

ECE4011/ECE 4012 Project Summary

Project Title	Monocular Visual Odometry on Blimp Platform
Team Members (names and majors)	Fanzhe Lyu - CMPE Ruoyang Xu - CMPE Yifan Shen - CMPE Yilun Xie - CMPE
Advisor / Section	Dr. Zhang, Fumin, Section L5B, XXLs Team, Group 37
Semester	2020/Spring Circle: Either Intermediate (ECE4011) or <u>Final (ECE4012)</u>
Project Abstract (250-300 words)	<p>The current blimp platform does not have a localization capability without OptiTrack system, which restrain the utility of the blimp within a lab. The dynamics of the blimp platform is unique and ruled out easy VO implementation. In addition, carrying capability of the blimp limits the camera that provides high quality images. We extended the blimp localization capability outside the lab given the blimp dynamics and hardware limitations.</p> <p>The benefits of a Visual Odometry system expands the blimps' capability and allow it to perform more complicated task such as autonomous navigation, robotics swarm, which can form applications such as people guiding.</p> <p>Thus, the project is designed to be an upgrade from the existing Blimp platform. The project is to deploy and achieve robust visual odometry for the robotic blimps (GT-MAB) to estimate the location and direction through a monocular camera. The system consists mainly of a robotic blimp, a monocular camera and a 5.8GHz transceiver system. The system costs around \$100 in total, and with probable replacement costs for malfunction parts caused by possible control failures of the aerial robot, the team is requesting \$200 to develop the system.</p> <p>Project delivered an architecture of software packages that individually performs the following functions in real time, and when used together, performs visual odometry in real time. Software packages include Noise reduction of camera stream and rejection of unrepairable image frames, Calibration of Fisheye camera, Visual odometry and studies on limitation, Visualization of estimated and ground truth trajectory in ROS and benchmarking.</p> <p>The final product is expected to estimate the trajectory of the blimp in an unknown environment using a single camera. The estimated result is compared with ground truth data, and each run is benchmarked for its performance.</p>

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<p>List codes and standards that significantly affect your project. Briefly describe how they influenced your design.</p>	<ol style="list-style-type: none"> 1. MIT Software License: Permissive free software license to put on software packages that impose minimal restrictions on reuse. This permits our design to be reused by most people on the internet yet restricted us from using certain proprietary packages such as GPL. 2. FAA Part 107: Drone regulation in public air space. UAVs must fly under 120m and under 45m/s during the day. This regulation set the highest speed we expected the blimp to operate. 3. Inter-integrated Circuit (I2C) features a maximum clock frequency of 400 kHz and can be used to connect low-speed devices like microcontrollers. We follow the protocol to establish the connection between the controller and a IMU sensor. 4. Universal Serial Bus (USB) features a high speed of 480 Mbit/s and multiple peripheral devices connections. We need to follow USB protocol to transfer data received from the transmitter to the computer.
<p>List at least two significant realistic design constraints that applied to your project. Briefly describe how they affected your design.</p>	<p>During the design of the software pipeline, we also need to take consideration of hardware platforms.</p> <ol style="list-style-type: none"> 1. Carrying capacity: The current existing platform of the blimp has 70gram load capacity including a 40-gram controller. Dedicated global shutter cameras are usually having large sizes and heavy weights that are not suitable for putting onboard. 2. Image quality: The only choices are analog and digital cameras with limited image qualities, with significant amount of noise. The original design of the blimp adopted an analog camera module with prebuilt 5G transmission. Not to disrupting the current hardware platform, we kept the original hardware settings though we tested the performance on the digital camera. However, we need to specifically address the problem caused by noise.
<p>Briefly explain two significant trade-offs considered in your design, including options considered and the solution chosen.</p>	<ol style="list-style-type: none"> 1. Noisy Image Rejection: Noisy images can significantly impact the performance of visual odometry, and thus noisy images need to be rejected to maintain the integrity of the system. There is a trade-off between the number of images retained and system performance. Too many images rejected will lead to feature loss and too little images rejected will affected the accuracy. We perform experiments to find the suitable parameter. 2. Number of tracked features: Number of tracked feature will impact the time consumed for optimization. To many tracked features will improve the system performance but will not enable a real-time execution. Too little tracked features will not let the system make an accurate prediction. We performed experiments and found a suitable parameter that will balance the performance and computation speed.

ECE4011/ECE 4012: International Program

(Only groups with one or more International Program participants need to complete this page)

Project Title	
Global Issues (Less than one page)	(10 point font, single spaced)