

# Model-based robot localization using April Tags

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**Abstract**—With advances in digitalization topics such as building information modeling (BIM) and structural health monitoring (SHM), the civil engineering industry provides possibilities for developing concepts for automation and robotic assistance. To combine robotics and BIM methods, the model-based localization of a robot is necessary. Localization – especially in indoor or subterranean construction sites – can become challenging because common techniques such as GPS are not accessible. Therefore, techniques working independently of global construction site conditions have to be developed. To address the problem of localizing a robot inside a BIM model and further on in a digital twin without depending on satellite connection, an indoor robot localization approach using AprilTags is developed. A mobile quadruped robot is equipped with a camera that is able to detect AprilTags in its environment. An algorithm calculates the relative position of the robot to the AprilTags and transforms the position into local coordinates. The calculated coordinates are transferred to a BIM model where the time-discrete location of the robot is visualized. After successfully localizing the robot inside a BIM model, a field test inside an office space is performed. The calculation of the local coordinates is successful under the condition, that two AprilTags with a fixed distance to each other are in the visual range of the robot’s camera. Therefore, the developed localization technique is usable for model-based, indoor construction sites.

**Index Terms**—AprilTags, Localization, BIM

## I. INTRODUCTION

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$$a + b = \gamma \quad (1)$$

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#### E. Some Common Mistakes

- The word “data” is plural, not singular.
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- In American English, commas, semicolons, periods, question and exclamation marks are located within quotation marks only when a complete thought or name is cited, such as a title or full quotation. When quotation marks are used, instead of a bold or italic typeface, to highlight a word or phrase, punctuation should appear outside of the quotation marks. A parenthetical phrase or statement at the end of a sentence is punctuated outside of the closing parenthesis (like this). (A parenthetical sentence is punctuated within the parentheses.)
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- Be aware of the different meanings of the homophones “affect” and “effect”, “complement” and “compliment”, “discreet” and “discrete”, “principal” and “principle”.
- Do not confuse “imply” and “infer”.
- The prefix “non” is not a word; it should be joined to the word it modifies, usually without a hyphen.
- There is no period after the “et” in the Latin abbreviation “et al.”.
- The abbreviation “i.e.” means “that is”, and the abbreviation “e.g.” means “for example”.

An excellent style manual for science writers is [8].

#### F. Authors and Affiliations

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**Figure Labels:** Use 8 point Times New Roman for Figure labels. Use words rather than symbols or abbreviations when writing Figure axis labels to avoid confusing the reader. As an

TABLE I  
TABLE TYPE STYLES

Table Head	Table Column Head		
	Table column subhead	Subhead	Subhead
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<sup>a</sup>Sample of a Table footnote.



Fig. 1. Example of a figure caption.

example, write the quantity “Magnetization”, or “Magnetization, M”, not just “M”. If including units in the label, present them within parentheses. Do not label axes only with units. In the example, write “Magnetization (A/m)” or “Magnetization {A[m(1)]}”, not just “A/m”. Do not label axes with a ratio of quantities and units. For example, write “Temperature (K)”, not “Temperature/K”.

#### ACKNOWLEDGMENT

The preferred spelling of the word “acknowledgment” in America is without an “e” after the “g”. Avoid the stilted expression “one of us (R. B. G.) thanks ...”. Instead, try “R. B. G. thanks...”. Put sponsor acknowledgments in the unnumbered footnote on the first page.

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Number footnotes separately in superscripts. Place the actual footnote at the bottom of the column in which it was cited. Do not put footnotes in the abstract or reference list. Use letters for table footnotes.

Unless there are six authors or more give all authors’ names; do not use “et al.”. Papers that have not been published, even if they have been submitted for publication, should be cited as “unpublished” [5]. Papers that have been accepted for publication should be cited as “in press” [6]. Capitalize only the first word in a paper title, except for proper nouns and element symbols.

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#### REFERENCES

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