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Research paper

UAV With the Ability to Control with Sign Language and Hand by Image Processing

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ABSTRACT

Automatic recognition of sign language from hand gesture images is crucial for enhancing human-robot interaction, especially in critical scenarios such as rescue operations. In this study, we employed a DJI TELLO drone equipped with advanced machine vision capabilities to recognize and classify sign language gestures accurately. We developed an experimental setup where the drone, integrated with state-of-the-art radio control systems and machine vision techniques, navigated through simulated disaster environments to interact with human subjects using sign language. Data collection involved capturing various hand gestures under various environmental conditions to train and validate our recognition algorithms, including implementing YOLO V5 alongside Python libraries with OpenCV. This setup enabled precise hand and body detection, allowing the drone to navigate and interact effectively. We assessed the system's performance by its ability to accurately recognize gestures in both controlled and complex, cluttered backgrounds. Additionally, we developed robust debris and damage-resistant shielding mechanisms to safeguard the drone's integrity. Our drone fleet also established a resilient communication network via Wi-Fi, ensuring uninterrupted data transmission even with connectivity disruptions. These findings underscore the potential of AI-driven drones to engage in natural conversational interactions with humans, thereby providing vital information to assist decision-making processes during emergencies. In conclusion, our approach promises to revolutionize the efficacy of rescue operations by facilitating rapid and accurate communication of critical information to rescue teams.

INTRODUCTION

In the U.S., during the 2022-23 season, there were 24 fatal incidents, with 29 fatalities related to avalanches. Between 1951 and 2021, a total of 187 climbers died as a result of avalanches in the United States. As of November 17, 2023, Colorado had the highest number of avalanche-related deaths in the U.S., with 323 fatalities since 1951 [1] [2], [3] Currently, casualty search systems are designed and implemented by companies that excel at identifying casualties trapped in debris. Search teams bring these systems near the disaster site, and their results are used to investigate and conduct the rescue procedure. Nowadays, with the increase of drones in the aerospace industry, the interaction between humans and robots is constantly expanding. Methods utilize artificial intelligence, image processing, and machine vision in drone control.

There are different algorithms for controlling drones that are controlled using sign language. One of these algorithms, which is very popular, is the Convolutional Neural Network (CNN). CNNs are a class of deep neural networks, most commonly applied to analyzing visual imagery. They use a mathematical operation called convolution which systematically applies learned filters to input data, reducing its dimensionality while preserving essential features, making them ideal for image recognition tasks such as interpreting sign language.

This article analyzed some of the most common classification methods, such as K-Nearest Neighbor (KNN), K-Nearest, which is random forest, XGBoost, Support vector classifier (SVC),

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logistic regression, and Stochastic Gradient Descent Classifier (SGDC), which are the most useful Convolution Neural Networks (CNN). Other articles use different methods whose purpose is first gesture recognition and recording, and then these gestures are read and interpreted by the camera [4].

In another article, the image processing technique known as Histogram of Oriented Gradients (HOG) with Artificial Neural Network (ANN) has been used [5]. Among other methods to recognize gestures, a video solution was also applied. In articles utilizing this method, researchers have addressed the problem of gesture recognition in video and have used a two-step method by writing and classifying the feature space [6].

Also, in some studies, sensors are used, one of which reports the recognition of the fixed alphabet of Mexican Sign Language from 3D data obtained from leaping motion and MS Kinect1 sensors [7]. Besides, deaf people have used motion sensors attached to their hands to communicate. Another application is the Internet of Things (IoT), which translates sign language into another language. By placing a glove on the hand of a deaf person, s/he can recognize English words and numbers [8].

Many articles suggest collecting American Sign Language (ASL) data and capturing it through a BGR webcam, then processing it using a program (Open CV) [9]. In an article on drone control with sign language, it is mentioned that sign language is used as an assistant, and that is a DJI Tello drone, the purpose of which is to allow the user to spell out a word letter by letter. At the same time, it chases other drones around simultaneously and forms a word that resembles an E. The drone moves around while scanning the area for the user's object. If the object is found, the drone will maneuver toward him [10].

In this study, we aimed to develop and assess a dual-mode control system for drones utilizing sign language recognition and radio controls to enhance precision and responsiveness in human-drone interactions. The primary hypothesis is that a drone can accurately interpret and respond to sign language gestures when equipped with advanced image processing technologies without reliance on additional sensory inputs. This approach seeks to enable drones to perform exact tasks in varied operational contexts, particularly in environments where verbal communication may be impaired or infeasible. We further hypothesize that the integration of sophisticated machine vision techniques, such as those enabled by YOLO V5 and Python-based OpenCV libraries, will allow for seamless navigation and interaction in complex and dynamic environments, thus significantly advancing the utility of drones in critical scenarios like emergency response and rescue operations.

METHOD

In this study, we took extensive measures to evaluate the proposed system. The drone used in this study is a DJI Tello drone, which can fly for 15 minutes with a battery. By combining two artificial intelligences based on image processing by the camera and sound processing and speaker, the drone has been able to extract the images of each person and simultaneously analyze the person's voice with their image. This has led to the fact that when rescuers rescue a person, the voice and image of the person as the person at the scene of the accident and in need of help are not sent to the competent centers (such as police, fire department, emergency). This way, the time of information analysis is reduced, and it can realize how many people were saved from the accident and how many more people should be searched for.

Since this drone is related to the equipment of the accident situation analysis and survival systems in natural and human disasters, this study is used to search for missing persons and possible injured persons. Because it is possible in the event of an accident, drones could be damaged, debris- and the damage-resistant enclosure has been designed in which the drone is kept, and this enclosure has a control and positioning system. The parts of this drone include a pressure sensor, piezoelectric sensor, esp32 module, color screen, battery with battery charger socket, gyroscope sensor, sound module, and storage compartment for electronic parts.

Along with this, several other drones in the complex or building interacted with each other through the Wi-Fi system in these robots. In case of loss of information transmission lines or the Internet, the drones are connected through their central Wi-Fi system. As a result, all information about injured people is provided to rescuers in real-time, based on which they prioritize areas with high casualties.

If one of the preceding situations happens (e.g., a terrible noise is heard, the ambient temperature rises, smoke appears in the environment, or severe vibration occurs), the drone is automatically activated, checks the situation, and prepares and sends a report. Moreover, the drone could turn on and check the reported suspicious cases since it is connected to centers. Of course, the robot had already been placed at the accident scene.

Along with hand gestures, the drone identifies the whole body and is controlled by a finger (parts a and c in Figure 1). At the same time as it is guided, the system's coding can be seen, and all these functions will help the drone's movement.

At the beginning of turning on the drone, the machine vision system and the whistle start to work. The YOLO V5 algorithm is written in the image processing system, which receives a raw image to identify or categorize the object and identify which category it belongs to (parts b and d in Fig). Classification and topography, in this case, is that we have an image, and there is only one object in it that we find the object's location. Then, in this case, the drone has found the object's position in the image (part e in Figure1).

Among the most critical features of this method are the following: It has 12 million bounding boxes to categorize 1.7 million images in 500 classes as collections, categories, and topics. According to the intended center, images with complex scenes include several different objects. On average, there are seven bounding boxes per image, and very diverse images contain different and distinct objects.

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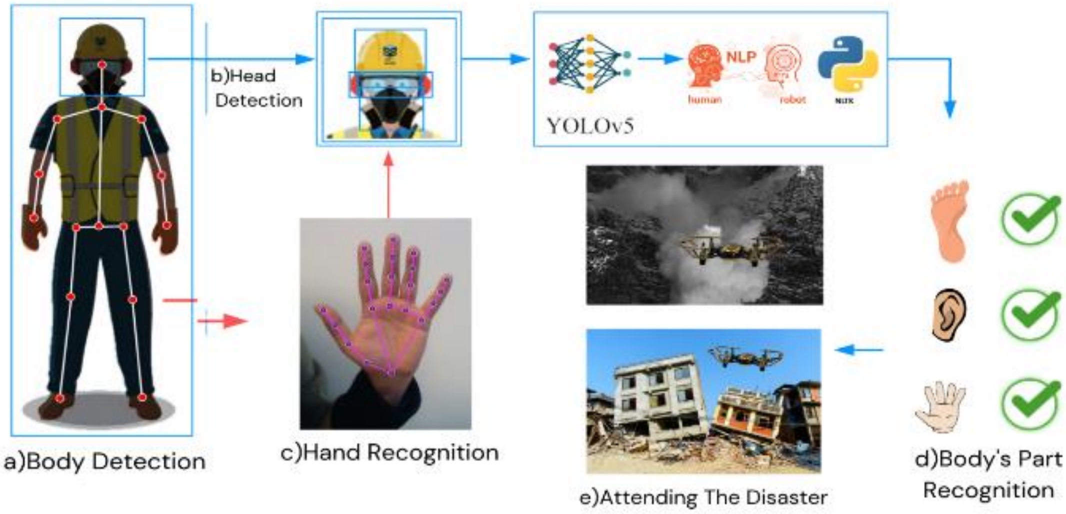

Figure 1: A sample method of image processing to recognize hand gestures and identify people's hands present in a disaster

The fire extinguishing support part has been able to mark the items needed for each area and analyze them, such as:

- Identifying and estimating the size of the fire
  The drone employs Convolutional Neural Networks (CNNs) trained on a diverse dataset comprising images of varying fire intensities and sizes. These networks analyze the visual input from the drone's cameras to estimate the fire's magnitude accurately. The integration of edge computing devices allows for real-time data processing aboard the drone, reducing latency and enabling immediate decision-making support.
- Identifying wall and floor cracks
  Image segmentation techniques, adapted from those commonly used in medical imaging, such as U-Net, are applied to detect anomalies like cracks in walls and flooring. The models are trained on a corpus of images featuring various structural damages to enhance their accuracy and reliability in real-world conditions. Deploying these models on drones facilitates rapid on-site structural assessments, which is crucial for safety evaluations and remedial measures.
- Identifying the places where the debris was dumped on people
  Object detection frameworks such as YOLO (You Only Look Once) or Faster R-CNN are utilized to identify debris and human figures amidst the rubble. This capability is critical for quick localization of affected individuals, optimizing rescue efforts by prioritizing areas with trapped victims. Training these models on annotated datasets featuring debris-laden environments ensures high sensitivity and specificity in detection tasks.
- Estimation of smoke and its volume for a possible fire in the coming hours
  The application of time-series prediction models leverages historical and current data to forecast the evolution of smoke from ongoing fires. This prognostic tool aids in anticipating areas at risk and facilitating timely warnings and evacuation plans. Environmental sensors integrated into the drone collect smoke density and distribution data, which are analyzed using AI to project future conditions.
- The degree of bending of the columns and metal beams in the building to estimate the duration of the collapse of the building and in which area of the building there was an accident or destruction.
  Structural analysis algorithms merged with machine learning techniques assess the degree of bending in columns and metal beams, offering predictions on potential collapse points. This system is trained using visual data depicting various degrees of structural stress, thereby supporting real-time monitoring and preemptive actions to mitigate further damage.
  The black signal in the camera embedded in the drone aims to scan through the camera for image processing. The red signal indicates the images received and recorded from the area. Also, the green signal indicates that information has been sent to the fire operator.

To support the police department, the image processing system starts to:

- Identifying potential thieves
  The UAV system utilizes deep learning-based object detection algorithms, specifically implementing Faster R-CNN (Region-based Convolutional Neural Networks), to identify abnormal behaviors or unauthorized access within a monitored zone. This model is trained on a comprehensive dataset comprising various scenarios of theft and everyday activities to distinguish between benign and suspicious actions. Real-time processing of video feeds enables the UAV to alert operators instantly upon detection of potential security threats.
- Identifying the property in the area
  For accurate property identification and monitoring, the system employs semantic segmentation techniques using a DeepLabv3+ model, which is renowned for its efficiency in parsing complex images into meaningful segments. This AI model processes high-resolution aerial imagery to delineate

property boundaries and precisely classify land use. Training involves diverse urban and rural landscapes to ensure robustness across different environments.

- Controlling the environment and identifying relevant people who need to be present in the area to prevent any abuse of the conditions
  To control the environment and verify the presence of authorized personnel, the UAV system integrates facial recognition technology alongside traditional motion detection algorithms. The facial recognition module, powered by a convolutional neural network, is calibrated to match individuals against a registered database, ensuring that only authorized personnel are present in sensitive areas. This setup is complemented by motion sensors that track movement patterns, providing an additional layer of security.
- Identifying people and getting the details of each person in the area, along with commuting information
  Gait recognition and enhanced facial analysis enable detailed commuting information to be gathered and individuals identified within the area. The AI system analyzes the gait patterns captured by high-definition cameras to recognize individuals based on movement characteristics, even when facial recognition is inconclusive. Additionally, the AI leverages temporal pattern recognition to map and predict commuting routes, enhancing situational awareness and operational planning.
  The black signal is still used to scan through the camera for image processing, and the red signal is used to receive and record images from the environment. Moreover, a green signal sends information to the police operator.
  According to each incident and operation, artificial intelligence has been able to reach general information based on the collection of information and its storage, according to which it begins its analysis based on this information and experiences, and with predicting possible cases, uses artificial intelligence to transfer learning. Finally, it suggests using tools in different situations and increases the preparedness to deal with accidents.
  The algorithm used in the voice processing system is a method for understanding human language for computers, considered one of the branches of artificial intelligence knowledge that helps computers and robots understand human language by knowing how humans use language.

The steps of performing natural language processing in the system include the following: First, the person talks to a flying robot, then the robot's audio device records the person's voice. Later, the audio device converts the human voice into text and sends it to the centers. After that, the texts are processed, the appropriate text response is considered, and the text response is converted into audio form. Finally, the drone plays the response audio file.

The voice assistant and interactive conversation are formed in three ways:

- Syntax analysis
- Semantic analysis
- Noisy data

Syntactic analysis is related to the subject of language style (Syntax), which examines the knowledge of studying the rules of the arrangement of words in people's speech and the order of words in a sentence in a meaningful way so that in times of stress, people's behavior can be analyzed.

Semantic analysis has been used to investigate the meanings of unclear words of persons or injured people at the accident scene.

Noisy data contains a series of information from the environment that is considered meaningless. Still, artificial intelligence must try to analyze the data to reach its final goal. This data analysis includes the following:

- The sound of injured people under the rubble to find the possible injured survivors
- Recognition of people's voices in crowded environments
- Analysis of the injured person's talks in crowded environments
- Analysis and identification of the sound of building and building materials at the time of the incident and obtain the probability of collapse or further damage

In the analysis and sending of audio information to the centers for the operator, as outlined in the Integrated UAV System Workflow, combining and coordinating the rescue and injury detection processes for each related center has significantly reduced operator confusion during the critical initial moments. The workflow illustrates how this integration increases the probability of locating injured individuals using artificial intelligence based on learned algorithms.

Sending the algorithm's recommended items to each of the specialized teams means that it stores similar events to improve artificial intelligence's performance according to the operation. The image processing system is integrated with the sound processing system to achieve accurate and sensitive information. Sending information from different places to the centers that are closest and more relevant to the subject of that incident allows them to form interactions between different centers. This is feasible according to the classifications done in the image processing department.

According to the drone's components and using the coding, it will turn on and start to function. According to the vision system, the drone scans the environment thoroughly. Considering this drone communicates with other drones, it can obtain many images and videos and send them to the centers. Then, according to the sensitivity of each organization/department to a specific subject, it starts analyzing images and videos. This is the camera's function system, which also allows the operator to communicate more with the injured or the rescuer via the built-in microphone. The operator inside the command center communicates with the rescuer at the incident scene.

If an injured rescuer cannot speak, the image processing system will read lip movements and find out the person's mental and physical condition. The number of rescued people will be automatically deducted from the injured person at the scene.

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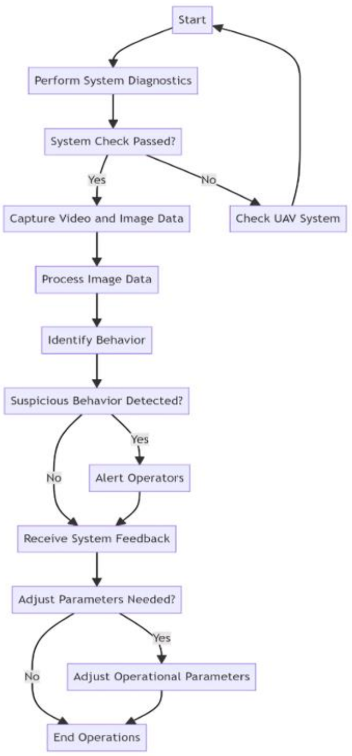

Figure 2. Integrated UAV System Workflow

RESULTS AND DISCUSSION

In this study, when the drone is turned on to reach its control output with sign language, using internal Python libraries, the camera marks and recognizes 24 points on the palm, and all these marks and points are connected. A skeleton is shaped, and all these programs are executed with the help of image processing.

Now, by determining the points relative to each other that are located in the same coordinate, the camera detects the hand, and any position the fingers take is considered a predetermined command, and the drone starts moving.

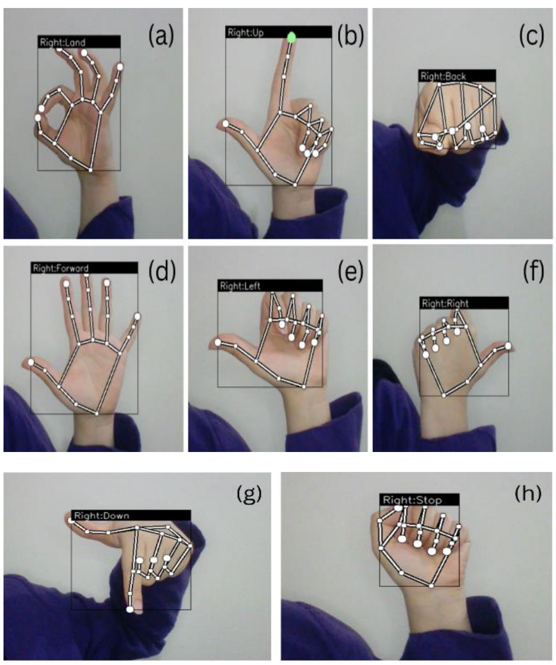

Figure 3. Recognize hand gestures and identify people's hands

The land command is used to control the landing of the drone (part a in Figure 2). Up is used to increase the altitude (part b in fig2), and down is used to command descend to the drone (part g in Figure 2). With the Back command, the drone moves backward (part c in Figure 2), and with the Forward command, the drone moves forward (part d in fig2). Pointing Right to move in the right direction (part f in Figure 2) and Pointing Left causes the drone to move to the left (part e in Figure 2). Whatever state the drone is in, when you run the Stop command, the drone will stop in that state (part h in Figure 2). The fact is, sign language is not used to take off the drone; as soon as the coding program is connected to the Wi-Fi module of the drone, the flight mode is activated.

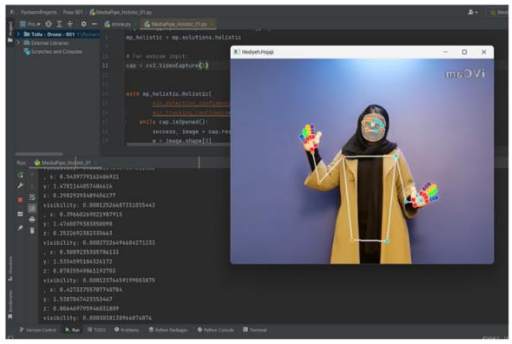

Figure 4. Upper body and open pose key points.

In developing our hand gesture recognition system for drone control, we applied image processing techniques similar to those in sign language recognition. Our methodology involved capturing and analyzing hand gesture data using a high-resolution camera integrated into the drone. The recognition process was based on a combination of spatial coordinates and color data analysis to identify various gestures accurately. To assess the effectiveness of our system, we established specific performance metrics: the success rate of gesture recognition and the response time of the drone to commands.

The success rate was calculated as the percentage of gestures correctly identified by the system out of the total number of gestures performed during test scenarios. This metric was vital for determining gesture recognition accuracy under different environmental conditions, including lighting and background complexity variations. Additionally, we measured the response time, which is defined as the duration from successful gesture recognition to the initiation of the corresponding drone movement. These measurements were crucial for evaluating the system's responsiveness and operational efficiency in real-time applications. Our experimental setup, designed to simulate real-world conditions, provided a comprehensive understanding of the system's performance capabilities and limitations.

Another result of our proposed approach to control the drone by fingers is the use of Control Activated, and at this stage, the flight and landing of the drone are performed with the help of the movement of the index finger. In this way, pointing the finger toward the Take Off section will make the drone fly, and pointing the finger towards Land will cause the drone to land. The result of guiding the drone is using the right circle for the right and left forward and backward directions and the left circle for the drone turning and increasing or decreasing the altitude (Figure 4).

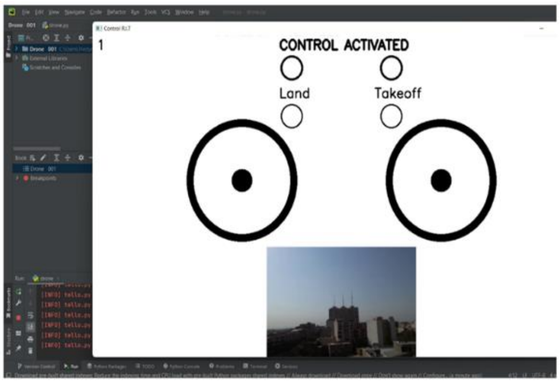

Figure 5. Proposed system for finger's gesture recognition using control-activated

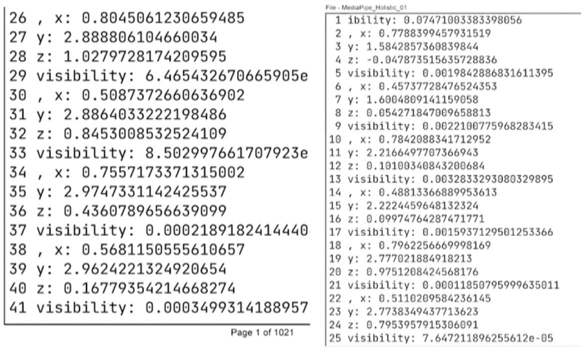

Figure 6. Scrutiny of the situation's drone

In our analysis, we meticulously investigated the spatial orientation and trajectory of the drone in the context of Euler's angles. These angles, representing the object's orientation in the environment relative to a specific reference, were derived from the spatial coordinates provided by the reference device. As demonstrated in Figure 5, which includes an extended visualization on page 1021 of our supplementary materials, we detailed the three principal axes of rotation: roll, pitch, and yaw. This approach facilitated a precise alignment with the recognized hand gestures, enabling us to map the drone’s trajectory more effectively.

To enhance our understanding of the drone's operational performance and interactive capabilities with human gestures, we plotted the drone's path over time against the variations in Euler's angles. This visual representation aids in comprehensively assessing how the drone's movements align with dynamic hand gestures in real-time, thereby verifying the effectiveness of our control system under varying environmental conditions. The trajectory visualization, along with Euler’s angles, provides a clear depiction of the drone's adherence to the intended navigational commands and its responsiveness to gesture-based inputs.

One limitation of our study is that if the slightest extra movement from the hand enters the camera, the device cannot detect and control it. It is suggested that this problem be improved with a new algorithm and dataset in the future. Voice assistant for controllability of the drone can be simultaneously improved with sign language control for the upgraded version.

With the progress of science, robots are being developed based on artificial intelligence and image processing. Interaction between humans and robots has become very easy and quick; removing the intermediary (remote control) allows the robot to be commanded. This has dramatically improved and advanced the control and guidance of the drone without the need for extensive knowledge. Our drone starts flying when the coding process is wholly written; otherwise, the drone will not take off, so we have paid attention to the safe and correct flight.

CONCLUSION

In the study approach, we were able to guide and control the drone without using a remote control, using image processing and machine vision. A very light body was used for the drone, which is very light compared to the existing samples and weighs 80 grams. Many people are left under the rubble every year, and the injured are not helped quickly. This drone is controlled by radio control and sign language at the same time, which has been able to connect to the operator of the centers and inform about the situation of the incidents that have occurred to improve the process of providing aid and the necessary equipment to the injured.

This written pattern for drones differs from the new sign language proposed in the paper for all camera-equipped drones. In another study, the AUTH sign language was proposed for the drone, which consists of 4930 videos distributed in 6 classes [11]. However, our proposed scheme uses 12 million bounding boxes to classify 1.7 million images into 500 different classes (sets, categories, topics). Moreover, images with complex scenes that contain several other objects were utilized. On average, seven bounding boxes were used in each image, which are very diverse images that include different and distinct objects.

In another study, the researcher used the YOLO V4 model to create a non-verbal language [12]. Developing a novel structure for UAV control via sign language and hand gestures through image processing addresses several limitations of traditional UAV control systems, which typically rely on direct manual inputs or basic autonomous commands. While effective in controlled environments, these traditional methods falter in complex, dynamic scenarios where nuanced interactions and quick adaptability are crucial. The requirements for line-of-sight operation generally constrain them. They can be impractical in situations demanding non-verbal communication, such as silent operations in covert military operations or emergency response scenarios where noise pollution could be detrimental.

To overcome these challenges, the proposed system utilizes advanced convolutional neural networks (CNNs), specifically designed for real-time image processing. CNNs are adept at analyzing visual data and interpreting human gestures, allowing for a seamless translation of sign language into UAV controls. This approach significantly enhances the UAV's operational capabilities, enabling effective functioning in diverse environments without vocal commands. By shifting from rigid, traditional frameworks to flexible, AI-driven systems, the new structure increases the efficiency and scope of UAV applications. It introduces higher safety and accessibility, mainly when

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traditional communication methods are unfeasible. This transition underlines a strategic pivot towards leveraging cutting-edge technology to address the evolving demands in UAV deployment, ensuring that UAVs can perform more autonomously and responsively in a broader range of applications.

Another study examines different steps in the automatic sign language recognition (SLR) system and KNN for classification. The accuracy of this model is 65% [13]. Also, in another article for recognizing fingerspelling in American Sign Language, this system shows good accuracy of up to 96% [14]The proposed design of the drone, which can be controlled with a finger, is highly accurate, between 92 and 98%.

Quoting from another article, an extensive test of CSL Split II and RWTH-PHOENIX-Weather 2014 datasets has been done to detect hand gesture state in sign language from RGB and gradient algorithm and different libraries in Open CV-Python were used [15]The approach we have considered for the drone is to communicate and interact nonverbally between humans and the robot, where the drone receives commands from a finger. This system is implemented using Open CV-Python. This design does not use RGB to detect the hand gesture mode; it detects the hand gesture mode live and speeds up the command.

Another study mentioned that a wearable sensor was used as a glove in image processing, and the data containing suitable sensors for the position was created. This method can be used in environments with limited resources [14]. However, the proposed method in this study is not limited to the environment because it is used for people trapped in debris and rescue missions in different organizations. Another similar study deals with an algorithm implemented for command interpretation using Spanish and English languages and for controlling drone movements in a simulated home environment.

Another paper refers to speech-to-action recognition for drone control, which is simulated for a home environment [16]. But in the proposed method of this study, in addition to the capability of language control, it is possible to analyze the images and the voice of the person on the person's image due to the integration of two artificial bits of intelligence based on image processing through the camera and sound processing through the speaker. This makes it possible that when rescuers rescue a person, their voice and image are no longer sent to rescue centers as people in the incident area need help. As a result, the time for information analysis is reduced.

In this study, we explored the capability of drones to operate simultaneously within a swarm, similar to previous research that has investigated the collective behaviors of groups of quadcopters. These studies typically focus on applications such as communication support, emergency guidance, public event monitoring, and tour guidance[17]. Unlike these applications, our project specifically leverages drone technology to facilitate the rescue of individuals trapped under rubble or in urgent need of assistance. This approach aligns with and extends the existing body of knowledge by demonstrating practical applications in emergency response scenarios.

While the results of our research are promising, several limitations were encountered. The primary challenge was maintaining stable communication and coordination among drones in cluttered or interference-prone environments, which can critically hinder operational efficiency during rescue missions. Additionally, the precision of hand gesture recognition under varied environmental conditions (e.g., poor lighting and adverse weather) sometimes affected the responsiveness of the drone control system. Future research could focus on enhancing the robustness of the drone swarm's communication protocols in complex scenarios. Further developing gesture recognition algorithms to improve accuracy and reduce latency under diverse operational conditions would also be beneficial. Moreover, integrating more sophisticated AI-driven decision-making systems could enable drones to autonomously navigate and make strategic decisions during rescue operations, potentially increasing the success rate of such missions.

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AUTHORS BIOGRAPHY

Hediyeh Hojaji

Hediyeh Hojaji is an aerospace engineer, innovation mentor, and award-winning inventor dedicated to fostering creativity and technological advancement. Currently pursuing a B.Sc. in Aerospace Engineering at Islamic Azad University Science and Research Branch, she applies her expertise to develop technologies in aviation and defense. Hediyeh has mentored workshops like the Idea to Invention program at Masih Daneshvari Hospital and serves as a tutor in creativity, innovation, and invention. Her achievements include multiple gold and silver medals from prestigious international invention fairs across the Middle East, Europe, and North America, along with recognition from organizations like WIPO. A published author of Aerospace Science with 5th Industrial Revolution Approach, Hediyeh combines ambition, precision, and a passion for research to inspire innovation and excellence in herself and others.

Alireza Delisnav

Alireza Delisnav is a robotics engineer, educator, and inventor specializing in unmanned flying robots, soft robotics, artificial intelligence, and machine vision. With an M.Sc. in Mechatronics Engineering and a B.Sc. in Design and Engineering Drawing Technology, he has excelled in designing and troubleshooting advanced robotic systems while mentoring students and professionals. Alireza has contributed to numerous publications and conferences on smart prosthetics, UAVs, and soft robotics and has earned prestigious awards, including a Gold Medal at the IFIA Invention Competition. A technical consultant and innovative thinker, he combines practicality with creativity to drive advancements in robotics and mechatronics, fostering innovation through teaching, research, and technical expertise.

Mohammad Ghafouri Moghaddam

Mohammad Ghafouri Moghaddam is an accomplished technical expert, educator, and inventor with a rich background in electronics, innovation, and mechanical design. Holding a B.Sc. in Electronics from Hatef Zahedan University, he has applied his expertise in roles such as Technical Manager at Cellulose Packaging Industries Co., where he drove continuous improvements, and as a Computer Systems Technical Expert at Parhan Company. Mohammad has also contributed to railway communication systems and taught electronics and innovation at various institutions, inspiring creativity in young minds. A prolific inventor, Mohammad has published research in esteemed journals, including innovative solutions for musculoskeletal pain relief and labelling insect specimens. He has earned multiple international awards, including medals from invention fairs in Geneva, Seoul, Rabat, and Kuwait, and special recognition for his technological advancements in robotics.

As a specialist in electronics and IoT, mechanical design, and graphic design, Mohammad leverages tools like Proteus, SolidWorks, and 3D printers to create groundbreaking solutions. His passion for education and innovation continues to inspire and drive progress in the fields of technology and design.

Fariba Ghorbani, MD, PhD

Dr. Fariba Ghorbani is an accomplished researcher specializing in tissue engineering. As the Director of Research and Development in the Organ Procurement Unit at the National Research Institute of Tuberculosis and Lung Diseases, she focuses on organ donation, transplantation, and pulmonary diseases. Her expertise spans systematic review processes, clinical trials, and advanced research methodologies, including statistics, scientific writing, and reference management. Dedicated to fostering innovation, she conducts training sessions to enhance creativity and idea generation among students. Fariba's contributions in both basic science and clinical research have significantly advanced the fields of tissue engineering and organ transplantation.

Shadi Shafaghi, MD, MPH, PhD

Dr. Shadi Shafaghi is a researcher specializing in biotechnology with a focus on heart and lung diseases. After earning her medical degree from Shahid Beheshti University of Medical Sciences in 2005, she pursued a PhD by research, where she introduced Ex-vivo Lung Perfusion (EVLP) as a groundbreaking method in lung transplantation in the Middle East. She is skilled in designing and executing research projects, analyzing data, and writing scientific articles. Proficient in statistical software such as SPSS and STATA, she is an expert in systematic reviews, meta-analyses, and various study designs. Currently, she teaches medical students and researchers advanced scientific writing while conducting research in heart failure, pulmonary hypertension, and transplantation.

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Masoud Shafaghi

Masoud Shafaghi serves as the Strategic Planning and Executive Office Manager at the International Federation of Inventors' Associations (IFIA) in Geneva, Switzerland. With over six years of experience as the Strategic Planning and Coordination Manager, he has played a pivotal role in promoting global innovation. Established in 1968, IFIA comprises more than 100 member organizations worldwide. Masoud has received numerous honorary diplomas, awards, and medals from prestigious international exhibitions in countries such as Germany, Russia, Belgium, Malaysia, and South Korea. He is a prolific author, publishing extensively on inventions and research. As a consultant in personal branding, marketing, and trade, Masoud has delivered lectures at TED Talks and universities in Canada. He also advises inventors globally, emphasizing strategic management, entrepreneurship, and integrating people with disabilities into innovation ecosystems. Masoud is passionate about coaching innovators and raising awareness about sustainable innovation practices.