**Histogram of Oriented Gradients Controls Proportional Navigation and Proportional-Integral-Derivative (PID) on Quadcopter Platforms**

Alfarih Faza and Surya Darma\*

*Department of Physics, FMIPA Universitas Indonesia, Kampus UI Depok,   
Depok 16424, Indonesia*

a)Corresponding author: [alfarihfz@gmail.com](mailto:alfarihfz@gmail.com)b)[suryadarma@sci.ui.ac.id](mailto:suryadarma@sci.ui.ac.id)

**Abstract.** Indonesia location’s is in Mediterranean Basin, Pacific Basin and flanked by 3 large plate i.e. Indo-Australian, Eurasian, and Pacific Plate. Therefore, Indonesia has a lot of volcanic mountain and prone of natural disaster such as earthquake, tsunami, and volcanic earthquake. Usually after that disaster has happened, the SAR (Search and Rescue) team would be deployed to search the victims, and mapping the area of the disaster quickly but the human-deploy to do that things especially after the disaster has happened is dangerous, and has a life risk. Hence, SAR need a device to help that situation and minimalize the risk. Quadcopter as victim’s finder and area mapper is the solution to minimalize the risk. High speed, and accurate response of quadcopter is needed to do that things. The Quadcopter has an object detection to give a signal for quadcopter to move closer to the victims and avoiding object for area mapping. The object detection using image processing method Histogram of Oriented Gradient (HoG). Proportional Navigation (PN) and Proportional-Integral-Derivative (PID) control system is used as quadcopter’s control system and both working simultaneous to control the movement of the quadcopter. Proportional Navigation (PN) will be used as default control system when the victims position is at long-distance. PN is used to make quadcopter move more aggressive with maximum acceleration. When the distance is close enough to the victims, the control system will be automatic switch to Proportional-Integral-Derivative (PID) Control System. PID is used at close distance because the flexibility and consistency of response in dynamic movement.

# IntrODUCTIONs

Human life is the most important thing that should be saved when a worst thing has happened such as an Earthquake, and Tsunami. Mostly, an earthquake and tsunami that has passed into a civilization might damaging to building and other environment which is lead to human life risk. Then, SAR would mainly have focused to save human life but deploying human after or in that situation to mapping the area and finding the victims is having a life-risk too. The first need is a human’s detector tool that allows SAR to find and recognized human victims. The tool is installed on a quadcopter as drone’s controller parameters. The tools must have a highly response, and highly acurate to detect human. The tools might use a camera as the main sensor and using image features to recognize human. One of image features is Histogram of Oriented Gradients (HoG) which is previous work by Dalal and Triggs on his paper on CVPR-05[5]. Dalal and B. Triggs showed on his paper that proposed HoG features combined with SVM had successfully detecting pedestarian on occlusions. We use that previous work as the basic human detection tools. After the object had been detected, we need to track the detected object. Hence, the tools must have an ability to tracking same object continuously. The tracked object features such as width of object on image form is processed and calculated. The drone’s controller use that features as PID and PN Controller parameter’s. The quadcopter’s controller is programmed using PID and PN Controller as main control system to controlling the quadcopter for approaching detected object. We could give another action to the quadcopter for the victim after it is found and approached.

## 1.1 Histogram of Oriented Gradients (HoG) Feature Descriptors

A feature descriptor is a representation of an image or an image patch that simplifies the image by extracting useful information and throwing away extraneous information. Typically, a feature descriptor converts an image of size width x height x 3 (channels) to a feature vector / array of length n. Histogram of Oriented Gradients (HoG) is one of image features so it is also feature descriptors of an image that simply likely by calculating vector area of objects in form of images. In the case of the HOG feature descriptor, the input image is of size 64 x 128 x 3 and the output feature vector is of length 3780. In the HOG feature descriptor, the distribution (histograms) of directions of gradients (oriented gradients) are used as features. Gradients (x and y derivatives) of an image are useful because the magnitude of gradients is large around edges and corners (regions of abrupt intensity changes) and we know that edges and corners pack in a lot more information about object shape than flat regions. HoG for human detection was proposed by Dalal and B. Triggs on his paper “Histograms of Oriented Gradients for Human Detection” on CVPR-05[5] and HoG on this paper is adopted from their Paper. Dalal and B. Triggs *et al* [5] using MIT pedestarian database [6], and ‘INRIA’ dataset and using SVM as classifier gives human detection only at front and back view but in any orientation and against a wide variety of background image including crowds.

## 1.2 Proportional-Integral-Derivative (PID) Controller

PID controllers are found in a wide range of applications for industrial process control. Approximately 95% of the closed loop operations of industrial automation sector use PID controllers.

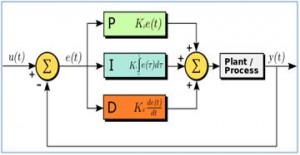


Image sources: <https://www.elprocus.com/wp-content/uploads/2013/12/Working-of-PID-controller-300x155.jpg>

As a feedback controller, it delivers the control output at desired levels. Error is calculated by calculating difference between process variable and set point/desired output Unlike simple ON-OFF controller which is only has two available control state and cause oscillating, PID use error controls as control parameters to maintains the output such that has zero error.

## 1.3 Proportional Navigation (PN) Controller (Use the Microsoft Word template style: *Heading 2*)

Apart from prepositions and articles, all words in second and third level headings should have their initial letters in uppercase. Prepositions are words like “for,” “from,” “with,” “in,” “off,” and articles include words such as “an,” “a,” “the.”

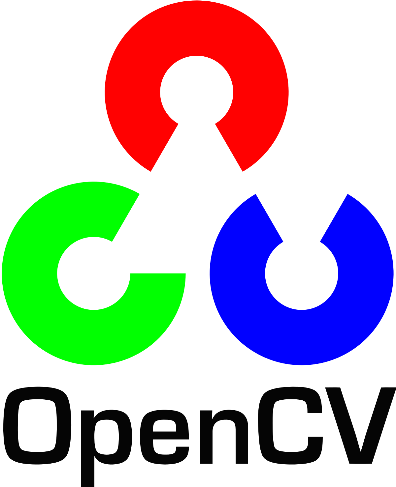
This is the paragraph spacing that occurs when you use the [ENTER] key.

### Heading with Each Initial Letter Capitalized (Third Level Heading) (Use the Microsoft Word template style: Heading 3)

As with first and second level headings, all words except prepositions and articles (see above) should appear with initial letters in uppercase.

## OpenCV Library

OpenCV (Open Source Computer Vision Library) is released under a BSD license and hence it’s free for both academic and commercial use. It has C++, Python and Java interfaces and supports Windows, Linux, Mac OS, iOS and Android. OpenCV was designed for computational efficiency and with a strong focus on real-time applications. Written in optimized C/C++, the library can take advantage of multi-core processing. Enabled with OpenCL, it can take advantage of the hardware acceleration of the underlying heterogeneous compute platform.



Images: OpenCV’s Logo

The library has more than 2500 optimized algorithms, which includes a comprehensive set of both classic and state-of-the-art computer vision and machine learning algorithms. These algorithms can be used to detect and recognize faces, identify objects, classify human actions in videos, track camera movements, track moving objects, extract 3D models of objects, produce 3D point clouds from stereo cameras, stitch images together to produce a high resolution image of an entire scene, find similar images from an image database, remove red eyes from images taken using flash, follow eye movements, recognize scenery and establish markers to overlay it with augmented reality, etc. OpenCV has more than 47 thousand people of user community and estimated number of downloads exceeding 14 million. The library is used extensively in companies, research groups and by governmental bodies

## II. CAMERA CALIBRATION

The frame captured by camera isn’t purely the pure image because every camera has its own specification such as scale, lens zoom, and lens angle. They’re called camera intrinsic parameters which is always applied (multiplied/divided) to every captured frame so it will always got distorted then. We need to re-scaling the frame to its pure condition by applying the same factor respectively. Before all of these factor applied to the frame, we must determine the intrinsic parameter first. OpenCV has a library to determine all of that thing called CameraCalibration by using chess board image then capture in various view. CameraCalibration’s will produce a matrix of intrinsic parameters, camera distortion coefficient, and camera coefficients. All of these parameters doesn’t depend on the scene view so it can be used later as long as the focal length is fixed (lens zoom, and lens angle).

In image’s (a), the image got distorted by c

# II. HUMAN DETECTING

In this section, frame is captured by the quadcopter then processed using HoG Feature Descriptors. Firstly, before the frame is being processed by HoG, frame must undistorted to remove camera effect..blur’s is calculated by applying frame multiplied with Laplace Kernel so the color distribution of each pixel as reperesentation of blur level of the frame.

## III. OBJECT TRACKING (Use the Microsoft Word template style: *Heading 2*)

From Word 2007 onwards, Microsoft Word provides two “Equation Editors,” which, for ease of reference, we’ll call “Old Style Equations” and “New Style Equations.”

* **“New Style Equations”** (Word 2007 onwards): With Word 2007 Microsoft introduced a powerful new built-in Equation Editor that enables input of sophisticated mathematics typeset (usually) in the Cambria Math font. You access it from the Insert menu.
* **“Old Style Equations”** (Word 97–Word 2003): For versions of Microsoft Word between Word 97 and Word 2003, mathematical input was created by an add-in: Inserting and editing a “Microsoft Equation 3.0 object,” typically by *Insert* ⇨ *Object* and selecting “Microsoft Equation 3.0.”

Newer versions of Microsoft Word (Word 2007 and onwards) still support the original “Old Style Equations” method of creating mathematics by inserting an equation via *Insert* ⇨ *Object* and selecting “Microsoft Equation 3.0.”

## IV. OBJECT APPROACHING (Use the Microsoft Word template style: *Heading 2*)

Due to technical requirements of OpenType font technology, Microsoft Word’s “New Style” Equation Editor works only with fonts specially designed for mathematical typesetting. Unless you have obtained and configured new OpenType math fonts, it is highly likely that your installation of Word will use the Cambria Math font for all mathematics created with the “New Style” editor. Using the Cambria Math font for mathematics and Times Roman for your text will cause a mismatch in the visual appearance of your article, so, for consistency, we prefer authors to use the “Old Style” Equation Editor because it is straightforward to amend the size/style of the fonts it uses.

## V. RESULTS (Use the Microsoft Word template style: *Heading 2*)

Equations should be centered with equation numbers on the right-hand side (flush right). Achieving a pleasing layout of equations can be tricky in Microsoft Word, so here are some tips. You can either:

1. Copy, paste, and edit the sample equation provided (recommended), or
2. Manually insert an equation and equation number

### Copy, Paste, and Edit a Sample Equation (Third Level Heading) (Use the Microsoft Word template style: Heading 3)

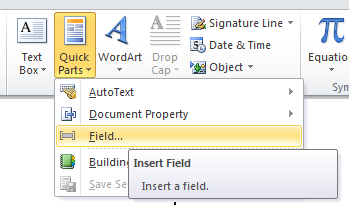
To use this “Old Style Equation” as a “template,” highlight the entire line, then use cut and paste to the new location. Note that the equation number will automatically update (increment).



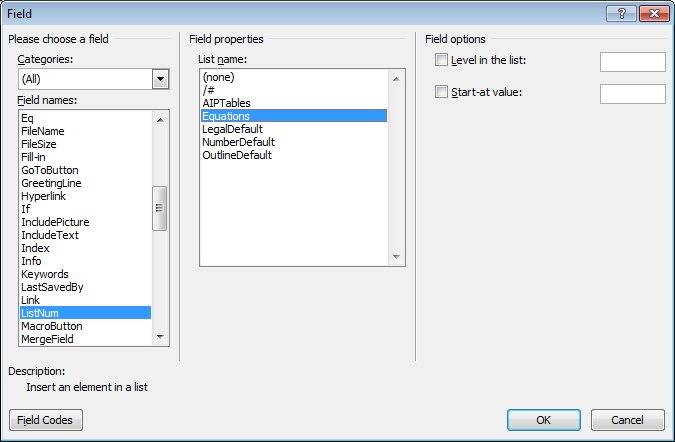
### Manually Inserting an Equation and Equation Number (Third Level Heading) (Use the Microsoft Word template style: Heading 3)

If you prefer to manually insert and number equations, follow this step-by-step guide:

1. Make sure you can see “hidden characters” by switching on “show invisibles” from the Home menu (it looks like this: ). This allows you to see paragraph markers (¶) and tab characters (🡪), which are usually hidden from view.
2. Create a blank paragraph by pressing [ENTER].
3. Format your new blank paragraph by applying the Microsoft Word template style: *Equation.* The *Equation* paragraph style sets up the tabs so that you can center the equation and have an equation number appear at the right.
4. Place your cursor at the start of your new paragraph and press the [TAB] key twice.
5. Place your cursor between the tab characters (🡪) and insert your equation using *Insert* ⇨ *Object* ⇨ *Microsoft Equation 3.0*.
6. To add an equation number, place your cursor at the end of the paragraph (just before the paragraph markers (¶) and after the second tab character (🡪)).
7. On the *Insert* tab, in the *Text* group, click *Quick Parts* and then click *Field*:



1. A dialog box should appear:



1. From the list of *Field Names* on the left of the dialog box, select *ListNum.*
2. From the list of *Field properties* on the right, select the “Equations” *List name* and click OK. You should now see an equation number in parentheses: e.g., (3).

# OTHER SPECIFICATIONS (first level heading) (Use the Microsoft Word template style: *Heading 1*)

Figures, tables, and equations must be inserted in the text and may not be grouped at the end of the paper. Important: A miscount of figures, tables, or equations may result from revisions. Please double check the numbering of these elements before you submit your paper to your proceedings editor.

## Figures (Second Level Heading) (Use the Microsoft Word template style: *Heading 2*)

If you need to arrange a number of figures, a good tip is to place them in a table, which gives you additional control of the layout. Leave a line space between your figure and any text above it, like this one:

|  |  |
| --- | --- |
|  |  |
| (a) | (b) |

**Figure 1.** To format a figure caption use the Microsoft Word template style: *Figure Caption*. The text “**FIGURE 1,**” which   
labels the caption, should be bold and in upper case. If figures have more than one part, each part should be labeled (a), (b), etc. Using a table, as in the above example, helps you control the layout

Cite all figures in the text consecutively. The word “Figure” should be spelled out if it is the first word of the sentence and abbreviated as “Fig.” elsewhere in the text. Place the figures as close as possible to their first mention in the text at the top or bottom of the page with the figure caption positioned below, all centered. Figures must be inserted in the text and may not follow the Reference section. Set figure captions in 9 point size, Times Roman font. Type the word “**FIGURE 1**.” in bold uppercase, followed by a period.

### Color Figures (Third Level Heading) (Use the Microsoft Word template style: Heading 3)

Authors are welcome to use color figures within their article. For online publication, there are no costs added for color figures. However, for *printed proceedings* (if requested by your conference organizer), there is an additional cost. Please consult directly with your conference organizer. If your conference organizer has asked AIP Publishing to produce printed copies (many ask AIP Publishing for online-only publication), then all figures will be printed in black-and-white unless you make specific arrangements with your organizer(s) to include color figures in your article and pay to them the associated fee(s) they request. We advise that many color figures can be printed in black-and-white with no loss of information; however, some figures do lose information when reproduced in black-and-white. Check your figure legends carefully and, if your figures are to be printed in black-and-white, remove from your text/descriptions any references to color.

## Tables (Second Level Heading) (Use the Microsoft Word template style: *Heading 2*)

Due to the wide range and complexity of tables, we simply offer an example for guidance. Please follow the style for table (and figure) captions.

|  |  |  |
| --- | --- | --- |
| **TABLE 1.** To format a table caption, use the Microsoft Word template style: *Table Caption*. The text  “**TABLE 1,**” which labels the caption, should be bold and all letters capitalized. Center this text above the Table. Tables should have top and bottom rules, and a rule separating the column heads from the rest of the table only. | | |
| **Column Header Goes Here** | **Column Header Goes Here** | **Column Header Goes Here** |
| Row Name Here | x | x |
| Row Name Here | x | x |
| Row Name Here | x | x |

# final key points to consider (first level heading) (Use the Microsoft Word template style: *Heading 1*)

Here are the main points you need to follow (the AIP author template packages contain comprehensive guidance):

* Write and prepare your article using the AIP template.
* Create a PDF file of your paper (making sure to embed all fonts).
* Send the following items to your conference organizer:
  + PDF file of your paper
  + Signed Copyright Transfer Agreement
  + (If it applies) Copies of any permissions to re-use copyrighted materials in your article (e.g., figures from books/journals)

## Font Embedding (Second Level Heading) (Use the Microsoft Word template style: *Heading 2*)

As the author and creator of your article PDF, you have the most intimate knowledge of exactly what the PDF should display. We ask all authors to carefully check their article PDF prior to submission. Perform visual inspections to detect subtle font errors and ensure that all fonts are embedded. With the wide range of tools and software that authors use to create PDFs, and the number of devices and platforms that readers use to view/print them, font embedding by authors is not only “nice-to-have”; it is essential.

### Why Should I Care About Font Embedding? (Third Level Heading) (Use the Microsoft Word template style: Heading 3)

Embedding fonts into your PDF file is critically important for two reasons:

1. Commercial printing companies are unable to print PDFs without the correct fonts embedded.
2. To ensure that your online article PDF file displays and prints correctly for everyone who wants to read your work.

Readers of scientific articles use an ever-increasing range of devices and applications to access, view, and print PDFs – from smart phones and tablets to desktop computers running any one of a number of operating systems. To ensure that readers of your article can display and print it correctly, it is important for your article’s PDF file to be truly portable: Your PDF file needs to be fully “self-contained.”

## Summary: Points to Consider when Preparing Your Paper (Use the Microsoft Word template style: *Heading 2*)

Well prepared papers enable rapid publication and reduce unnecessary work for your proceedings editor(s). The following points summarize the key issues you need to comply with when preparing your paper for AIP Proceedings.

* **Check your article PDF file! It is not uncommon for errors to appear in PDFs generated from Microsoft Word – corrupted math, figures reflowing, etc. It is absolutely essential to very carefully check your article PDF file before sending it to the proceedings editor(s).**
* **Do not add page numbers or headers/footers**. Our article templates **deliberately** do not include these, so please do not add them.
* **Do not alter the margins of our templates**. They are carefully **designed** for AIP’s production process: Altering them can cause significant delays.
* **Prepare and format references with care**. Please prepare and **format** your references in accordance with the examples supplied with the author templates and documentation.
* **Embed all fonts into your article PDF**. The **importance** of font embedding is discussed in the section *F*ont Embedding (above). PDFs supplied without embedded fonts are often completely unusable for printing or publication purposes. In such cases, we have to return those PDFs to the proceedings editors for font embedding. Failure to embed fonts can cause unnecessary inconvenience to your proceedings editor(s) and publication delays for other authors. Failure to provide a replacement paper in a timely fashion may result in an article being removed from the proceedings.
* **Use clear, legible graphics and diagrams**. Readers of your paper will be grateful. If they cannot read it, they are unlikely to cite it.
* **Do not use copyrighted material without permission**. **Papers** using copyrighted material without appropriate permission and acknowledgment will be excluded from the proceedings.
* **No 1-page papers please**. 1-page, abstract-only contributions **are** not acceptable and will be excluded from the proceedings.
* **Avoid large PDF files (10 MB maximum, ideally)**. For **the** benefit of your readers, we recommend keeping your article PDF file below 10 MB. This is a recommendation, not a requirement.

## Where to Find Further Information (Use the Microsoft Word template style: *Heading 2*)

We warmly invite you to visit our online platform, *Scitation*, where you can find further help/advice and publishing policies for AIP Proceedings:

* For authors: <http://proceedings.aip.org/authors>
* For conference organizers: <http://proceedings.aip.org/organizers>

# Acknowledgments (Use the Microsoft Word template style: *Heading 1*)

Ut wisi enim ad minim veniam, quis nostrud exerci eliton ullamcorper suscipit lobortis nisl ut aliquip ex en commodo consequat. Duis te feugifacilisi per suscipit lobortis nisl ut aliquip ex en commodo consequat.Lorem ipsum dolor sit amet, consectetuer adipiscing elit, sed diem nonummy nibh euismod tincidunt ut lacreet dolore magna aliguam erat volutpat.

The reference section will follow the “Acknowledgment” section. References should be numbered using Arabic numerals followed by a period (.) as shown below, and should follow the format in the below examples.

# References (Use the Microsoft Word template style: *Heading 1*)

1. M. P. Brown and K. Austin, *The New Physique* (Publisher Name, Publisher City, 2005), pp. 25–30.
2. M. P. Brown and K. Austin, Appl. Phys. Letters **85**, 2503–2504 (2004).
3. R. T. Wang, “Title of Chapter,” in *Classic Physiques*, edited by R. B. Hamil (Publisher Name, Publisher City, 1999), pp. 212–213.
4. C. D. Smith and E. F. Jones, “Load-cycling in cubic press,” in *Shock Compression of Condensed Matter-2001*, AIP Conference Proceedings 620, edited by M. D. Furnish *et al*. (American Institute of Physics, Melville, NY, 2002), pp. 651–654.
5. B. R. Jackson and T. Pitman, U.S. Patent No. 6,345,224 (8 July 2004)
6. D. L. Davids, “Recovery effects in binary aluminum alloys,” Ph.D. thesis, Harvard University, 1998.
7. R. C. Mikkelson (private communication).