FAMU-FSU College of Engineering
Department of Electrical and Computer Engineering

PROJECT PROPOSAL AND STATEMENT OF WORK

EEL4911C – ECE Senior Design Project I

Project title: **E-BIKE CHARGING AND DOCKING STATION**
Team #: 7

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Project Executive Summary

Electric bikes are on the rise in other countries such as in Asia and Europe. The company Efficient Systems LLC is ahead in the race and is implementing similar concepts to America. The purpose for this project is to provide electric bike users with charging and docking stations where they can access them quickly with minimizing user involvement. The emphasis is on simplicity of the design where users of all types can access them and the station itself can be molded to the customers' needs.

Team 7 is comprised of mechanical, electrical, and computer engineers that will design the entirety of this charging and docking station. The budget set at this time is $1000 and the first prototype will be developed by Mid-March of 2015. This prototype is expected to be under budget and have the best design possible.

The design will have to pass a series of tests to ensure it is functioning correctly and is meeting the needs of Efficient Systems LLC and other investors. The stations are projected to be placed at small to large businesses and on school campuses.

Team 7 is determined to excel and develop an innovative method to solving the design problem provided by Efficient Systems LLC. The team will overcome challenges for the wireless charging method and the automated locking mechanism that will be researched and developed using methods on the frontier of innovation.

This report encloses all the details of the full analysis of the design selection and determining of the most efficient ways of implementing the design. Key factors will be compared to analyze how these designs specifications will be selected and determined.

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1 Introduction

1.1 Acknowledgements

Efficient Systems, LLC. Is the sponsor of the design project and will be contributing significant assistance in the form of providing equipment such as the predesigned bike, access to a 3-D printer for constructing components for the design, and possibly newly developed technology that would be applicable to the e-bike and the charging station depending on their development team. Efficient Systems will also be making a financial contribution to the team to purchase materials for testing and building the station. Finally, the engineering team of Efficient Systems will be giving technical advice on how to approach the problem and suggesting alternative methods to solving different issues that might arise. The FAMU-FSU College of Engineering has resources such as the materials lab that will most likely get used when the design is finished and ready to put through production.

1.2 Problem Statement

The design project problem statement is to develop a new innovative station that does two things, charges and docks Efficient Systems electrical bicycles. One must also know that the charging and docking station that has been previously developed is primitive and difficult for the user to dock and charge the e-bike. The current design requires the user to manually lock the e-bike with a combination lock and manually plug in the battery to charge. The role of the design team is to eliminate the need for excessive user input and make the station as easy to use as possible.

The approach to a solution to the given problem is to incorporate a design that all inclusively uses features of charging, locking, docking all in one complete station unit. To eliminate the need for the user to manually plug in the e-bike battery to a source, an induction charging method. This requires developing an induction plate for both the station side and the e-bike side. The docking portion of the station will address the need to manually lock and unlock the bike by developing a mechanism to operate the e-bike locked and unlocked status. A microcontroller will implement all the operations by consolidating them into a simple easy to use user-interface.

1.3 Operating Environment

The E-Bike Charging and Docking station will most likely be in an outside and exposed environment. The station is intended to be commercialized to any consumer or company, so all different weather and climate environments have to be taken into consideration. Although currently, the testing environment will be the climate of Tallahassee, FL through all seasons as this will be the first place for the station implementation. The station will have a shelter of some sort provided by Efficient Systems, which is out of the scope of the design project. This will ensure protection from excessive heat transfer from the sun and moderate coverage from rain or snow. The station should be durable enough where it can handle possible theft. If a client does decide to place the station in public access, the station must withstand any theft attempts from high forces pulling on the locking mechanism to ensuring the e-bike cannot be removed from the station.

1.4 Intended Use(s) and Intended User(s)

The intended use of the station is self-evident in the fact that it is a charging and docking station for e-bikes. The e-bike should be docked in a manner that it is securely fastened in position to easily dock and undock with ease and also prevents the e-bike from being stolen. The charging feature will allow the user to ensure the e-bike has the full range of intended battery usage so they may commute farther and longer without worry of a dead battery.

The intended user of the station will simply be a user of the e-bike. This could have several scenarios in which a company purchases a large quantity of e-bikes for their employees to commute or a consumer and owner of an e-bike. Given the needs and requirements of the station, let it be emphasized that the intended user is not for public use. Over the course of planning and discussion with the sponsor, it seems to be an issue out of the scope for the design team to consider the e-bike stations to be available for rent and public use. For any case in this matter, the intended users could range in computer literacy and competency so it is important to address this by making the station as easy to use as possible with minimal interaction from the user. For example, if a company gives the option for their employees to use the stations, it would cut costs and time down to have to explain and show how dock and undock the bicycles by having the station self-explanatory to use.

1.5 Assumptions and Limitations

The charging and docking station has the assumptions that the design may need a larger capacity microcontroller depending on how large scale the station will be. If the client buys 50 e-bike for its employees, the station can be replicated, but will need to consider a controller that provides a wider range of input and outputs.

The limitations of the design may include the size of the station will depend on how many e-bikes are purchased. The estimated size of a 10-bike charging and docking station will be the size of a parking space. The e-bike cannot be undocked until the battery is fully charged. The station is not intended for public use and is vulnerable to theft of bicycles if not used by contracted employees or users. In order for the e-bikes to charge through induction of the station, a detachable plate that connects to the e-bike battery is required.

1.6 Expected End Product and Other Deliverables

The Efficient Systems, LLC E-Bike Charging and Docking Station is the user-friendly innovative way to charge and store your electric bicycle. The station will include a track with guide rails, ensuring the bicycle makes the perfect fit into the station. A mechanical lock will prevent the e-bike from being stolen or removed. The inductance charging component sets the user up for an easy and efficient way to have a full battery before commuting to your destination. The expected delivery date of the Charging and Docking Station will be close to May 2015.

2 Concept Generation & Selection

2.1 Mechanical Components

This section involves all the mechanical components and features that have been thoughtfully proposed and compared to decide the final proposal.

2.1.1 Material Selection

When deciding for the type of materials to use for the frame and cover of the entire station, a few factors need to be included. The material will be exposed to environmental factors such as strong winds, rain, and possibly lightning. Also the material must also be isolative and have a high reflectivity to regulate the temperature internally to protect electrical components from overheating. Also since the cost for the entire system needs to be minimized, this will be also be a big factor when comparing the types of materials.

2.1.1.1 Galvanized Steel

This type of steel is the most commercially used and is inexpensive. Most galvanized steel are zinc coated and will protect against corrosion. They are also easy to weld, form, and drill. They are also very strong having a high yield and hardness strength which is ideal for this application [3] Although zinc has a high heat transfer coefficient of 116 W/(m*K) the thickness of zinc is very small compared to the thickness of steel that will be selected. Steel has a heat transfer coefficient of 43 W/ (m*K) which would be satisfactory for this application [2]. The galvanized steel can be painted with a special technique Approximate cost is for 32 ft^2per station will be $130.00 [5].

2.1.1.2 Stainless Steel

This type of steel is an alloy that is mixed with chromium to attain its non-corrosive property. It is most ideal for this application but the biggest drawback is the price. It is more aesthetically pleasing than any other type of metal. This type of steel has a low heat transfer coefficient at 16 W/ (m*K) and has a [2]. Most stainless steels are very expensive so this material will not be chosen for the project because of cost issues. Approximate cost is for 24 ft^2per station will be $1,075.20 [5].

2.1.1.3 Aluminum Alloy

This type of metal is naturally non corrosive when in contact with water and is generally inexpensive. Aluminum alloys have are strong and have a high hardness to protect against denting [3]. It is also generally more aesthetically pleasing than other materials but can also be painted to enhance that attribute. Its thermal conductivity is 205 W/ (m*K) which is high and can pose a problem for this design [2]. High strength aluminum alloy can range from $110 to $190 which is much more expensive than galvanized steel [5].

2.1.1.4 Hot Rolled or Cold Rolled Steel

This type of metal is an iron-carbon alloy with a high strength and hardness. The drawback for this type metal is that it is corrosive and needs to be painted with a non-corrosive paint. The paint allows aesthetics of the stations to be enhanced and unique but the paint wears off faster than the coating of zinc on galvanized steel. It can be formed, welded, and drilled without any problem but will need to be maintained on a yearly basis to ensure longevity. The prices are range from $80 to $100 but with added protective paint and consistent maintenance, the cost will pile up very quickly [5].

2.1.1.5 Durable Plastics

Certain plastics could be applicable to this design but there are a few negatives. Plastics deteriorate faster in outdoor conditions and can potentially melt with high temperatures similar to on a hot day. Also it would have to be custom printed to fit the dimensions needed. Plastics are inexpensive but will not be the best option for this design.

2.1.2 Security System

The station will have features to ensure the bike is safely transitioned from locking to unlocking states with minimal user interaction. Also the locking mechanism needs to be strong and reliable to protect from theft.

2.1.2.1 Locking Mechanisms

The locking mechanisms were compared between factors that meet the requirements for our design. The mechanism must extend out to grab and connect securely to a portion of the bike frame. The mechanism must meet certain clamp force requirements to ensure a strong grip onto the bike. The frame will be the prime location for the locking mechanism to attach to because all other components are attached to the frame.

2.1.2.1.1 Electro-Magnetic Lock

The magnetic locks most commonly found on doors around campus buildings and offices are electrically efficient and easy to implement. The advantage for this type of lock is that only one motor is needed to extend to make contact with the bike. The bike frame is also made out of a ferromagnetic material which can easily be magnetically locked onto. The biggest disadvantage is if the power to the station is shut off, the electromagnet will stop functioning and the bike will no longer be secured. This will not be applicable for the design.

2.1.2.1.2 Extended Gripper

An extended gripper is a mechanism that will extend and use claws to hold the bike tightly. In this design, two motors will be needed to complete the two degrees of motion that are needed. The first being that the gripper needs to extend out to the frame and the second being the claws that will grip down. This makes the system more complicated and susceptible to failure. With the added features and complexity, this design could be expensive than the next design. This design is overshadowed by the next design which will be chosen for the design proposal.

2.1.2.1.3 Four-Bar Robotic Claw Arm (2 DOF)

A robotic claw arm with 2 degrees of freedom is optimal for our design. As you can see in figure 1 below, the robotic arm made by DAGU and is completely aluminum. This will have be tested against the rated clamp force needed to resist outside force factors. This overall schematic will be utilized for our design even if this product does not work for our design criteria because of its advantage of only needing one motor. Also the end effectors where the clamps touch down would need to be more circular to fit onto the circular bike frame. This pre-built part is around $50 without the motor.

Figure: 1 [6]

2.1.2.1.4 Motors and gears

For the mechanism being selected, there are two options to secure and lock so that the clamp/hinge does not open manually. The first option is a shaft worm drive gearbox that can be found pre-built at around $60. The gears are made of a durable metal and the motor can be chosen to have a high torque which will be determined later. The motor specs will have to be chosen later to compare against torque and speed that is needed. Worm gears are ideal for self-locking mechanisms and cannot be back driven which is being selected for design. This can be seen below in figure 2.

Figure: 2 [6]

The second option is a ratchet device that also doesn't allow back driving. As seen in figure 3 below it will tick and lock everywhere there is a groove. The main disadvantage is that the latch will have to be removed when the system is unlocking which will need an actuator. This will not be chosen for our design.

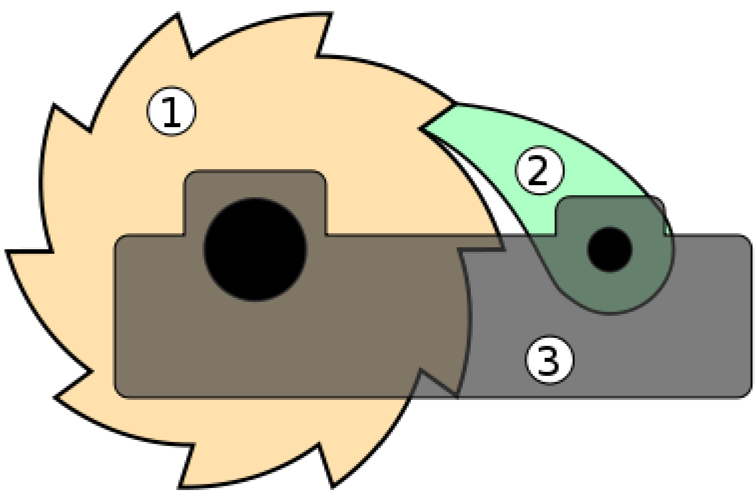


Figure: 3

The gear motor selected for now has the specifications that will work for our design. Servo or stepper motors will be harder to control because of the need of a microcontroller to control the motors accurately. Standard DC motors have a large angular speed and more gears will needed to reduce the speed increasing the complexity and chances for failure. It has multiple ratings that can allow us to select the best option. We will select it against the how fast we need it to move the claw and how much torque needed to secure the claw on to the bike frame. The motor can be seen below in figure 4 and the brand is Servo City which has a good reliability.

Figure: 4 [6]

2.1.3 Extra Features

The electric bike charging station will be intuitive where the user can simply figure out how to take and return the bike without damaging the bike.

2.1.3.1 Orientation of Bike

The bike will be compared to two different situations for docking and undocking easiness. The bike could either be moved in to the docking station forward with the front of the bike pointing towards the main lines or the bike could be moved in backwards and the front of the bike will be point away from the main lines. This will be compared by asking people what is the desired orientation.

2.1.3.2 Guiding Track

A track that will be on the ground that is slightly larger than the width of the tires and will guide the tires and the entire bike to the desired point. A funnel type opening will be in the front to increase easiness for the user to move in the bike to its position. Also the bike track will act as an extra security feature to block movement of the bike in the left and right directions. The bike can still move slightly for a few degrees but a slot for the bike seat will ensure the bike is oriented correctly for the latch system to lock.

2.1.3.3 Orientation of Station

The station orientation is specifically how the tracks and actual locking and charging components are oriented compared to the main lines, which would be easily rerouted. There is much variability in how the orientation can be and it will be dependent on where the stations will be placed. The station will be completely modular so that individual stations can be oriented in such a manner to not take up a lot of space. Also, the placing of the entire station can be creative as much as to make it into a circle of 5 bike stations.

2.2 Electrical Components

This section involves all the electrical components and features that have been thoughtfully proposed and compared to decide the final proposal.

2.2.1 Mainframe

A single centralized unit will be built to control the charging and docking of all of the bikes. This system will have one or more microcontroller units to control all of the electrical components of the station.

2.2.2 Main Electrical Line

An array of electrical lines will be needed to provide power between the mainframe and the individual bike stations. Because of the simplicity of the design, the housing for the lines is flexible; the bike stations could connect either perpendicular to the line or at an angle to reduce the overall area of the station, or could even connect in a circle for a more novel design.

2.2.3 Induction Coils

Coils of various sizes will be compared and tested to determine the best balance between the compactness of the coil housing and the efficiency of the magnetic induction. In other words, a larger coil will provide a higher power transfer efficiency, but would have the tradeoff of being bulkier and eventually becoming a hindrance of the bike design. Currently coil sizes between 70mm and 120mm in diameter are being considered. The induction coils may also be used to step down the voltage to a value more suitable for the bike battery.

2.2.4 AC/DC Converter

After the induction coils, the power output will need to be converted from AC to DC. It may also possibly need to be stepped down more to get the correct voltage. Our main option for the placement of the converter circuit is in the bike adapter attachment. This is assuming that there will be enough space to have such a circuit. If not, then the design of the sequence of each module will need to be modified to gain the correct voltage at the proper time.

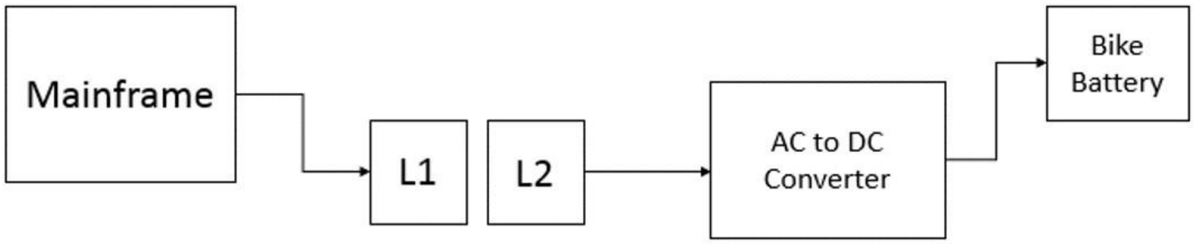


Figure 5

2.2.5 Microcontroller

The top level design is given below. The station needs to know when the bicycle is in the docked and locked position, when it is gone, when it is charging, and when it is charged and ready to use. On the e-bike side, a radio frequency transmitter is needed to notify the controller when the bike is in place and charging and locking can take place. Once signal is sent the receiver sets the controller to toggle the locking mechanism and begin the charging. The battery status and charging status go hand in hand making sure that the system is efficiently used and then goes to notifying the user it is ready to take. The user then sees the LCD screen which bike is ready to take and inputs a pin or id of some sort to toggle the unlock feature and undock the e-bike. The radio frequency receiver no longer gets a signal from the bike and outputs on the LCD display the bike is out for use.

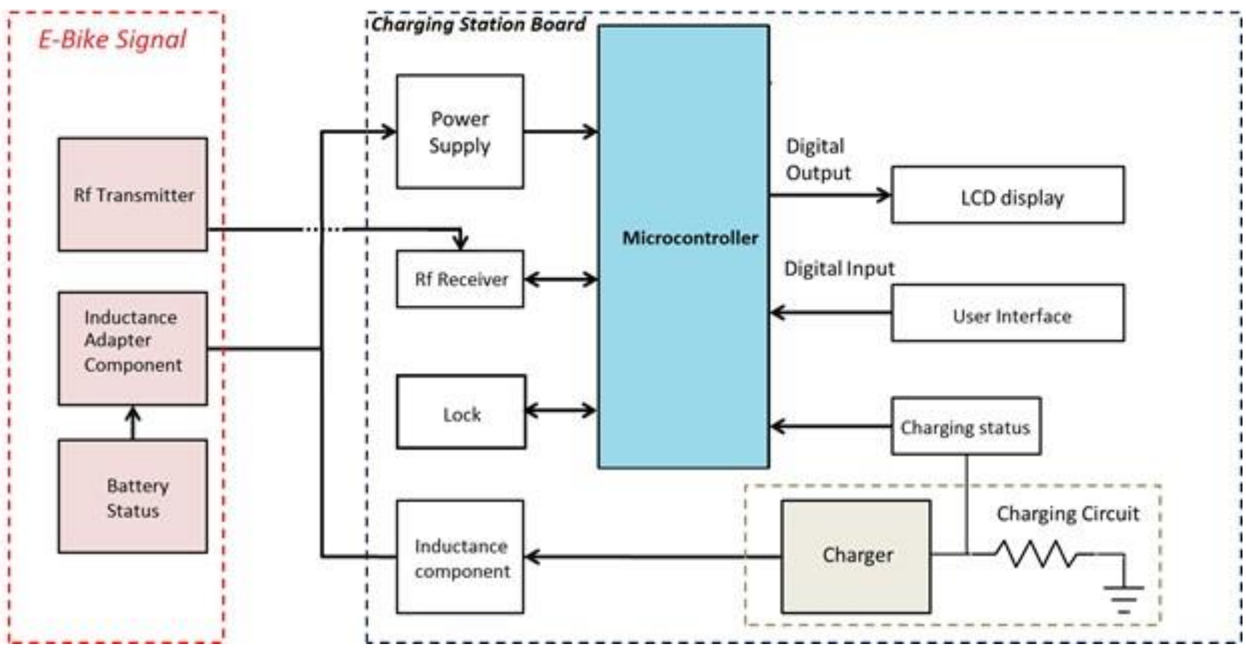


Figure 6

3 Proposed Design

3.1 Overview

The design selected was carefully chosen to have balance between simplicity and cost effectiveness. The proposed design will comply with all the needs and requirements proposed by Efficient Systems LLC. The overall design will be structurally similar to the current design implemented but will have many component modifications to provide full automation of the station. It will consist of a charging and locking system on the right side of the bike and will have a track to guide the bike into the correct direction parallel to the charging and locking dock. I will use an induction coil system to provide power to the batteries, and microcontrollers on the bikes will transmit information to the controller in the mainframe.

3.2 Charging Station Structure

For the charging station structure, galvanized steel sheet was chosen to be the most suitable material. It was chosen due to the fact that is fairly inexpensive and that it is zinc coated, making it non-corrosive. This type of metal is also moldable and easy to form into specific dimensions.

3.2.1 Housing

The housing portion of the charging station is what contains wires and other important parts and electrical components. This includes motors for the gripping /locking mechanism and microcontrollers. The housing will be supported by at least one steel beam or pipe, and galvanized sheet metal will compose the outside of the structure. This part of the station also includes the wires coming from the main hub, which will also be enclosed in galvanized steel to protect them from the elements. The overall structure will be designed as shown in figure 8.

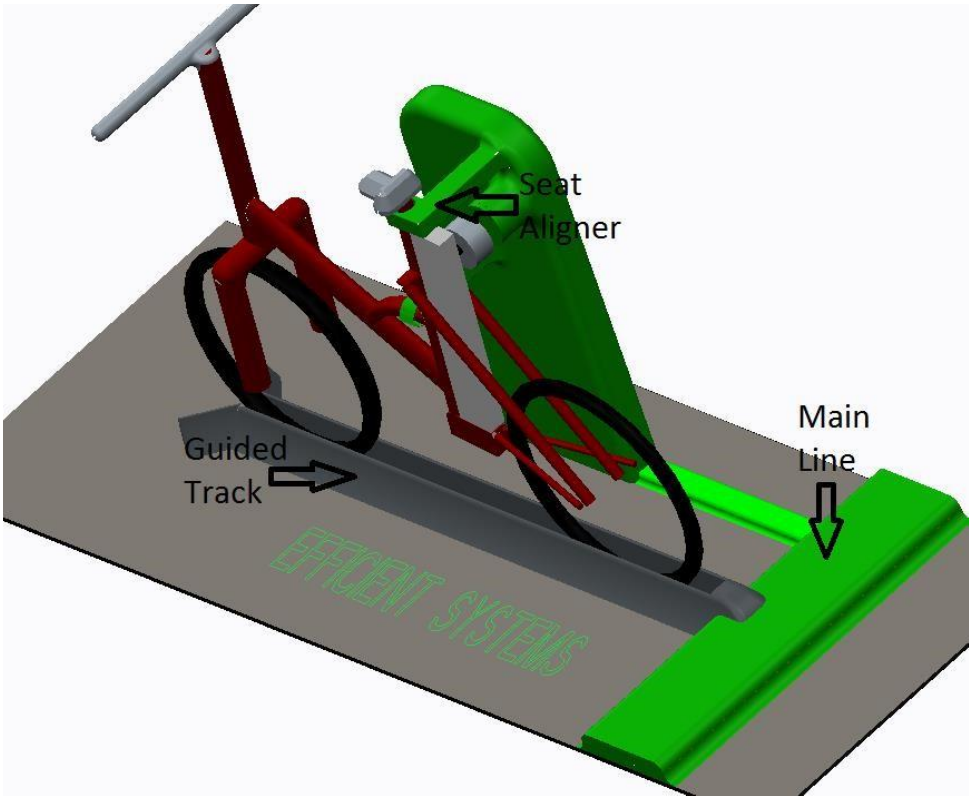


Figure: 7

3.2.2 Locking Mechanism

To lock the bike in place, some sort of lock is needed and it also needs to be held in place to be locked. To guide the bike into the right position, a track will be used to align the bike and guide the bike smoothly into the station. Coming from the housing will be a beam that will be used to stop the bike when it is in the correct position and keep it from wobbling from side to side. This will be placed right under the seat because it is the best place to balance the bike as shown in figure 8 as the seat aligner. Once the bike has been mated to this, it can then be locked. The actual locking mechanism that will be used will be a gripping mechanism. The gripping mechanism is composed of two four bar geared mechanisms. They both rotate at the same time to close the gripper and lock onto the bike and hold it in place. The gripper will lock onto the triangle region on the frame. This is ideal because all the components are locked onto the frame and the proposed track should hinder the bike being moved from the sides. The clamps will be padded with rubber to ensure no damage to the bike and to ensure it does not move when an outside force is applied.

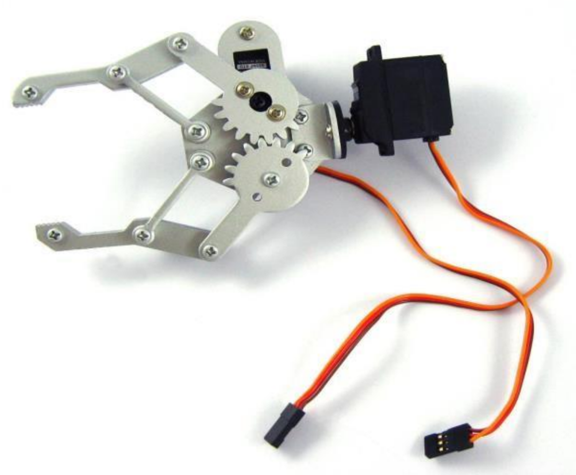


Figure 8

3.2.2.1 Contingency Plan

The properties of this device will be carefully examined for its mechanical properties to test if it will be suitable for our design. The DUGA made 2 degrees of freedom robotic arm costs around $50 and is made out of aluminum. It is already weatherproof but the screws are exposed and need to be covered by a rubber coating. The same design may be taken and replaced with higher strength metals, i.e. steel, and will need to be covered so no joints are exposed to being damaged. Also the end effectors are not rounded and will not give a snug fit onto the frame. This will have to be modified to achieve that tight fit and so the tips of the end effectors touch. Figure 9 shows where the actual clamp will lock onto.

3.2.3 Gears and Motor

The worm shaft gear that comes pre-built will be our main locking device. Since worm gears cannot be back driven, they work as excellent locks. The steel gears and bearings should allow for a smooth transition of the robotic claw and also be wear resistant to increase longevity before repair. The motor is a specified gear motor from Servo City will be ideal for the worm gear set. Since the motor ratings are based on needs or torque output and speed, the balance between the two will be critical. Estimating the torque resistance from the claw weight and friction to be about 10 oz.in and the clamping force to be about 50 oz.in the 51 RPM gear motor will suffice. This will be compared against rate of locking. If the time needs to decrease, the gear motor can be chosen to be 81 RPM which will also suffice to the torque requirements.

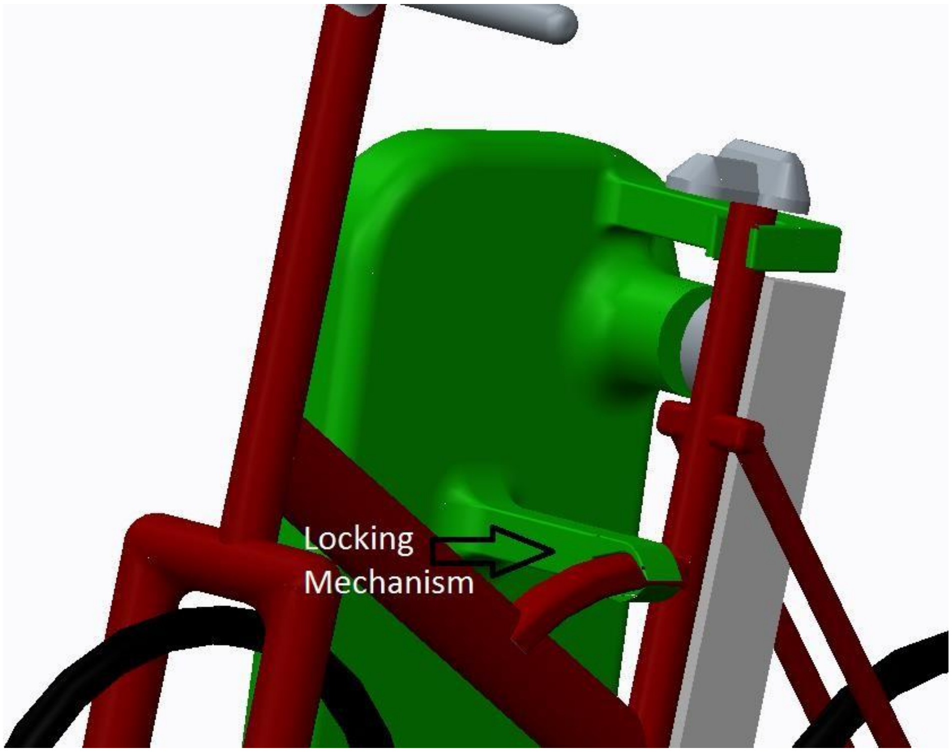


Figure: 9

3.3 Charging Plate

Because of the weather conditions of outdoors, a high priority was place on the charging mechanism having no metal-to-metal contact, as this could eventually lead to corrosion and other factors reducing or preventing the ability to charge the bike. As such, induction and resonance systems were considered. Induction was picked over resonance because induction has a higher potential energy efficiency, whereas resonance can operate better at longer distances, which is not a factor for the current design. Multiple diameter coils were considered, and preliminary measurements indicated that a 100mm diameter coil would be the largest that would comfortably fit on the bike.

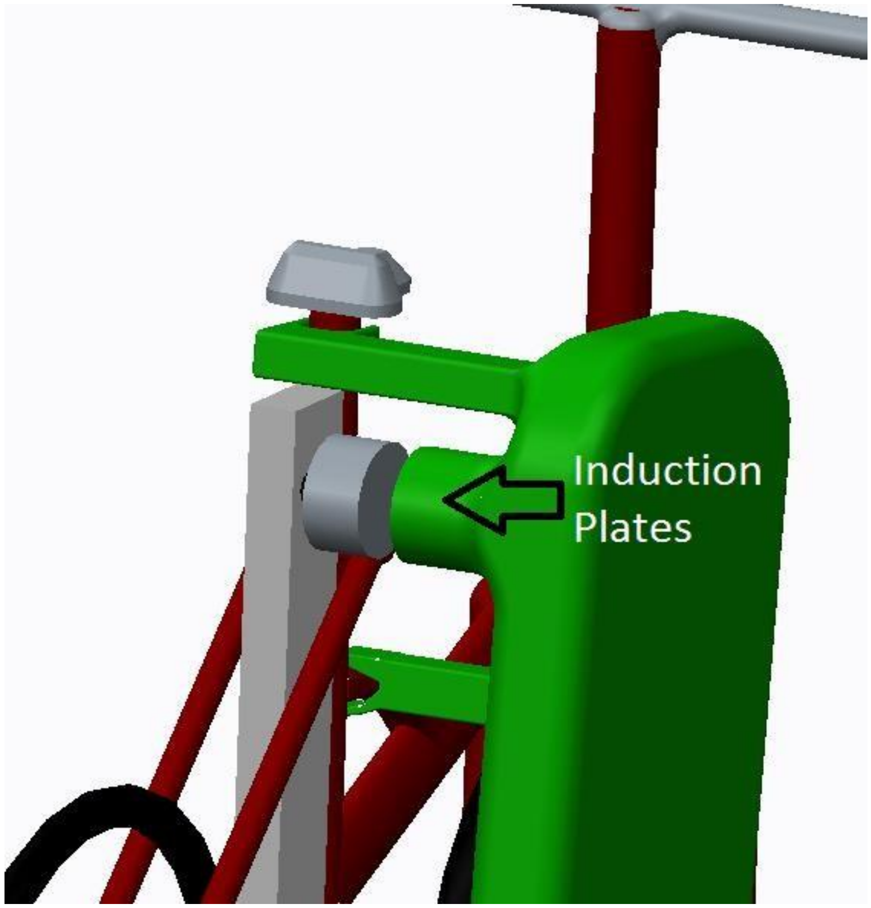


Figure 10

3.4 Power Conversion

The input voltage of the system is assumed to be an 110V 60Hz AC signal. This needs to be stepped down to a 36V DC signal with up to 3A current. In order to do so, the induction coils will act as a transformer to step the voltage down to approximately 36V. Then, inside the bike charging adapter will be a rectifier and filter to provide a near constant voltage. See Figure 10 for a generalized diagram of the overall circuit.

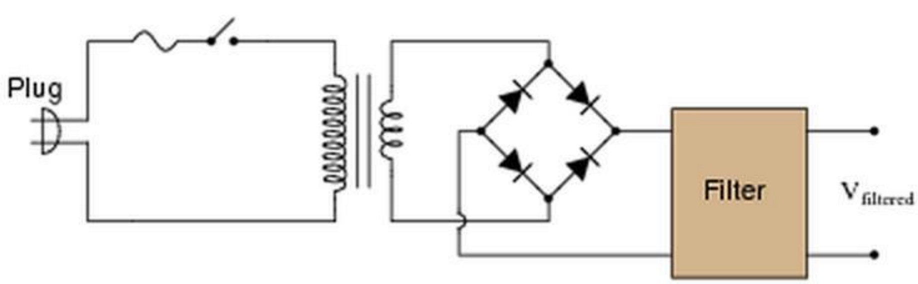


Figure 11 [7]

3.4.1 Transformer

The ratio of the voltages is almost exactly 3:1 for the input and output respectively. In the ideal situation of both coils being perfectly coupled, a turn-ratio of 3:1 would provide a sufficient stepped-down voltage. However, because a perfectly-coupled system is not attainable, the ratio will need to be lower in practice to account for magnetic leakage. For example, if after testing a 30% loss in efficiency is observed, the output would need to divide a voltage of 77V, so roughly a 2:1 turn ratio would be desirable.

3.5 Interfacing

The system interface that will control the locking and unlocking features is described below in the simple block diagrams in figure 5 and 6.

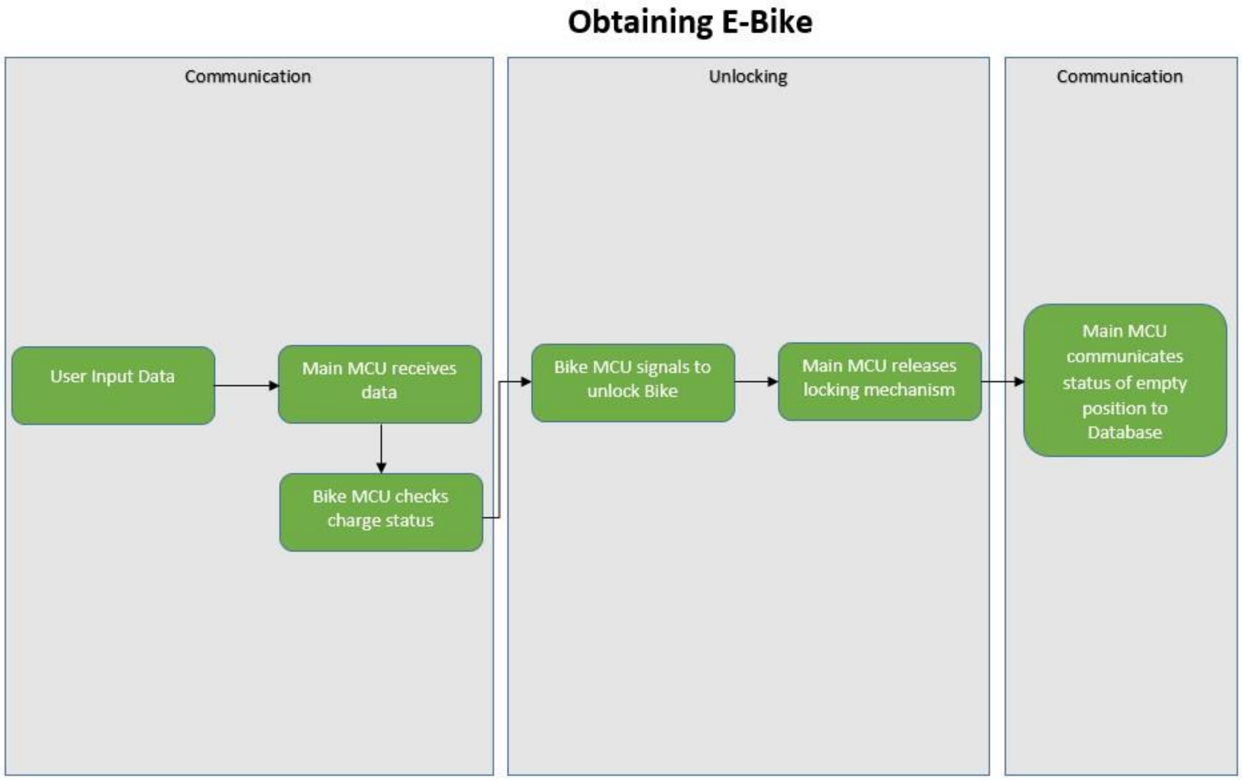


Figure 12

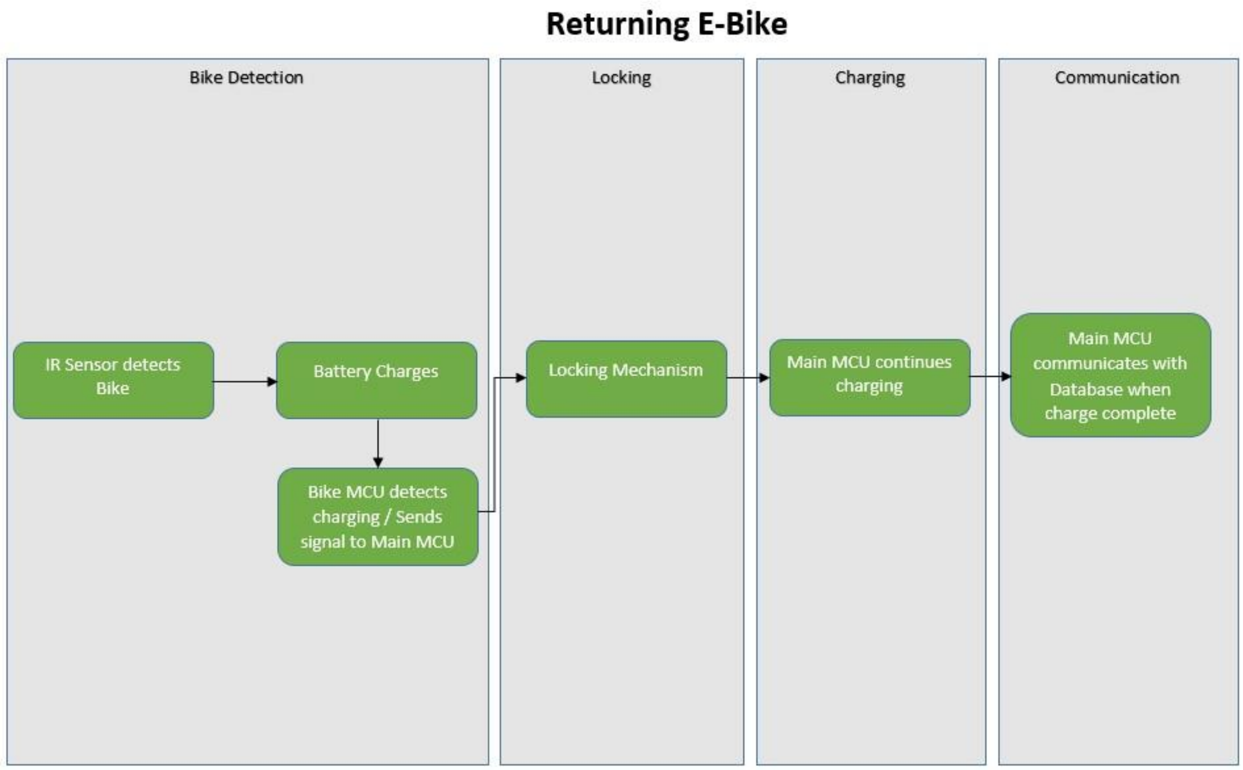


Figure 13

4 Statement of Work (SOW)

4.1 Task 1: Project Management

The project design work will be delegated to the area of expertise for each team member. The structure and design of the station components, mechanisms, and systems will be handled by the Mechanical Engineering team and their departmental resources. The electrical circuit and induction analysis and design will be handled by the Electrical Engineer team member. The programming and microprocessor modular design will be handled by the Computer Engineers on the team.

Seve Kim is in charge of ensuring that all deadlines are being met and the group work progression is stable. He will also be charge of developing the microcontroller and modular design of the station system and responsible for all components related.

Bilal Rafiq is in charge of the mechanical engineer portion of the team and overseeing the team’s communication and priorities are carefully organized and kept up to date.

The mechanical design and planning of the station is also in his job description and will be working closely in developing and testing that portion of the development.

Bryan Castro is in charge of managing the funds and money of the team, keeping good contact with the facility advisor as well as the project sponsor. He will be ordering and keeping track of the items purchased for production of the project. The inductance charging method will be the main goal of developing and testing for the project.

Jacob Knoblauch is the keeper of all documentation and setting meeting and presentation times for the group. He also will keep contact with the project sponsor and the faculty advisors. He is the primary coder for the user interface system and programming the necessary components.

Justin Johnson is in charge of being the supportive driver in making sure the team isn't falling behind. He is responsible for taking up tasks that a team member might not be able to finish in the given time. He is also in charge of developing the design of the mechanics as well.

4.2 Task 2: Component Selection

4.2.1 Objectives

The objective of selecting the components for the project is to address the needs and requirements of the project and prioritize them while maintaining the overall design of the end-product without having to sacrifice functionality for lower priority items.

4.2.2 Approach

Before any of the components for the charging and docking station are purchased, there will have to be at least three items presented to an advisor or resource that will determine which best fits the needs of the intended use and functionality. Other factors such as the price, weight, size, and energy consumption will all have to be taken into consideration and weighed depending on how the team wants to move forward.

4.2.2.1 Subtask 2.1: Microcontroller Selection

4.2.2.1.1 Objectives

The microcontroller that meets the requirements of the project would be a controller that has a digital output, digital or analog input, wireless sensor or receiver, wide range multiplexer, and good power rating.

4.2.2.1.2 Approach
The controller that would best fit our needs is one that is all inclusive but we can sacrifice the need for a sensor or receiver feature and just purchase that separately.

4.2.2.2 Subtask 2.2: Material Selection
4.2.2.2.1 Objectives
The material selected needs to provide weather resistance, in both high and low temperatures.

4.2.2.2.2 Approach
This subtask will be approached by analyzing and testing small amounts of materials that offers the needed requirements. Because material is not as expensive, they can be bought in samples to test and when it comes to selecting the proper material, they can be bought in bulk.

4.2.2.3 Subtask 2.3: Locking Method Selection
4.2.2.3.1 Objectives
The locking method needs to help secure the e-bike in place while also preventing the bike from being removed from the station.

4.2.2.3.2 Approach
The e-bike has many different areas to which it can be locked into place. The question is what kind of robotics or mechanism can be developed to efficiently accomplish the objective. The approach will be to make the strongest capable system with the fewest motors to ensure the bike is locked into place. The motor must toggle from motion to locked position so that no force can break the arm or motor.

4.3 Task 3: Design & Implementation
4.3.1 Objectives
Once the components are purchased and properly tested, the design and implementation step will be next. The objective is to make sure that all these components work seamlessly together as best as possible in an all-inclusive system.

4.3.2 Approach
The components will have to be small and easy to mesh together to provide a compact and easy access design during maintenance and troubleshooting situations.

4.3.2.1 Subtask 2.1: Inductance Charging

4.3.2.1.1 Objectives

The battery needs to be charged as fast as possible. The inductance component and circuit will have to be designed in such a way that the battery gets fully charged as quick as possible without damaging the battery or the components.

4.3.2.1.2 Approach

Calculating the specifications for the inductance coils will be vital to making an efficient transfer of power from the station to the e-bike. The windings of wire will determine the ratio and turns of the inductance system.

4.3.2.1.3 Test/Verification Plan

Different set-ups of coils and circuits will need to be tested and ensure the best design is getting applied to the final product. Multiple types of wire, including 22 gauge and lower, will be analyzed for best efficiency and safety, and various cross-sectional areas will be tested to find the optimal choice for the final design.

4.3.2.1.4 Outcomes of Task

Once the inductance component of the charging is addressed, that will be one of the needs and requirements completed. The station will then be a completely innovative way of charging the Efficient Systems bike.

4.3.2.2 Subtask 2.2: Docking

4.3.2.2.1 Objectives

The bike needs to be upright without the user having to hold anything in place.

4.3.2.2.2 Approach

The docking portion of the station includes guide rails for the wheels of the e-bike to follow easily into the station. The bike will have to be held up at some part of the seat post.

4.3.2.2.3 Test/Verification Plan

The bike will need to be stable with no external forces to help it stand. Stress tests will be done on the bike and station to ensure stability of the system.

4.3.2.2.4 Outcomes of Task

The bike will have a point of stability to charge and lock the bike in place without having the user maneuver the bike into a specific position. This eliminates the need for coordinated precision from the user.

4.3.2.3 Subtask 2.3: Locking

4.3.2.3.1 Objectives

The locking mechanism of the station needs a way to secure the e-bike in place without damaging the exterior of the e-bike or any of its components.

4.3.2.3.2 Approach

Since the bike is stable in an upright position from the docking, the locking mechanism only has to secure it to prevent movement of the bike undocking from the station. In the ideas presented, a clasp or claw mechanism seemed to best fit the needs of the system.

4.3.2.3.3 Test/Verification Plan

The strength of the lock would be tested by a measurement of forces against the locking arm and claw as well as making a protective layer around the lock to prevent vandalism.

4.3.2.3.4 Outcomes of Task

This will be the last big requirement for the station and provides ultimate security for the e-bikes.

5 Risk Assessment

5.1 Loss of Bike(s)

Risk: Because the E-Bike station will ideally be entirely automated, security is a major issue for the system. If not properly designed to be secure and robust, the bikes could potentially be stolen, which is of particular concern because the electric bikes are the majority of the cost of the entire system.

Solution: Much consideration has and will be put into providing a design that prevents theft of the bikes by creating a strong locking mechanism that cannot be tampered with. Furthermore, multiple checks will be run to verify that a bike is allowed to be unlocked when requested and that a bike is in the correct position when locking (preventing users from activating the locking mechanism and walking away with the bike).

5.2 Damage to Station

Risk: Because the bike station will more than likely be in a reasonably accessible area, damage from vandalism or simply improper usage must be a consideration. If the housing is not structurally sound, it could be bent, dented or broken due to accidental or intentional misuse.

Solution: Materials will be chosen based on what is less likely to be bent or broken. Welding's and other joints will be put under stress tests to ensure they can hold up to abuse.

5.3 Power System Failure

Risk: In the situation of a power outage or the power supply to the station being cut off, two major risks could result: First, the locking mechanisms may be compromised depending on their design and whether they need constant power to stay locked. Second, the microcontrollers could boot up incorrectly when powered back on, which could potentially prevent any docking, undocking, and/or charging from occurring.

Solution: The locking mechanism chosen will be one that requires no power in its locking state specifically to prevent theft of the bikes during loss-of-power situations. The microcontrollers will have their program instructions and any important data saved to static memory such as FLASH in order to ensure that they work properly in the case that a power outage occurs, or in the case of the bike MCU, the battery is fully discharged and no longer can supply power to the microcontroller.

5.4 Component Failure

Risk: In any mechanical and electrical system, individual components and connections are susceptible to failure. For instance, if one of the wires in the main line housing shorts, then one of the stations will be rendered unusable. If the individual stations are not built properly, parts could fall off or be removed, potentially compromising essential parts of the system.

Solution: As much emphasis as possible will be placed on acquiring reliable components that are not susceptible to failure. Materials have been selected that are strong and durable rather than simply cheap and/or easy to manufacture. Electrical components will be chosen based on their history of reliability.

5.5 Overcomplicated Design

Risk: Because there is a high priority on user-friendliness, a potential pitfall would be that the design becomes too complicated and fails to provide a seamless interface between the user and the rental of a bike. Physical limitations could make automatically locking and charging the bike difficult or even unfeasible.

Solution: In every design decision made, the first priority has and will be to find a solution that is as user-friendly as possible. Much of the testing of components will be to assure that the design is seamless and easy-to-use.

6 Qualifications and Responsibilities of Project Team

Task	Assignment	Skills and Knowledge
1	Seve Kim	EM fields and RF techniques
2	Bilal Rafiq	Material selection and testing
3	Jacob Knoblauch	Computer programming and simulations
4	Bryan Castro	Power Systems design
5	Justin Johnson	Mechanical system and model construction

SEVE DAERYONG KIM

sevedkim@gmail.com
727.631.1551

2341 Yorkshire Drive
Tallahassee, FL 32304

Education

Florida State University — Tallahassee, FL
FAMU-FSU College of Engineering — May 2015
Bachelor of Science, Computer Engineering

Relative courses:

C/C++ Programming I	Object Oriented Programming	Introduction to Unix
Microprocessors	FPLDs	Circuits I & II
Signals & Systems	Digital Logic	Abstract Algebra

Computer Skillset

- C/C++ Programming
- Object Oriented Programming
- Basic Unix scripting
- Assembly language
- VHDL
- Adobe Photoshop
- Adobe Illustrator
- MS Office (Word, Excel, PP)
- Basic MATLAB
- Multisim

Experience

Datamaxx Group — Tallahassee, FL
Software Quality Assurance Intern — September 2014 – Present

Involvement

Presidential Search Advisory Committee — March 2014 – Present
Undergraduate Representative — Florida State University

- Listen & analyze the student needs & opinions through forum
- Deliberate & debate on effective ideas and qualities of an ideal candidate

66th Student Senate — May 2014 – Present
Student Senator: Engineering seat — FSU Student Government Association

- Vote on funding bills & legislative resolutions after pro/con discussion
- Interview and forward candidates applying for various SGA branches for Internal Affairs
- Improve the student experience by identifying student issues and resolving them

Asian American Student Union — August 2011 – April 2014
Director (2013) — FSU Student Government Association

- Led the planning of social, cultural, informative & service programs for the student body
- Advocated for Asian Pacific American students by addressing their welfare & concerns
- Managed executive board by delegating tasks & tracked progress by effective communication

Achievements

2013-2014 Agency Director of the Year
Seminole Torchbearers Recipient
Garnet & Gold Key Leadership Honorary

BILAL RAFIQ

Bdr11b@my.fsu.edu • Mobile: (954)-881-8734
2305 Skyland Dr. Tallahassee, Florida. 32303

MECHNICAL ENGINEERING UNDERGRADUATE

Highly motivated engineering student looking for a full-time position in a high quality engineering environment / platform where my academic skills will add value to organizational operations. Very eager to obtain a position which offers key participation, team oriented tasks, immediate challenges, and future career opportunity

AREAS OF EXPERTISE

Physics - Differential Equations - Engineering Mechanics - C++ - Mechatronics - Statics Experimental Fluids - Dynamics - Mechanics of Materials - Thermo-fluids - Fluid Dynamics - Mechanical Systems - Material Science

EDUCATION

Bachelor of Science in Mechanical Engineering – Florida State University –Tallahassee, Fl. Grad Date 5/2015
Minor in Mathematics and Physics – Florida State University –Tallahassee, Fl. Grad Date 5/2015

PROFESSIONAL EXPERIENCE

CITY OF OAKLAND PARK , OAKLAND PARK, FLORIDA Nov. 2012 to Jan. 2013

ENGINEERING / COMMUNITY DEVELOPMENT –VOLUNTEER

- Helped manage the city's capital improvement program with the Director of Development.
- Oversaw planning and zoning division protocol and requirements.
- Understanding and distributing engineering permit applications.
- Coordinating program activities for the development of private property.

ENGINEERING PROJECTS

Thermal-Fluids

- Designed, built, and tested a portable refrigeration system that is compatible for items of multiple geometries.

Mechatronics

- Computer programmed a three wheeled robot to map out and navigate a course while avoiding or moving obstacles into a specific pattern.

Senior Design

- Team leader for designing an electric bike docking and charging station for Efficient Systems LLC.

TECHNICAL CAPABILITES

Experience with Microsoft Office XP – Excel/ PowerPoint/Word/Outlook/Publisher
-Pro Engineering, -PTC Mathcad MATLAB and CodeBlocks, -C++ and C , -Working Model

REFRENCES

- Available upon request

Bryan Zachary Castro

1436 Cedar Lake Dr. Orlando, FL 32824, (321) 945-2352
bzc10@my.fsu.edu

Objective:

Seeking a full-time position where I will utilize my analytical and engineering skills to advocate personal growth and career development, while furthering the organization.

Education:

Florida State University, Tallahassee, FL
Bachelor of Science in Electrical Engineering
GPA: 3.26 Expected graduation date: 5/2015

Cypress Creek High School, Orlando, FL
International Baccalaureate and High School Diploma, 5/2010

Experience:

Florida State University Office of Admissions, Tallahassee, FL **1/2011-Present**
Communications Assistant

- Edit and proof student applications using Talisma and CICS Programs
- Organize incoming applications for the university

Owens Corning, Amarillo, TX **5/2014-8/2014**
Intern

- Analyzed the advantages/disadvantages of a new fiberglass cooling process
- Performed trials for new products and improved processes
- Conducted quality tests on products to ensure correct specifications
- Supported customer complaint investigations

BMW Manufacturing Co., Greer, SC **1/2013-8/2013**
Intern

- Oversaw $4 million Associate Belt Conveyor project alongside Sr. Project Manager
- Coordinated and implemented planning for three plant wide shutdowns
- Conducted several time studies of technical equipment in the assembly hall
- Tracked the status of several plant expansions through constant contact with contractors
- Updated and analyzed downtime/faults for various technical equipment in the assembly halls

Center for Advanced Power Systems (CAPS), Tallahassee, FL **5/2012-12/2012**
Laboratory Research Assistant

- Assembled equipment and wires to be used for research experiments
- Assisted in setting up and running experiments
- Organized the laboratory after experiments were conducted

Groovy Dancing, Orlando, FL **5/2011-7/2011**
Sales Associate

- Promoted and sold all video products to customers
- Managed cash register and tracked all sales for the day

Activities/Honors:

- Institute of Electronic and Electrical Engineers (IEEE)
- Honors Student Association
- FSU Wrestling Club
- Dean's List- 4 semesters
- INROADS Internship Candidate

Technical/Non-Technical Skills:

- Microsoft Word, Excel, Power Point, Outlook
- C, C++, VHDL, MATLAB, NI Multisim, Talisma, CICS Program
- Fluent in Spanish, Conversational in German

Justin Leon Johnson
850-258-8980
jlj11d@my.fsu.edu
2537 Verrata Drive
Tallahassee, Fl, 32304

Objective: Seeking internship for Mechanical Engineering field.

Academic Preparation:

Florida State University
- April 2013
- Tallahassee, FL
  - BS degree achievement in progress

Chipola College
- Graduated May 2011
- Marianna, FL 32446
  - Earned AA degree

Experience:

United States Marine Corps
- USMC Officer Candidate
  - Aviation Component

McCormicks Deli
- August 2011 to August 2012
- Tallahassee, FL 32304
  - Catering and team member

Pizza Hut
- July 9, 2010 to May 22, 2011
- Chipley, FL 32428
  - Delivery Driver and Team Member

PBS & J
- October 2008 to May 2009
- Chipley, FL 32428
  - Engineering Internship
  - Errands and scanning

Computer Skills:
- Microsoft Office (Word, Excel, Power Point and Access)
- Pro Engineering and PTC design software
- Matlab ,CodeWarrior,Codeblocks, and C++ Programming
- Embedded system programming
- Mechatronic systems and microcontrollers

Other:
- Familiar With: Physics, Calculus, Mechanical Systems, Thermal Fluids, Aerodynamics
- Familiar with Heavy Machinery and Tools
- Member of AIAA (American Institute of Aeronautics and Astronautics)

Jacob Knoblauch
874 Conrad Hills Rd, Havana, FL 32333

850-566-3764 email: jmknoblauch@bellsouth.net

EDUCATION:

Bachelor of Science, Computer Engineering Degree anticipated Fall 2015
Florida State University
Current GPA 3.95

Associate of Arts, Fall 2012
Tallahassee Community College
4.0 GPA

EXPERIENCE:

Student Intern Tutor, November 2011 to June 2014
Florida Virtual School

- Tutored students in grades 6 through 12 on subjects of math and science.

Tutor, August 2014 to present
Florida State University

- Tutoring in subjects of College Algebra through Calculus 3

Private Tutor, August 2013 to present

- Tutoring in subjects of College Algebra and SAT/ACT prep.

Assistant Instructor, November 2007 to April 2011

- Assistant instructor for Alpha UPKUDO Karate School, Tallahassee, FL.

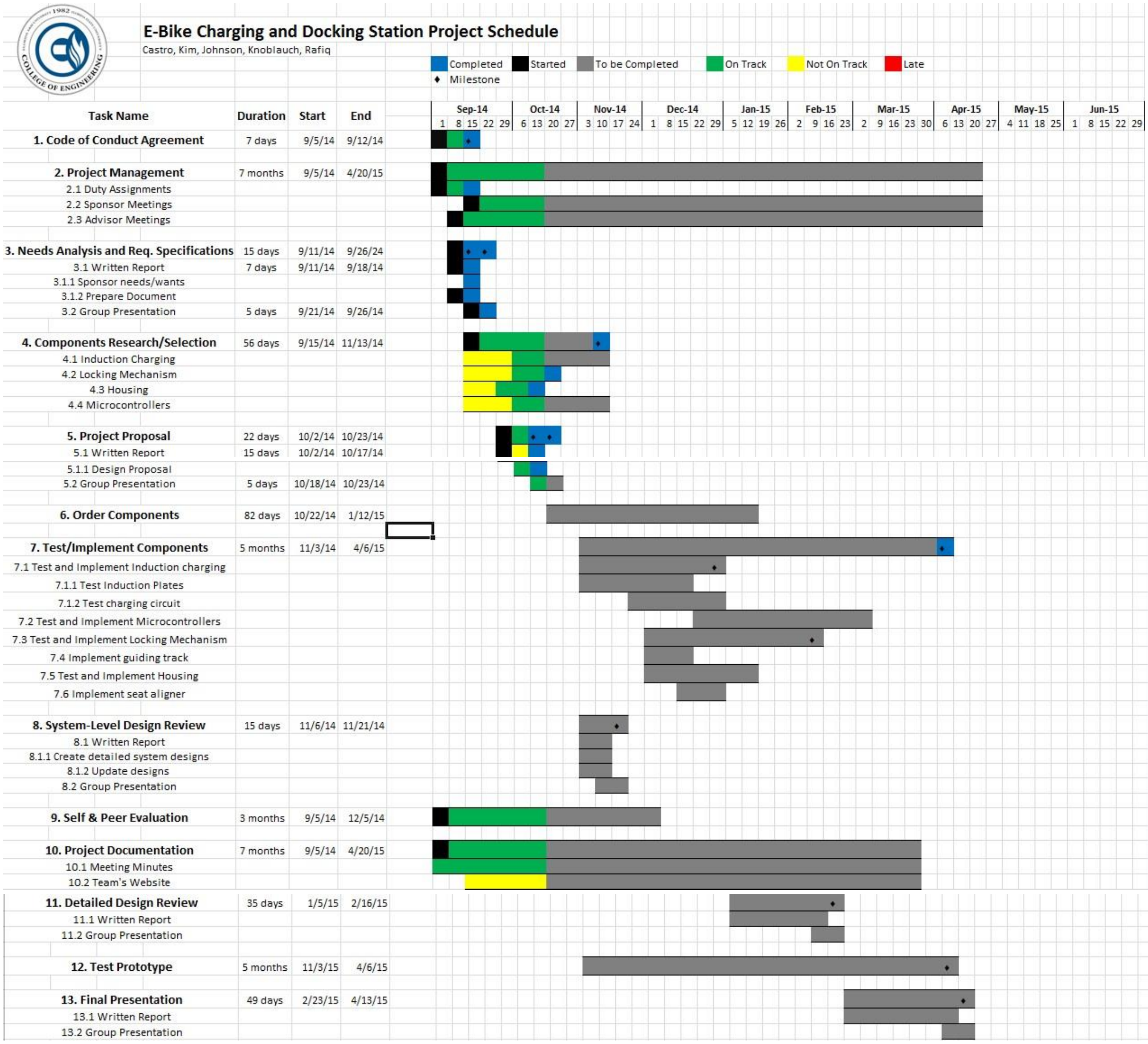
Instructor, April 2011 to Present

- Black Belt instructor for Alpha UPKUDO Karate School, Tallahassee, FL.

AWARDS AND ACHIEVEMENTS

- President's List - Fall 2010, Spring 2011, Fall 2011, Spring 2012, Summer 2012, Fall 2012, Spring 2013
- Dean’s List - Fall 2013
- Superior rating in National Fraternity of Student Musicians Guild Auditions – 2001 through 2011
- First Degree Black Belt in UPKUDO Karate with 7 years of experience

7 Schedule



8 Budget Estimate

A. Personnel			

Engineer	**Hours**	**Hourly Pay**	**Total Pay**
Bryan Castro	348	$30.00	$10,440.00
Seve Kim	348	$30.00	$10,440.00
Bilal Rafiq	348	$30.00	$10,440.00
Justin Johnson	348	$30.00	$10,440.00
Jacob Knoblauch	348	$30.00	$10,440.00
		Personnel Subtotal	**$52,200.00**
B. Fringe Benefits		**29% of Personnel**	**$15,138.00**
C. Total Personnel			**$67,338.00**
D. Expenses			
Item/Description	**Quantity**	**Price/Unit**	**Total Price**
Galvanized Steel Sheet (32 ft.^{2})	1	$130.00	$130.00
Four-Bar Robotic Claw Arm	1	$50.00	$50.00
Worm Drive Gearbox	1	$60.00	$60.00
81 RPM Gear Motor	1	$25.00	$25.00
Microchip PIC Ethernet Board w/ RS232 & Web-Based Configuration	1	$72.00	$72.00
Arduino UNO	1	$18.50	$18.50
22 AWG Copper Magnet Wire (1 lb, 507 ft)	1	$16.50	$16.50
14 AWG Copper Wire (25 ft)	1	$14.00	$14.00
LED R/Y/G	1	$2.75	$2.75
		Expenses Subtotal	**$388.75**
E. Total Direct Costs		**Personnel + Expenses**	**$67,726.75**

F. Overhead Costs		**45% of Direct Costs**	**$30,477.04**
G. Total Project Cost			**$98,203.79**

9 Deliverables

The final deliverable of the project will be a working prototype of a user-friendly and efficient docking and charging station for an electric bicycle. The design will fit all the requirement specifications given by Efficient Systems, LLC and will be assembled using the provided budget. The station's main components will include: inductance charging, a locking mechanism, and communication with the company's database. The prototype will be able to pass all testing and will be susceptible to a minimal amount of risks. All project reports and design reviews will be a fundamental deliverable at the end of the year. Also, all major components of the design will have a block diagram of the system implemented, as well as CAD drawings. If the design of the project results in pursuing a patent, all appropriate measures will be taken with Efficient Systems, LLC.

10 References

[1] J.A. Marin, J.E. Armstrong, and J.L. Kays, “Elements of an Optimal Capstone Design Experience,” Journal of Engineering Education, January 1999, pp. 19-22.

[2] http://www.engineeringtoolbox.com/thermal-conductivity-d_429.html

[3]http://www.engineering.com/Library/ArticlesPage/tabid/85/ArticleID/113/CommonMaterial-Properties.aspx

[4] http://robosavvy.com/store/product_info.php/products_id/1593

[5] http://www.metalsdepot.com/

[6] http://letsmakerobots.com/content/new-mkii-robot-gripper-dagu

[7] http://www.allaboutcircuits.com/worksheets/supply1.html

11 Appendices

Appendix A: Battery Specifications