University of Central Florida

Computer Science Senior Design I

Animatronic Lamp

Project Proposal

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February 21, 2018

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1 Introduction

The project internally formulated by the group is to create an animatronic lamp capable of tasks such as being able to recognize, track, and interact with its environment. Through these actions, the lamp will have the ability to interact with the user, express emotions, and adapt to new situations. Technologies including hardware implementations, computer vision algorithms, and machine learning will be implemented to see the success of this project. Further details regarding these implementations will be discussed in Section 5.

Within this group, every member possesses their own individual motivation and reasoning for seeking the success of the project at hand. As such, the remaining paragraphs below are the detailed and tailored responses from each group member to the inquisition of what reasoning they have for participating and their expectations for the final result.

1.1 Statements of Motivation

Timothy Allen: When I heard the proposal for the animatronic lamp it really stuck out because it was unlike any other project that I had worked on before. I have never programmed an actual "physical thing" to do something before. Even though computer vision and machine learning interests me I have never tried to tackle either. In fact, that is a major reason that I chose this project. It sounded like a good opportunity to get some experience with both computer vision and machine learning and have fun doing it. I'm hoping to not only contribute a bunch to this project, but to also learn new and exciting things.

Ian Lasky: Since I was a kid I have always had a fascination with animation. Around two years ago in the middle of my computer science curriculum, I revisited my childhood interests and thought about the challenges that would be involved in bringing the ubiquitous "Pixar lamp" to life. At that point in time, it was far too extensive of a project to take on alone with the limited time I possessed. Now, however, with a team and more computer science knowledge under my belt, I believe the goal is achievable. The challenges are still challenging and the end result just as impressive. For me the project is presented more as a technological showcase of "can it be done?", yet at the same time it could present uses previously unconsidered which will be detailed in later sections.

Raphael Miller: The nature of robotics and computer vision has always been of interest to me. In this time of unlimited information and newer and more interesting ideas coming to the forefront we can assume that the field of robotics has been underrepresented. The world of science fiction has produced promises of artifical intelligence and machines that can not only perform tasks that we command but to do it in a way that it allows the users relative safety and comfort. From Issac Asimov's Laws of Robotics to the Tryell Corporation we have seen a vision of the future that founders of those concepts could have only dreamed of. In the 21st century, we finally have an opportunity to create those useful machines of yesteryear. Simple playthings in the minds of directors and writers come to life in real and practical forms. This lamp is more then just a Senior Design project, it helps bridge the nessesary gap to create the automatons that everyone hopes to own and use.

Joshua Schroeder: Since I saw the initial proposal for this project I knew I would be interested. After viewing all of the other project proposals I knew this was the one for me. The thought of combining hardware with computer learning has always interested me but I never had the right project to bring it to life. If we can successfully combine hardware with software to control this lamp and give it a personality, I'll be satisfied. Hardware and hardware interfacing has always been a large interest of mine, so getting to do that and working with others is awesome.

Kevin Tran: This project is very new and exciting for me, and I'm excited to help implement the machine learning portion. My interest is primarily motivated by the tangibility of the final product. Personally, I believe it is very rewarding to bring into this world a dynamically moving lamp that can interact with the user and bop its head to music. This lamp will be the life of any party, and it will also serve practical uses in-home by providing a unique lighting solution.

2 Broader Impacts

An intrinsic aspect of the project at hand is the interaction of human and robot. This subject is still a poorly understood area of research and therefore the resulting outcome of this project could be of use in broadening its knowledge base. Such human-robot interaction has the potential to improve aspects of the user's daily life including their mood and productivity. Within the project, once the team believes they have reached a point of automation they are content with, they will field test the lamp with other students, perhaps faculty, and determine which aspects are seen useful and which can be improved or removed.

Additionally, this project could prove useful to those with a movement disability. The hands-free aspect would allow such users to control and interact with the lamp without needing to strain themselves.

3 Required Functionality

Within this section will be the discussion and listing of required functionalities of the project. These requirements are non-negotiable and are the most basic actions that the completed project must be able to perform. These requirements are broken into two sections: quantitative and qualitative requirements. The former being measurable and definitive metrics set by the project team and the latter being more subjective functionality requirements unable to be attached to such a metric. The project team believes these requirements are both challenging and achievable within the scope of time allotted for the project.

The functionalities will be expressed in terms of a matrix with the first column being the functionality, the second being the importance to the final project, the third being the expected difficulty of the task, and the fourth being the priority of the task. The priority of the task is calculated from the product of the importance and the difficulty. This task matrix will help define the final project and determine the functionalities on which the team will focus. Both the scale for importance and difficulty range from one, being the least important or least difficult, to ten being the most difficult or most important. Thus, the priority can range from one to one hundred. Each of the team members completed their individual importance/difficulty matrix and the results were averaged.

3.1 Quantitative Requirements

Table 1: Quantitative Requirements

Functionality	Importance	Difficulty	Priority
The system must attain a minimum of eighty percent (80%) accuracy when tracking objects	10	5	50
The system must attain five (5) degrees of freedom	9.4	2.2	20.7
The system must be able to capture and process a minimum of twenty (20) frames per second	9.4	2	18.8
The system must be able to emit colors in the RGB spectrum from (0,0,0) to (255,255,255)	3.8	1.4	5.3
The system must be able to emit a brightness value measured in lumens in the spectrum from 5 to 800	5.6	1.2	6.7

3.2 Qualitative Requirements

Table 2: Qualitative Requirements

Functionality	**Importance**	**Difficulty**	**Priority**
The system must be able to smoothly move along its five (5) degrees of freedom	8.6	8.6	74
The system must be able to illuminate objects on objects of interest	9	3	27
The system must be able to detect a user's face within the viewing space	7.4	4	29.6
The system must be able to convey basic emotions through movement	7.2	8.6	61.9
The system must be able to listen to commands from the user	8	4	32
The system must be able to turn on and off at the user's command	10	1	10
The system must show minimal latency in movement or tracking	8.6	8.6	74
The system must integrate the Google Assistant API	8	2.8	22.4

4 Optional Functionality

Along with the required functionality of the project detailed in Section 3, the team has compiled a list of desirable functionalities that, if time permits, would result in a more robust system. The following functionalities will be included within the project timeline presented in Section 7 to motivate the team towards the completion of not only the required functionality but also the optional ones.

Table 3: Optional Functionalities

Functionality	**Importance**	**Difficulty**	**Priority**
The system shall be able to shake its shroud in response to a question asked by a human user.	3.4	5	17
The system shall be able to 'bop' with the music being played by the user	3.2	6.6	21.1
The system shall be able to learn new commands	4.8	6	28.8
The system shall be able to play "catch".	1.2	10	12

5 Block Diagrams

5.1 Overall High Level Schematic

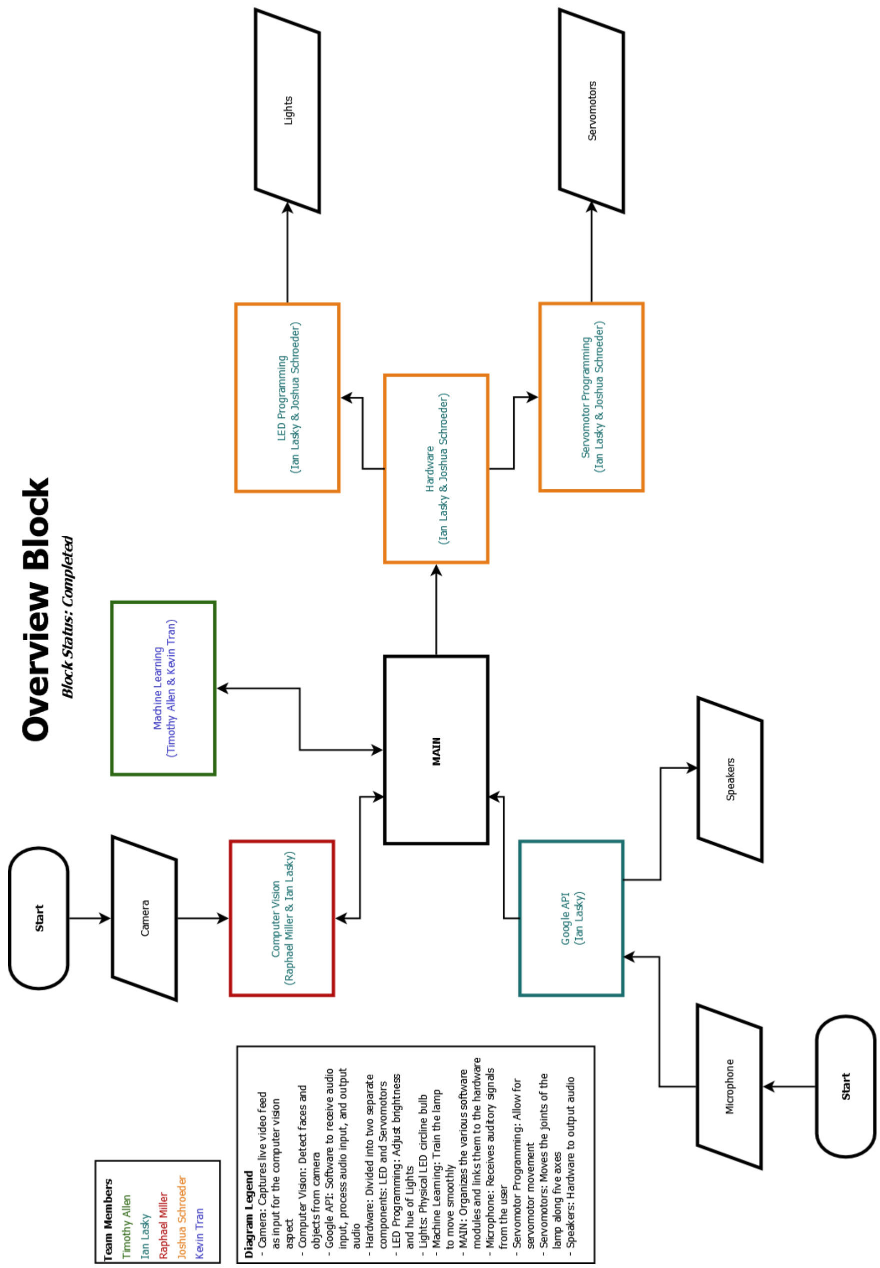

Figure 1: Overall Organization Flow Chart

5.2 Software Block Diagram

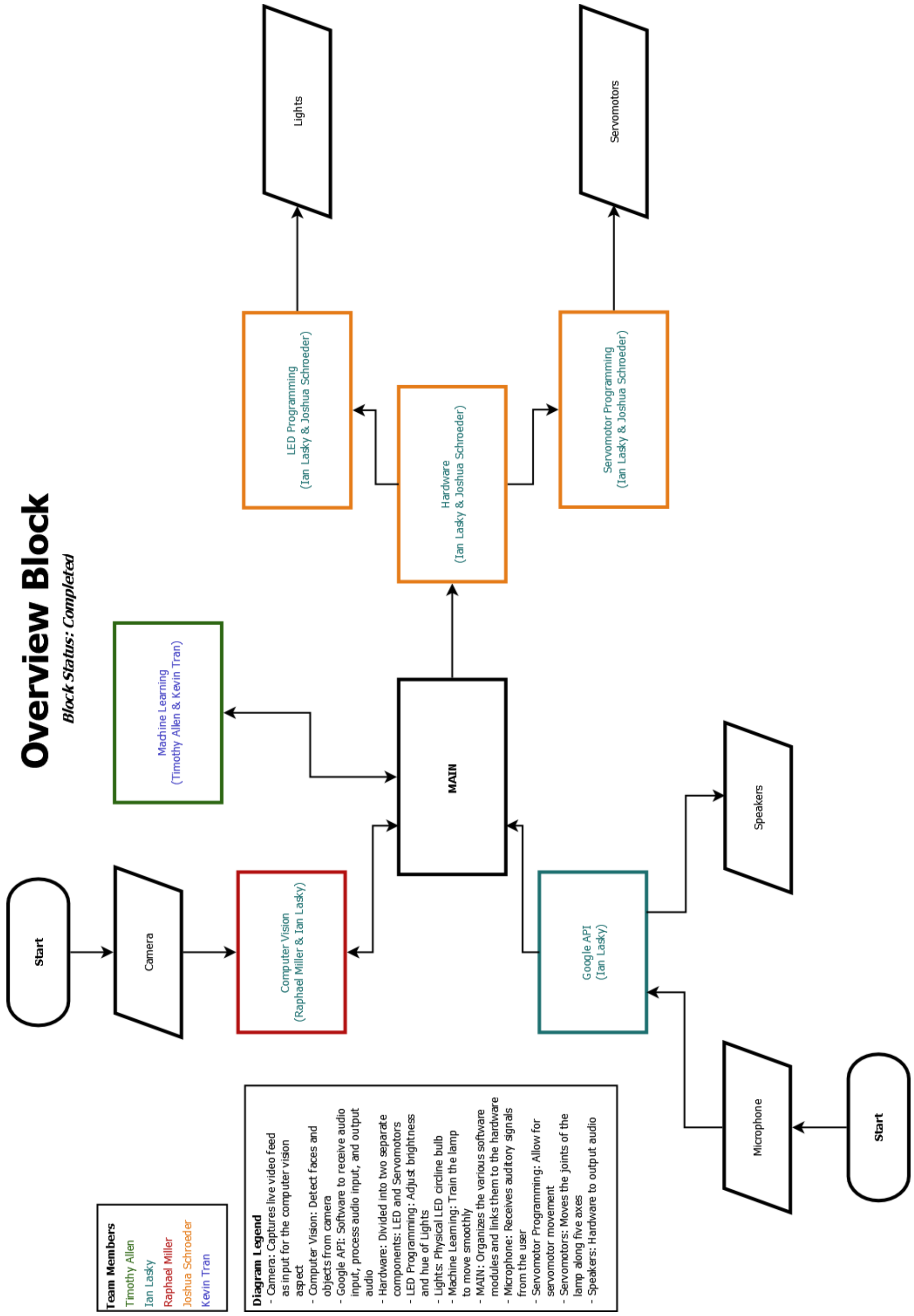

Figure 2: Software Organization Flow Chart

5.3 Hardware Block Diagram

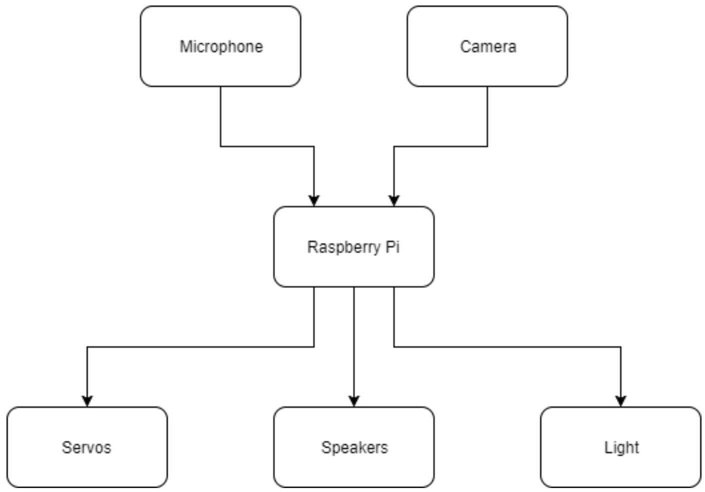

Figure 3: Hardware Organization Flow Chart

6 Budget and Financing

Table 4: Parts and Budget

Part	Price	Quantity Needed	Quantity Have	Quantity Left	Price Needed	Price Have	Price Difference
Lamp	\$20	1	1	0	\$20	\$20	\$0
Servo Motors	\$14	5	3	2	\$70	\$42	\$28
Raspberry Pi 3	\$35	1	1	0	\$35	\$35	\$0
Webcam	\$22	1	1	0	\$22	\$22	\$0
Servo HAT	\$17.50	1	0	1	\$18	\$0	\$18
Power Supply	\$13	1	0	1	\$13	\$0	\$13
LED Ring Light	\$14	1	0	1	\$14	\$0	\$14
Microphones	\$6	1	0	1	\$6	\$0	\$6
Speakers	\$8	1	0	1	\$8	\$0	\$8
Power Splitter	\$3	1	0	1	\$3	\$0	\$3
Adapter	\$2	1	0	1	\$2	\$0	\$2
TOTAL					\$211	\$119	\$92

7 Proposed Project Milestones

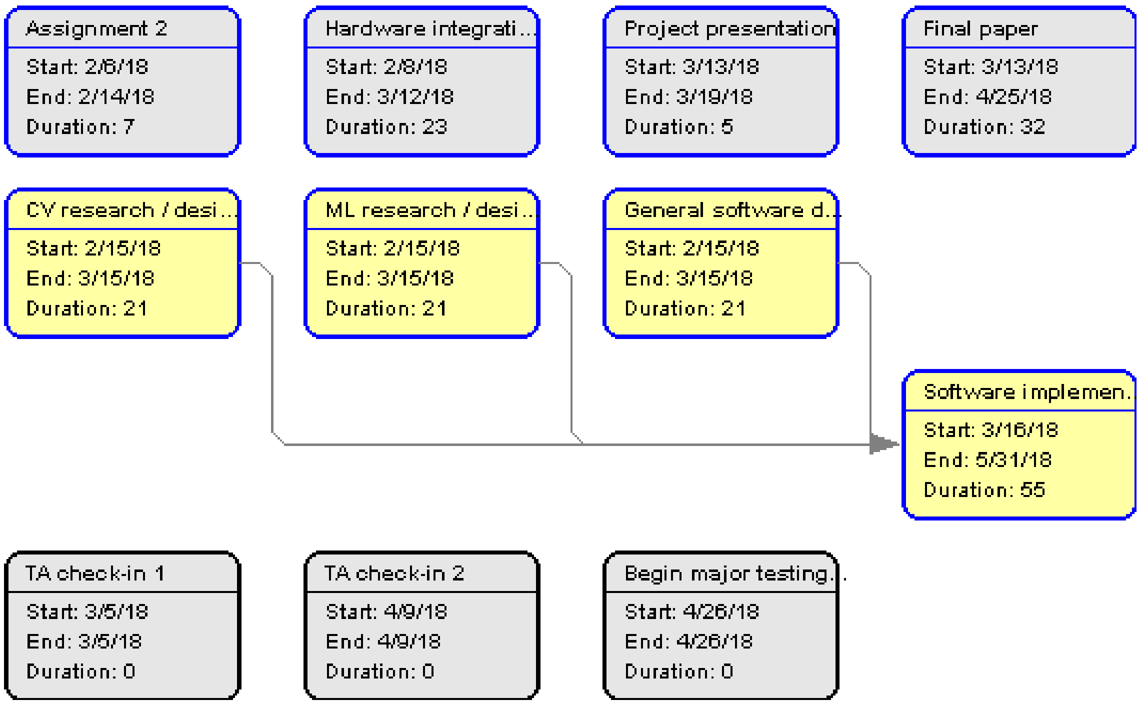

Figure 4: PERT Chart of Proposed Project Milestones

8 Concluding Remarks

In summary, the project proposed by the group represents the fusion of creativity, challenging concept design and implementation, and exploration in the fields of robotics, computer vision, and machine learning. To prepare for undertaking such a task, the team has set forth requirements, their respective importance to the final project, and the difficulty of each task. The result of these requirements is a set of deadlines which the project team is prepared to meet to see the success of the final project. The project team is willing to contribute their strengths to the project but also enter fields of which they are not familiar to make the project not just a capstone, but a learning experience.