detection and recognition. The complete control flow of proposed system is shown in Fig. 3. As soon as the connection is established between the leap motion and the computing device a signal from the IR sensor is generated. If no signal, then check for connection and again wait for the signal from IR sensor. If LED glows by indicating ON state user can give hand gestures. The leap motion controller captures the hand movements in frames per second and it is responsible for capturing the information about the operator in the flow of video and depth sensing, the captured information is sent for pre-processing.
Fig. 3: Control flow of system.
If the hand is not detected by the leap motion then gain input the hand gestures. Otherwise detect the contour of the hand and extract the features from the current frame and features computed over a reference image. Leap motion returns a set of relevant hand points and hand pose features and these features are extracted by recognizing the operators hand and mapping the hand movements with predetermined gestures learnt in the training phase. The extracted key points are the coordinates of finger positions from the input gesture. At the runtime, distances are calculated from the feature points. If the extracted feature is not matched with the predefined gesture again give the gesture, otherwise gesture is recognized. The recognized gesture is converted into control signals which serve as a command to control the flying robot and it flies accordingly.

**Results**

Fig. 4 shows the gesture learning interface to trace the hand movements.

![Hand tracing.

The gestures are created using gesture learning interface namely LEFT, RIGHT, UP and DOWN. Fig. 5 shows the learnt LEFT gesture and its matching with the predefined gesture shown in percentage.
Fig. 5: Learnt LEFT gesture

Fig. 6 shows the learnt RIGHT gesture and its matching with the predefined gesture shown in percentage.

Fig. 6: Learnt RIGHT gesture.

Fig. 7 shows the learnt UP gesture and its matching with the predefined gesture shown in percentage.

Fig. 7: Learnt UP gesture.
Fig. 8 shows the learnt DOWN gesture and its matching with the predefined gesture shown in percentage.

![Fig. 8: Learnt DOWN gesture.](image)

Fig. 9 shows the X-Y-Z co-ordinate points generated for DOWN gesture by gesture learning interface.

![Fig. 9: X-Y-Z co-ordinates generated for learnt gesture.](image)

Fig. 10 shows a simple web interface to make an action of mouse click using hand gesture to open the slide bar.
Fig. 10: Web interface

Fig. 11 shows a simple web interface which has opened the side bar by taking hand gesture.

Fig. 11: Web interface controlled by hand gestures (open/close)

Fig. 12 shows the Graphical User Interface to control the Flying Robot using hand gestures. It contains Leap Motion State (ON/OFF), gesture view, live video streaming, battery and altitude indicators of Flying Robot and also the Take Off and Land buttons.
**Fig. 12:** User interface to control Flying Robot

**Fig. 13:** shows an operator controlling the Flying Robot using hand gestures

**Fig. 13:** Controlling Flying Robot using hand gestures

**Conclusion:**
Gesture based flying robot is an effective solution to the existing problems in the field of agriculture and other related fields. The aim is to provide service to farmers by reducing their efforts in simplifying the tasks, save time consumption and boost the yield of crops. This is achieved using available technologies with innovation. The proposed idea helps for precision agriculture by overcoming the traditional agricultural practices and also it is a substitute for remotely controlled aircrafts.

**Scope for future work:**
The future of drones in agriculture is automation hence several challenges need to be overcome for fully or even partially automating the process. Automating the
controlling of flying robot using flight plan and auto identification, auto grabbing based on plant stress caused by: nutrients, water stress, diseases of crops. Most common agricultural use of drones is for high-resolution visible spectrum photos, NDVI images and surface gradient maps. To detect pest, insects, weeds high resolution cameras are very much necessary, so attaching high resolution cameras into the flying robot and making it more accurate in future. Implementation of this gestured mechanism in various other fields and enhancing the productivity of controllers.