Anupadin1.0

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Abstract. The Unmanned Aerial Vehicle is commonly an Aircraft of feasible sizes with its pilot or controller aboard. Over the years we have seen the usage of UAVs in various multicultural activities that include:
1. Military & Defence
2. Conservation
3. Irrigation
4. Mapping
5. Patrolling, etc.

In this System, we Introduce and propose a new application for the use of drones in the field of Search and Rescue of human body insights of regions affected by Natural and Manmade Calamities and is stuck under debris, where it is impossible for human being to conduct a wide scale search mission. This system uses eight highly efficient and lightweight UAVs that is directed towards eight different geographical axes. Each drone initially detects the zones with high possibilities of human existence and then the drones’ uses SWARMING techniques and gives the data about the possibility of human existence in and around the particular geographical positioning leading to a better effective search in the most affected zones. The drone carries a location tracker, a Ground Penetrating Radar, Pixhawk and a specially assembled system that generates Microwave Radiations. This uses a technique of detection of a human body through the generation of Microwave Radiations. This Microwave system operates at a frequency of 1150 MHz and 450 MHz and can easily detect the human being through the heartbeat and the breathing even if the subject is trapped in between a 10 ft. deep construction rumble.

1. Introduction

Natural calamities are scarily becoming a matter of daily news. Each incident results in great loss of human lives and millions of dollars’ worth losses to infrastructure. To help overcome the losses of lives to quite some extent, a new drone system known as ANUPADIN 1.0 is devised. Drone is a flying robot or unmanned aerial vehicle which can be remotely controlled or operate being entirely autonomous through the use of different software’s and inbuilt technologies. This system is created to locate alive and trapped human beings under the earthquake debris. ANUPADIN means ‘rescuer’ and 1.0 indicates the first version of this device. This paper is based on the theoretical study of disasters and various technologies available to save human lives, exact feasibility will be confirmed only after implementation. The system, ANUPADIN 1.0 is a set of fully autonomous drones which are spread across 8 different geographical axes. These drones detect the presence of a human body, state of the human body whether alive or dead and the location of a human body by using inbuilt devices such as

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ground penetrating radar, pixhawk flight controller, Swarm Intelligence, microwave life detection system.

This essential piece of information is passed to the Rapid Action Forces and can help reduce the time taken for detection by the teams and also their workload, thereby increasing the number of people rescued. Also, there is a dire need for a system which can operate in human-inaccessible areas in times of a disaster. The drones offer high degrees of accuracy and operate quickly with maximum efficiency. As the technology in this arena advances, the system will only improve upon its present capabilities.

The drones are entirely autonomous and do not require any skilled human control in the course of their operation.

2. Literature Survey

Earthquakes measuring high on the Richter scale are turning out to be common around the world, causing major destruction to infrastructure and affecting lives of millions of people at one go, almost all of them happening just because of lack of time and reach. Detection of alive and trapped humans in these difficult to access areas is a big factor in reducing the number of people losing their lives in these earthquakes, stuck under the rubble.

Searching for alive and breathing humans beneath the rubble is a time-consuming job and requires the use of technology and skill. Existing methods like detection by a dog through its sniff is turning out to be outdated as they won’t be able to access all degrees of rubble. Rapid action forces are responsible for removing trapped humans but at the time of the disaster, this is a time-consuming process which causes the humans to eventually die.

Autonomous drones are being employed in various fields due to its increased mobility in tough places coupled with the speed which drastically decreases the time consumed for a task. To add to it, the technologies that make it are reliable and efficient.

Our solution to the problem described above uses a group of drones equipped with various types of equipment’s to detect life. These drones uses techniques to scan the area, share vital information with each other and confirm this information with the local team of rapid action forces along with the exact co-ordinates it has read which cuts down the time taken by rapid action forces in finding the humans and thus, they can, more effectively save the humans.

3. Proposed System

3.1 Principle of working

ANUPADIN 1.0 is a search and rescue drone employed to find the existence of life over a particular search zone. The drone uses effective ground penetrating search radars to identify the presence of life and its state under the surface of the target. ANUPADIN 1.0 will be a team of 8 drones loaded with a server and surveillance screen. The different drones in the unit are directed towards 8 different geographical axes and these inspect and survey the zones. A detailed surveillance report is then sent to the surveillance screen. The process of inspection uses ground penetrating radar to find the location of the victim. Through swarming, the information is passed to the other drones which then increases the traffic in that target zone. A microwave detection system checks the state of the victim’s body and if found alive, sends the location of the detected body to the surveillance screen which will be shared with the Rapid Action Forces.

3.2 Ground Penetrating Radar [1]

A GPR system contains the Control Unit, Antenna, and the Power Supply.

The control unit consists of the electronics emitting the radar energy sent by the antenna to the ground. The unit comes with a built-in computer which stores the data for later examination and analysis. The electrical pulse received by the antenna is amplified and transmitted to the ground at a particular frequency. This antenna frequency is a major factor in determining the depth of penetration,
more the frequency, lesser is its penetrating power. Also, a high-frequency signal ‘identifies’ smaller targets.

GPR sends a small pulse of energy towards the material and records the time taken by the signal to return and its strength. This process of sending pulses in a series is called a scan as shown in Figure 1. The reflections occur when there are any differences in the electrical conduction properties or dielectric permittivity in the material. The strength of the signal received is determined by considering the dielectric constants and conductivities of both the materials. While some portion of the energy is reflected back, the remaining portion does travel through the material until it dissipates or until the GPR control unit’s time window is closed. The rate of attenuation varies widely and this depends on the properties of the material to which the pulse is striking or passing through.

To enhance the portability and convenience so that it can be easily carried and can access tough locations easily, the device, ANUPADIN 1.0 has a portable and rugged design and is compact and extremely lightweight. The drone operates on low frequencies for increasing the penetration depth. The built-in electronics ensure low battery consumption so that the drones can fly for a longer time. The system is capable of operating in temperatures ranging from -20 to 50 degrees centigrade.

![GPR block diagram](image)

**Figure 1. GPR block diagram [2]**

### 3.3 Swarm Intelligence Technique

Swarming is a unique Artificial Intelligence Technique through which the drones can be linked through their mechanical outputs. The drones communicate with each other through the process of swarming. This technique is used for locating the surface effectively and for identifying the axis at which each of the drones is placed. They communicate the surface positioning and pair up successfully.

As soon as there are fewer targets in a particular axis, the paired up drones are informed to reduce the traffic prevalent in that particular zone and these divert to places where the incidence of the target is more. Swarming is a smart search and rescue method which consumes much lesser time than conventional methods.

Simultaneous Localization and Mapping (SLAM) is an advanced mapping technique used in mapping the environment without GPS. The map is generated by processing multiple images that are captured using RGB and depth imaging.

All the images are stitched together to form a single 3-D structure. In ANUPADIN, the SLAM follows a loop pattern to ensure effective search and minimal error. SLAM makes it easier for ANUPADIN to detect the other drones and identify their positions thus reducing the factor of the collision.
3.4 Microwave Detection System

Microwave Technology is the major life-detecting system employed in the unit. The use of low-frequency microwaves (L band or S band) makes it possible for it to penetrate even through the highly thick rubble. It senses the heartbeat and breaths of the people underneath the rubble. When the microwave beam hits the human body, it is reflected back with additional modulations created by the heartbeat and the lungs as shown in Figure 2. This modulated beam is received and checked for any clutter signals from other objects. These clutter waves are cancelled to maintain sensitivity by an automatic clutter cancellation system.

This system contains three major components. First is the microwave circuit which generates, amplifies and distributes signals to different components. The second is a dual antenna system which consists of two antennas energized sequentially and lastly, a microwave controlled clutter cancellation system to cancel the clutter signals.

![Figure 2. Principle of Operation [3]](image)

3.4.1 Microwave Circuit: This component further consists of phase locked oscillators, directional couplers and oscillators as shown in Figure 3. A Phase-locked oscillator generates a highly stable electromagnetic wave of 2 GHz Range. Power dividers and directional couplers couple part of the transmission power in a transmission line by a known amount, out through another port, often by using two transmission lines set close enough to each other such that the energy passing through one is coupled to the other. In the Microwave life detection system, 10 dB and 3 dB couplers are used. 10 dB coupler is used to divide the power into 1/10th and 9/10th parts while the 3 dB coupler divides the power into two equal parts.

The clutter canceller is the soul of the life detection system. It contains the Programmable Phase Shifters, Programmable Attenuator, a Microprocessor based control unit and a RF amplifier which is shown in Figure 4.
Figure 3. 1150-MHz Microwave Life Detection System. [4]

3.4.2 CLUTTER CANCELLATION CIRCUIT:

[Diagram showing the clutter cancellation circuit]

The clutter canceller is the soul of the life detection system. It contains the Programmable Phase Shifters, Programmable Attenuator, a Microprocessor based control unit and a RF amplifier which is shown in Figure 4.

3.4.3 Working of Life Detection System [5]: The phase-locked oscillator releases an Electromagnetic wave at 1150 MHz and this wave is highly stable. The power output is at 400 mW (25.6 dBm). The EM wave next finds its way through a 10-dB directional coupler and a circulator. The RF switch then energizes the dual antenna system sequentially. The coupler gives off 1/10th of the wave amounting to 40 mW and is then divided equally by a 3-dB coupler. One 20 mW part of this output drives the clutter cancellation circuit and the other 20 mW output acts as a local reference signal for the double balanced mixer. The antenna radiates the wave which then penetrates through the rubble for detection. The antenna receives the reflected wave along with the clutter signal from the rubble. The clutter wave is large compared to the reflected wave off the human body. This clutter wave is cancelled by the clutter cancelling signal. The wave emerging of the human body cannot be cancelled by any pure sinusoidal or cancelling signal because of its modulation by the motions on the body. The system consists of two antennas, energized in sequences and it can act as both a transmitter and receiver. The cancellation circuit contains a phase shifter (0-3600) controlled digitally, an attenuator (4 dB), a RF amplifier (20 dB) and another attenuator (0-30 dB) but controlled digitally. The clutter cancellation circuit gives an output of equal amplitude and opposite phase as that of the clutter.

When this signal is mixed with the signal from the rubble, the clutter signal is cancelled effectively. The output then consists of only the wave reflected off the human body. The output of the 3-dB coupler is made to go through the 6-dB coupler and the signal generated is partially divided. 1/4th of the output is amplified by the RF amplifier and is then mixed with a local reference signal. The remaining 3/4th of the output is sensed by the microwave detecting system to provide a voltage which ultimately serves as the indicator for the degree or amount of clutter cancellation.

In the double-balanced mixer, the strengthened signal off the human body is mixed with a local reference signal whose phase is controlled by another digitally controlled phase-shifter for better output from the mixer. This output is the motions in the human body like the heartbeat and the breathing, plus some unavoidable noise. This is fed to the low-frequency amplifier (20–40 dB) and a bandpass filter (0.1–4 Hz) and then goes on to be displayed on the monitor. The phase shifter plays the role of controlling the phase of the local reference signal aiming to increase the system sensitivity.
4. Conclusion
The drone, ANUPADIN 1.0 has found its application in detecting alive human beings buried underneath the earthquake rubble. The entire system is essentially a set of autonomous drones spread in 8 geographical axes which will sense the presence of life trapped, during or after a disaster. The state of the human body is detected through microwaves and that information along with the co-ordinates is passed to the RAF. This technique is compact and as a result, consumes lesser time than manual removal of debris and finding bodies. Adding to that, ANUPADIN 1.0 can reach areas which humans otherwise cannot thereby improving retrieval rates drastically.

Note that this system is automated and does not require any skilled operator. As technology evolves coupled with our research endeavours, ANUPADIN 1.0’s capabilities will be enhanced by reducing its size for instance or improving its capability of detection through the debris.

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