Senior Design Project - ParkSense

Spencer Karpati
Martin, Tennessee, USA
spebkarp@ut.utm.edu

Aaron Alden
Martin, Tennessee, USA
aardalde@ut.utm.edu

Zachary Rose
Martin, Tennessee, USA
zacerose@ut.utm.edu

ABSTRACT

UPDATED—September 19, 2023. A problem that has always plagued our campus is the struggle to find open parking anywhere during class hours. This has led to students parking farther away from campus, leading to longer-than-expected travel times to arrive to class. Consequentially, some students may arrive late, disrupting the lecture and possibly leaving a mark on their attendance grade.

To address this issue, we are working on an IoT approach to solving this problem by using OpenCV, YOLOv8, a Raspberry Pi, and a camera module. With OpenCV's extensive and real-time computer vision library and YOLOv8's deep learning capabilities, we will build our own object detection software that is trained on our own custom data to detect empty and taken parking spots. We will then feed this data to a user interface which will update periodically and accurately communicate the availability of parking to the user. If we are finished with our main goals before our project deadline, we will implement our stretch goals for the project such as statistical analysis of sampled data regarding the best and worst times to find open parking and the creation of a mobile-formatted version of our interface.

The duration of the implementation and completion of the project's base goals as well as any further implementation of stretch goals before our deadline is roughly 3 months (August-November). We will be using a parking-lot mock-up to assist the creation of our data as we believe that any modification and collection data will be substantially easier as compared to the required set-up and maintenance for collecting data of a real parking-lot.

Author Keywords

Authors' choice; of terms; separated; by semicolons; include commas, within terms only; this section is required.

1. INTRODUCTION

The purpose of developing ParkSense is to detect and deliver relevant information about parking to Students and Faculty in real-time. Using the design philosophy *The Internet of Things*, we intend to show how it's possible to use machine learning and computer vision technologies to make things more convenient in a cost-effective manner. By training a new model, this technology can be applied to many different aspects of life.

The technologies in use are primarily software-based. A camera feed is used for data input, and a Raspberry Pi can be used for data processing and delivery. We intend to show how to build a data set for training a model, how to train said model using the data set, and how you can use the model to generate a useful set of data to feed to a user interface. We want to show how to do all of this with the selected modules that we will use for this project: OpenCV, YOLOv8, and RoboFlow. OpenCV will provide computer vision for real-time processing for our video feed while YOLOv8 will provide a deep learning algorithm for training on our dataset and producing weights for our model once training is complete. RoboFlow will help with labelling each image of our mock-up with taken and empty instances as it provides extensive image annotation tools needed to produce a training data-set that is accurate and efficient. We will record mean average confidence, recalls, and object loss across different epoch values to show how the algorithm produces more accurate results with more training.

2. PAGE SIZE AND COLUMNS

On each page your material should fit within a rectangle of 7 $\times$ 9.15 inches (18 $\times$ 23.2 cm), centered on a US Letter page (8.5 $\times$ 11 inches), beginning 0.85 inches (1.9 cm) from the top of the page, with a 0.3 inches (0.85 cm) space between two 3.35 inches (8.4 cm) columns. Right margins should be justified, not ragged. Please be sure your document and PDF are US letter and not A4.

3. TYPESET TEXT

The styles contained in this document have been modified from the default styles to reflect ACM formatting conventions. For example, content paragraphs like this one are formatted using the Normal style.

LaTeX sometimes will create overfull lines that extend into columns. To attempt to combat this, the `.cls` file has a command, `\sloppy`, that essentially asks LaTeX to prefer underfull lines with extra whitespace. For more details on this, and info on how to control it more finely, check out http://www.economics.utoronto.ca/osborne/latex/PMAKEUP.HTM.

3.1 Title and Authors

Your paper's title, authors and affiliations should run across the full width of the page in a single column 17.8 cm (7 in.) wide. The title should be in Helvetica or Arial 18-point bold. Authors' names should be in Times New Roman or Times Roman 12-point bold, and affiliations in 12-point regular.

See `\author` section of this template for instructions on how to format the authors. For more than three authors, you may have to place some address information in a footnote, or in a named section at the end of your paper. Names may optionally be placed in a single centered row instead of at the top of each column. Leave one 10-point line of white space below the last line of affiliations.

3.2 Abstract and Keywords

Every submission should begin with an abstract of about 150 words, followed by a set of Author Keywords and ACM Classification Keywords. The abstract and keywords should be placed in the left column of the first page under the left half of the title. The abstract should be a concise statement of the problem, approach, and conclusions of the work described. It should clearly state the paper's contribution to the field of HCI.

		Test Conditions	
Name	*First*	*Second*	*Final*
Marsden	223.0	44	432,321
Nass	22.2	16	234,333
Borriello	22.9	11	93,123
Karat	34.9	2200	103,322

Table 1. Table captions should be placed below the table. We recommend table lines be 1 point, 25% black. Minimize use of table grid lines.

3.3 Normal or Body Text

Please use a 10-point Times New Roman or Times Roman font or, if this is unavailable, another proportional font with serifs, as close as possible in appearance to Times Roman 10-point. Other than Helvetica or Arial headings, please use sans-serif or non-proportional fonts only for special purposes, such as source code text.

3.4 First Page Copyright Notice

This template include a sample ACM copyright notice at the bottom of page 1, column 1. Upon acceptance, you will be provided with the appropriate copyright statement and unique DOI string for publication. Accepted papers will be distributed in the conference publications. They will also be placed in the ACM Digital Library, where they will remain accessible to thousands of researchers and practitioners worldwide. See `http://acm.org/publications/policies/copyright_policy` for the ACM's copyright and permissions policy.

3.5 Subsequent Pages

On pages beyond the first, start at the top of the page and continue in double-column format. The two columns on the last page should be of equal length.

3.6 References and Citations

Use a numbered list of references at the end of the article, ordered alphabetically by last name of first author, and referenced by numbers in brackets. Your references should be published materials accessible to the public. Internal technical reports may be cited only if they are easily accessible (i.e., you provide the address for obtaining the report within your citation) and may be obtained by any reader for a nominal fee. Proprietary information may not be cited. Private communications should be acknowledged in the main text, not referenced (e.g., "[Borriello, personal communication]").

References should be in ACM citation format: `http://acm.org/publications/submissions/latex_style`. This includes citations to internet resources according to ACM format, although it is often appropriate to include URLs directly in the text, as above.

4. SECTIONS

The heading of a section should be in Helvetica or Arial 9-point bold, all in capitals. Sections should *not* be numbered.

4.1 Subsections

Headings of subsections should be in Helvetica or Arial 9-point bold with initial letters capitalized. For sub-sections and sub-subsections, a word like *the* or *of* is not capitalized unless it is the first word of the heading.

4.1.1 Sub-subsections

Headings for sub-subsections should be in Helvetica or Arial 9-point italic with initial letters capitalized. Standard `\section`, `\subsection`, and `\subsubsection` commands will work fine in this template.

5. FIGURES/CAPTIONS

Place figures and tables at the top or bottom of the appropriate column or columns, on the same page as the relevant text (see Figure **??**). A figure or table may extend across both columns to a maximum width of 17.78 cm (7 in.).

Captions should be Times New Roman or Times Roman 9-point bold. They should be numbered (e.g., "Table 1" or "Figure **??**"), centered (if one line) otherwise justified, and placed beneath the figure or table. Please note that the words "Figure" and "Table" should be spelled out (e.g., "Figure" rather than "Fig.") wherever they occur. Figures, like Figure **??**, may span columns and all figures should also include alt text for improved accessibility. Papers and notes may use color figures, which are included in the page limit; the figures must be usable when printed in black-and-white in the proceedings.

The paper may be accompanied by a short video figure (we recommend staying within five minutes in length). However, the paper should stand on its own without the video figure, as the video may not be available to everyone who reads the paper.

5.1 Inserting Images

When possible, include a vector formatted graphic (i.e. PDF or EPS). When including bitmaps, use an image editing tool to resize the image at the appropriate printing resolution (usually 300 dpi).

6. QUOTATIONS

Quotations may be italicized when *"placed inline"*.

> Longer quotes, when placed in their own paragraph, need not be italicized or in quotation marks when indented.

7. LANGUAGE, STYLE, AND CONTENT

The written and spoken language of SIGCHI is English. Spelling and punctuation may use any dialect of English (e.g., British, Canadian, US, etc.) provided this is done consistently. Hyphenation is optional. To ensure suitability for an international audience, please pay attention to the following:

- Write in a straightforward style.
- Try to avoid long or complex sentence structures.
- Use common and basic vocabulary (e.g., use the word "unusual" rather than the word "arcane".
- Briefly define or explain all technical terms that may be unfamiliar to readers.
- Explain all acronyms the first time they are used in your text—e.g., "Digital Signal Processing (DSP)".
- Explain local references (e.g., not everyone knows all city names in a particular country).
- Explain "insider" comments. Ensure that your whole audience understands any reference whose meaning you do not describe (e.g., do not assume that everyone has used a Macintosh or a particular application).
- Explain colloquial language and puns. Understanding phrases like "red herring" may require a local knowledge of English. Humor and irony are difficult to translate.

- Use unambiguous forms for culturally localized concepts, such as times, dates, currencies, and numbers (e.g., "1–5–97" or "5/1/97" may mean 5 January or 1 May, and "seven o'clock" may mean 7:00 am or 19:00). For currencies, indicate equivalences: "Participants were paid ₩ 25,000, or roughly US $22."

- Be careful with the use of gender-specific pronouns (he, she) and other gendered words (chairman, manpower, man-months). Use inclusive language that is gender-neutral (e.g., she or he, they, s/he, chair, staff, staff-hours, person-years). See the *Guidelines for Bias-Free Writing* for further advice and examples regarding gender and other personal attributes . Be particularly aware of considerations around writing about people with disabilities.

- If possible, use the full (extended) alphabetic character set for names of persons, institutions, and places (e.g., Grønbæk, Lafreniére, Sánchez, Nguyễn, Universität, Weißenbach, Züllighoven, Århus, etc.). These characters are already included in most versions and variants of Times, Helvetica, and Arial fonts.

8. ACCESSIBILITY

The Executive Council of SIGCHI has committed to making SIGCHI conferences more inclusive for researchers, practitioners, and educators with disabilities. As a part of this goal, the all authors are asked to work on improving the accessibility of their submissions. Specifically, we encourage authors to carry out the following five steps:

1. Add alternative text to all figures
2. Mark table headings
3. Add tags to the PDF
4. Verify the default language
5. Set the tab order to "Use Document Structure"

For more information and links to instructions and resources, please see: http://chi2016.acm.org/accessibility. The `\hyperref` package allows you to create well tagged PDF files, please see the preamble of this template for an example.

9. PAGE NUMBERING, HEADERS AND FOOTERS

Your final submission should not contain footer or header information at the top or bottom of each page. Specifically, your final submission should not include page numbers. Initial submissions may include page numbers, but these must be removed for camera-ready. Page numbers will be added to the PDF when the proceedings are assembled.

10. PRODUCING AND TESTING PDF FILES

We recommend that you produce a PDF version of your submission well before the final deadline. Your PDF file must be ACM DL Compliant. The requirements for an ACM Compliant PDF are available at: http://www.scomminc.com/pp/acmsig/ACM-DL-pdfs-requirements.htm.

Test your PDF file by viewing or printing it with the same software we will use when we receive it, Adobe Acrobat Reader Version 10. This is widely available at no cost. Note that most reviewers will use a North American/European version of Acrobat reader, so please check your PDF accordingly.

11. CONCLUSION

It is important that you write for the SIGCHI audience. Please read previous years' proceedings to understand the writing style and conventions that successful authors have used. It is particularly important that you state clearly what you have done, not merely what you plan to do, and explain how your work is different from previously published work, i.e., the unique contribution that your work makes to the field. Please consider what the reader will learn from your submission, and how they will find your work useful. If you write with these questions in mind, your work is more likely to be successful, both in being accepted into the conference, and in influencing the work of our field.

12. ACKNOWLEDGMENTS

Sample text: We thank all the volunteers, and all publications support and staff, who wrote and provided helpful comments on previous versions of this document. Authors 1, 2, and 3 gratefully acknowledge the grant from NSF (#1234–2012–ABC). *This whole paragraph is just an example.*

13. REFERENCES FORMAT

Your references should be published materials accessible to the public. Internal technical reports may be cited only if they are easily accessible and may be obtained by any reader for a nominal fee. Proprietary information may not be cited. Private communications should be acknowledged in the main text, not referenced (e.g., [Golovchinsky, personal communication]). References must be the same font size as other body text. References should be in alphabetical order by last name of first author. Use a numbered list of references at the end of the article, ordered alphabetically by last name of first author, and referenced by numbers in brackets. For papers from conference proceedings, include the title of the paper and the name of the conference. Do not include the location of the conference or the exact date; do include the page numbers if available.

Citing something[1]. Citing something else.[2]

REFERENCES

1. Epic Games Inc. The Unreal Engine. https://www.unrealengine.com/en-US, 2022.
2. J. G. Smith and H. K. Weston. Nothing particular in this year's history. *J. Geophys. Res.*, 2:14–15, 1954.