Dynamical Models for Instruction Completion and Error Recognition for NASA Physical Procedures

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Abstract

1. Introduction

Procedures are the accepted means to operate a spacecraft system or systems to perform specific functions, and consequently are at the heart of all NASA human spaceflight operations [2]. A procedure is a detailed set of instructions specifying how a piece of equipment is operated or a task is performed [1]. They are often written to be very general and to cover numerous contingencies. Procedures to operate a class of equipment (e.g., smoke detector) will differ based on make, while procedures to operate a piece of equipment will have conditional or optional steps based on configuration. As an additional complication, constraints of some procedures may be highly conditional, discretionary, or unordered. At the same time, there may be external constraints that limit how a procedure must be executed, and these constraints are not made explicit. The outcomes of NASA missions rely on crew members properly executing a multitude of these complex procedures, making procedure execution support and monitoring a critical factor that can determine success or failure measured both in terms of monetary costs as well as preventing loss of life.

There is a body of prior NASA work focused on monitoring the progress of procedures that are not physical. For instance, when instructions to systems of the ISS are sent from ground, the application ThinLayer highlights commands as they are executed to show procedure progress [1]. IPV itself also allows for manually tracking procedure progress for a crew person onboard ISS. However, to date there is little work from NASA in the realm of tracking execution status of physical procedures where crew members are manually manipulating physical objects, such as during maintenance tasks. Our goal with this work is to develop a method to computationally model a procedure to enable tracking of the execution of its steps and detection of crew errors during physical execution.

2. coold-word-adj cool-word-noun pipeline

2.1. Feature Representation

optical flow lucas kanade histograms (HOOF)

2.2. Codebook Generation

kmeans on HOOF

2.3. Hidden Markov Models

2.4. Petri Network

3. Experimental Evaluation

4. Discussion and Future Work

5. Conclusion

References

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