PDEng Mechatronic System Design

Mathematics and Computer Science Department

Autonomous Referee System

Feasibility Report of Drone Usage

Project Team 2021

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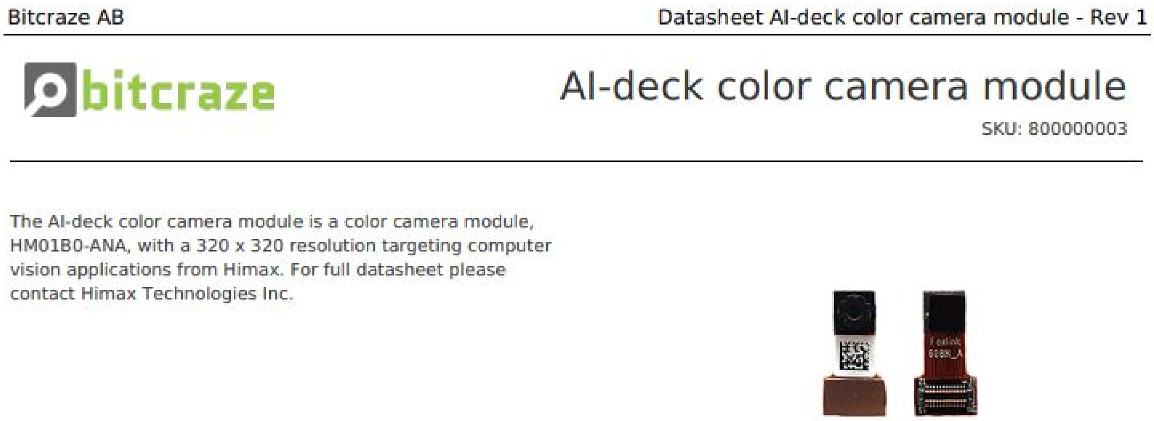
Contents

1 Introduction

In line with the decisions of the second week retrospectives meetings, it has been requested to evaluate the use of drones in Autonomous Referee System. This report contains the results of the preliminary evaluation made in this context. The reviews have been mainly based on the drone system parts already supplied by the stakeholder.

2 Feasibility Analysis

The features of the camera system proposed by the Quadcopter manufacturer, in Figure -1 and it appears in Page-1, have been investigated. The scenarios, involving one or more stable flying quadcopters, have been created and analyzed parametrically in an excel file in Figure-2. The required flight altitude and quadcopter numbers have been obtained. In these studies, the pixel dimensions of the objects have also been obtained based on the geometric dimensions specified in the rule book.


Bitcraze AB   Datasheet AI-deck color camera module - Rev 1

bitcraze

AI-deck color camera module

SKU: 800000003

The AI-deck color camera module is a color camera module, HM01B0-ANA, with a 320 x 320 resolution targeting computer vision applications from Himax. For full datasheet please contact Himax Technologies Inc.

Figure 1: BitCraze IO

Scenario 1 -1 Quadrocopter		
Location	Center of the Field	
Quadcopter	Coordinate (m)	
#	x	y
1	0	0
Parameters		
Configuration	1	1
Field	24.0	16.0

Scenario 1 -2 Quadrocopter		
Location	-	
Quadcopter	Coordinate (m)	
#	x	y
1	-4	0
2	4	0
Parameters		
Configuration	2	1
Field	16.0	16.0

Scenario 1 -3 Quadrocopter		
Location	-	
Quadcopter	Coordinate (m)	
#	x	y
1	-6	0
2	0	0
3	6	0
Parameters		
Configuration	3	1
Field	12.0	16.0

Scenario 1 -4 Quadrocopter		
Location	-	
Quadcopter	Coordinate (m)	
#	x	y
1	-4	-2.66667
2	4	2.666667
3	-4	-2.66667
4	4	2.666667
Parameters		
Configuration	2	2
Field	16.0	10.7

Scenario 1 -6 Quadrocopter		
Location	-	
Quadcopter	Coordinate (m)	
#	x	y
1	-6	-2.66667
2	0	2.666667
3	6	-2.66667
4	-6	2.666667
5	0	-2.66667
6	6	2.666667
Parameters		
Configuration	3	2
Field	12.0	10.7

Figure 2: Parametric Studies

According to best scenarios in Table-2, minimum two or more quadcopters should be flight at constant altitude such as 9 meters. If one check the tolerances in Table–**??**, it may be seen a mistake within a pixel is unavoidable even if in perfect image processing results. Then, it may be assumed tolerance per pixel will be around ± 5 cm.On the other hand, the positioning sensors has already such an tolerance ± 10 cm. In this altitude, cumulative tolerance effect on the other tolerances will be less than 2 percent. It can be neglected. The last effect is the calibration problem of the view angle. it may be observed ± 17 cm position error in the case of one degree positioning error due to any flight disturbances. It would be said the location of the objects may

Number of Quadcopter	Pixel/m	Height (m)	Ball in pixel	Robot in pixels
1	13	12.6	3	6
2	20	8.4	4	8
3	20	8.4	4	8
4	20	8.4	4	8
6	27	6.3	6	11

Table 1: Minimum Flight Heights and Pixel Dimensions

be detected with a total positioning error around ±32 cm. The important point can be that the stable camera point has great advantages and it means the cameras such as security ones may be better than Quadcopters. If one implement a probabilistic estimator (because it is also possible to use multiple quadcopters), the deviations will focused between one standard deviations which it means we may locate the objects with a positioning error around ±17 cm. Another solution is also to use a reference point on the field like a calibration. However, to succeed it, we have to implement minimum 4-5 or more positioning sensors and some of them should be located such a high places around 15 meters.

	Error
Pixel	±5 cm
Angle	±18 cm
Position	±10 cm
Total	±15 cm (±33 cm)

Table 2: Error Estimations