Unmanned Aerial Vehicles (UAVs) have been proven to be useful tools to assist response teams during the Disaster and Crisis Management (DCM) Cycle. Unfortunately, many of the available platforms are specialized to a single application and the solutions are fairly expensive. Lots of problems have still to be solved to create a reliable, compact, and low priced UAV which is useful in a broad range of DCM applications. The author tries to solve a set of these problems in his research, to bring the vision of such an UAV closer to reality.

THE IDEA.

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The base of the UAV is a commercially available remote controlled helicopter kit (T-Rex 700E). Spare parts for the helicopter with a 1.4m main rotor diameter are cheap and easy to get due to the fairly large international RC helicopter pilot community.

The UAV is driven by an electric motor and flies up to 15 minutes with one set of batteries. The decision to use an electric motor instead of a petrol based engine decreases the flight time significantly. On the other side it has the advantage that no smoke is around which can be seen on aerial photos taken by the payload camera. In addition to that, air quality measurements can be achieved with the electric powered vehicle as well.

PLATFORM.

Our helicopter platform uses a MEMS-based Attitude and Heading Reference System (AHRS) which fuses GPS measurements, inertia measurements as well as the output of a static pressure sensor to a global position. A laser ranger is used to determine the relative distance of the UAV above ground.

In addition to the built-in sensors which the helicopter needs for autonomous flight, the UAV platform has been equipped with a sensor gimbal in the front. Depending on the application, different sensors can be mounted on the gimbal: Cameras, Laser Range Finders, CO₂ Sensors, Ultrasonic Sensors, ...

SENSORS.

STEP BY STEP.

[Object Detection]

A multi-purpose helicopter platform needs to be able to fly autonomously and must be able to avoid obstacles at the same time. Therefore, sensors which are able to detect obstacles are necessary on the UAV.

The challenge arises from the payload requirements of the helicopter: Lightweight sensors are needed. At the same time, a great variety of obstacles must be reliably detected soon enough that the helicopter can fly around or above them. But common sensors do not detect all obstacles, are too expensive or just too heavy.

[Obstacle Avoidance]

After an obstacle has been detected, the helicopter has to react quickly: A new trajectory has to be calculated, prohibited zones have to be avoided and the overall goal has to be achieved. A reactive approach in conjunction with a global planner has to be developed to satisfy these constraints.

[Autonomous Take Off and Landing]

The author’s research focus in the first year of his PhD lied in finding a solution to localize the UAV only by means of its intrinsic sound recorded by four microphones built into the helicopter landing pad. The developed algorithm uses the GCC (Generalized Cross Correlation) method to calculate the time differences of arrival (TDOA) of the helicopter noise to each of the microphones. Based on the TDOAs the position of the helicopter can be calculated, which enables a precise landing on the landing pad even in the absence of GPS reception.

[Autonomous Flight]

To be able to fly autonomously to a specified position, the UAV platform first uses its built-in AHRS sensor to gain its current position. A new trajectory is then calculated on an Atom processor on board of the helicopter. The derived path has to satisfy specific constraints e.g. avoid prohibited flight zones like areas in which people might be standing, car parks or lakes. Other scenarios demand the shortest possible or the most energy efficient path.