**A REVIEW ON TILTROTOR UNMANNED AERIAL VEHICLE FOR WATER LEVEL MAPPING**

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ABSTRACT:

UAV (unmanned aerial vehicle) which is also well known as a drone or unmanned aerial system (UAS) is now becoming a popular tool in all aspects and fields as its functionality and practicality are diverse and can be cast-off anywhere with ease expect some issues of privacy risks which have to be taken. Firstly, they were only the assets of the military but as their control technologies have enhanced, they have been introduced into many non-military applications such as farming surveys, aerial photography, and videography, freight carrying, water level inspection, etc. The tiltrotor is a unique combination of both the propeller plane and the multi-copter. In this model, the unique working is the tilting mechanism of the rotors as they provide the capability of both the VTOL (vertical take-off and lift) as such of the helicopter and the cruise efficiency of the propeller plane. The changing of the rotors from VTOL to cruise condition is known as transition and in this type of model, we get three stable transitions which are VTOL mode, plane mode, and partial conversion mode. So, this type of drone equipped with hydrological sensors can be used to access large areas of hydro variables and also which are remotely located and can also be used in times of extreme meteorological events such as floods or droughts where we can have a fair chance of analyzing the area. Based on the information apportioned in more than 45 published papers and on our research, a symposium is provided regarding the use of the tiltrotor UAV mechanism and its applications for water level mapping.

INTRODUCTION:

Even the tiltrotor is made and sensors are attached for the water level mapping, the tiltrotor basics come from the basics of making an RC plane and then attaching the required motors, speed controllers, etc. to it and finally bring it in the form of the tiltrotor. So certain basic rules and procedures have to be followed for making the RC plane more efficient. Initially, the model of the drone has to be done by using the commercial software of CATIA v5, and later all its parameters have to be calculated in XFLR5, and finally, the analysis of the components has to be done in the ANSYS FLUENT [1][2][3] and after all the part is done more amount of time have to give for the propulsion testing because this part is the one which determines the best motor, propeller, and battery combination to give the optimum thrust, efficiency and low system weight[4] along with which the longitudinal stability and tail sizing, location and shifting of the center of gravity and the neutral point of the RC plane under steady conditions have to be elaborated [5][6]. Even for the component selection which is to be used in the RC plane, a specific study has to be done and the required calculations have to be made using the appropriate equations and formula as all these components are linked with each other [7][8][9]. For the manufacturing and assembly of the RC plane components, some complex guidelines have to be followed such as designing parts with tolerances that are within their capability, minimizing the flexible components, using modular designs, etc. landing gears have to be chosen wisely and mainly are divided into two types as tri-cycle and the bi-cycle models which we have to choose based on the centre of gravity [10][11][12]. Certain precautions have to be also taken for the fuselage and the wing-fuselage conjunction aerodynamics. By using the basic drag parameters, the fuselage drag can easily be calculated, and by using the 3D panel code the potential flow field and the boundary layer along some streamlines are evaluated [13][14][15][16]. Finally, after the complete fabrication of the RC plane, the lift force and drag force of an RC plane have to be calculated using computational fluid dynamics (CFD). The flow trajectories of velocity and pressure on the airplane are given at different AOA values [17][18].

LITERATURE REVIEW ON TILTING MECHANISM AND WATER LEVEL MAPPING:

Researchers in the plunge of aircraft type with the capabilities of VTOL (vertical take-off and lift) combined with the cruise efficiency of the propeller plane came up with the idea of Tiltrotor UAV. But for this type of specially designed UAV, a detailed investigation of the material that has to be used in its construction and blow-by-blow analysis of the wing of the UAV has to be achieved [19][20] and apart from this lot of obstacles have to be considered and overcome such as the root-tip twist, retreating blade stall, etc. Coming to the paramount factor of the tiltrotor UAV is its tilting mechanism whose design methodology lies on its basic kinematic model, the calculation of loads and its execution, and its actualization to the UAV. Many concepts such as the total weight, complexity, consistency, and safety have to be considered and have to be calculated analytically using the high fidelity CFD software solving with the Reynolds averaged Navier-stokes equation(RANS) equation and for the grid-generation, we have to use the BETA ANSA pre-processing software and for predicting the turbulent and transitional external flows with imposed external adverse and satisfactory pressure gradients Low-Reynolds Spalart-Allmaras turbulence model is adopted[21][22][23][24]. The control laws of the commencing phase consist of rate SAS feedbacks, control surface mixtures, a rotor governor, and a manual tilt command path. To evaluate the flight characteristics of the tilt-rotor aircraft the rate feedback SCAS (stability control augmentation system) control law is used and an attitude SCAS should be used if the attitude of the aircraft is not properly acknowledged. The first and automatic conversion to a fixed-wing mode is done with the speed hold command in compliance with the pre-defined conversion corridor [25][26][27]. For the design and implementation of the tilting mechanism, a mathematical model based on the Newton-Euler formation (provides equation of motion of any rigid body) and a control strategy in decoupling the 6-DOF dynamics into 3 independent subsystems can be pre-owned which could be used to simplify the control task. To deal with the chain of integrators using the smooth bounded functions a control algorithm is designed [28][29][30]. The UAV rotors are tilted laterally by a fixed angle, which enhances the system’s controllability, and the displacement of the center of mass for all axis is considered. A non-linear dynamic model is developed by using the Euler-LaGrange formulation and then a linearized error model is then deduced to synthesize the feedback state controllers with the LMI approach (linear matrix inequality). The potential and kinetic energy of the system is used to derive the inertia matrix, Coriolis and centrifugal force matrix, gravitational force vector, and independent force vector of the Euler-Lagrange equation [31][32][33][34].

The use of UAVs for water level and bathymetry measurements as well as for the calculations of orthometric water level, water depth, and surface water speed have been mentioned in this article. Their research also provided the use of a radar system and GNSS receiver for the measurement of orthometric water levels and the use of tethered sonar controllers for the calculation of water depth and also compared them with the less accurate remote sensing techniques. They explained the advantages of the unmanned system compared to the manned system and also provided their limitations [35][36][37]. It mentioned the in-situ measurements to quantify the flow of water in rivers and channels but little information was given about the spatial dynamics of surface water. They also mentioned the use of different visible band sensors such as SPOT, MODIS, Landsat, and SAR imagery techniques such as RADARSAT, JERS-1 to find out the surface water extent and also provided their limitations. It was also mentioned about both the profiling and imaging methods for the measurement of surface water elevations along with the radar altimetry methods. It also specified that the use of repeated altimeter measurements and repeat-pass interferometric SAR can be used to determine the temporal changes in the water levels [38] and the same measurements for the continental surface water were carried [39] and were used to access the ongoing climatic changes but failed to deliver the spatial coverage and timely delivery. They used the satellite altimetry data of 10 years to create the stages, discharges, profiles, and in-situ situations based on time series. The steps to obtain bathymetric data from UAV images were given in detail [40] which they described as the generation of 2D coordinates, rectification and stabilization (transfer of 2D coordinates to XYZ coordinates), and finally the depth computation. These images were accessed and processed based on SFM (structure from motion) and then were overlapped to get multiple images of the geometry of the object. For this calculation, they used the software of Wxtide and MS excel for applying tidal corrections and in-situ processing, Cloud Compare for generating the aerial stitched images, Python for refraction correction algorithm, and QGIS for viewing, editing, and analysis of the topographic and bathymetric points and the same information along with some advancement in laser airborne bathymetry was mentioned in [41][42][43][44]. The use of the lidar concept in the bathymetry is very notable and crucial and the LIDAR physics, capabilities, and parameters are separated based upon the water body being surveyed and some limitations also have to be considered [45][46] and the use of LIDAR for accurate mapping in gravel-bed river environment showed considerable potential and the use of single return LIDAR also showed many accurate results when the results of the ground survey profiles were compared and also recommended to use the multi-spectral laser imagery for the measurement of the bed surface beneath deeper water but limitations such as suspended sediment attenuation were non-prohibitive but proved that this approach was better compared to previous use of aerial photography to estimate the water depth in shallow water bodies[47][48][49]. Even in the LIDAR concept use of the single-photon radar showed more feasibility for the water surface mapping [50] as it uses low energy pulses and has increased areal coverage compared to the normal LIDARs in use and it can be used also for area-wide topographic mapping and derivation of shallow water bathymetry and the water bodies can be given a point of view by comparing the single and multi-photon LIDAR based on the laser-radar equation. The surface water was detected based on the assumption that at least some of the photons were scattered back from the air-water interface and with the equation of the number of photons from the beamlet and the laser-radar equation required parameters were calculated [51][52] and for the evaluation of the vertical accuracy of the EEARL(experimental advanced airborne research LIDAR), NASA surveyed the braided, sand-bedded river for which the GPS point measurements were compared with the LIDAR measurements and computed against the algorithm basing the measurement on the interval between the time taken for the transmitted pulse corresponding to the return of the backscattered wave[53][54]

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