HACETTEPE UNIVERSITY
COMPUTER ENGINEERING DEPARTMENT

UNDERGRADUATE PROJECT PROGRESS REPORT - 1

Project Name	Report Date
Ball Balancing PID System	04.11.2017

Student Number(s)	Student Name(s)
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Supervisor(s)	**Company Representative(s)**
Prof. Dr. M. Önder EFE	

Project Coordinator	Report Approval
Ayça TARHAN Date: 04.11.2017	☒Yes ☐ No If no, rational of rejection: _____

A. TECHNICAL SPECIFICATION

I. INTRODUCTION

The main purpose of the project is to develop a ball balancing system to keep a ball balanced on a plate using a microcontroller and related control algorithm to adjust the servo motors with real-time feedback.

II. FUNCTIONAL PRODUCT REQUIREMENTS

-System shall implement PID controller.
-System shall balance the ball by using PID.
-System shall recognize the ball by using inputs coming from camera.
-User shall be able to select controller calculation modes which are P, I, D and balancing modes which are rectangle, infinity, normal.
-System shall calculate PID in Arduino MEGA.

III. PRODUCT QUALITY REQUIREMENTS

Quality requirements of this product;
-Should be stable (Low shaking at balance point).
-Should respond quickly.
-The ball should be balanced at equilibrium point quickly without swinging too much.
-Overshooting should be minimum.

IV. PRODUCT INTERFACES

Servo motors are attached to Arduino with one of the Digital I/O port on the Arduino and 5V, GND.
Arduino is attached to PC via USB cable to send commands to Arduino.
For different modes, we use PC keyboard 'C' to change.

V. PRODUCT CONSTRAINTS

-Camera should capture images in binary format and low resolution to get the ball's position faster.
-At least two servo motors are necessary to build this ***2DOF*** system.
-***Servo.h*** library has to be used while programming arduino. This library allows us to control servo motors.
-Since arduino is used as a microcontroller, pid implementation language should be ***C++.***

VI. PRODUCT COMPLIANCE

It uses Computer Vision library Python version of OpenCV which is an open-source library. Other than that, it is compatible for every operating-system, and the system is implemented by us, so there is no other compliance.

B. PROJECT PROGRESS

I. CHANGES TO PROJECT PLAN

We have not made any change on the project plan from the time submit of proposal 1. However, because we have not had trouble with the slowness of the project, we have not bought a touchscreen yet. Unless the image processing process work as we have planned, we do not plan to buy a touchscreen.

II. PROGRESS OF PROJECT MILESTONES AND OBJECTIVES

Milestone #	Primary Objective	Due Date	Project Deliverable (if any)	Milestone Achieved?
1	Detecting the position of the ball by using OpenCV	Nov 3	--	Yes
2	Implementing the PID System and mechanics to arduino	Dec 1	Prototype of the project	Not yet
3	Converting the working principle of the project computer to arduino	Dec 29	Final project delivery	Not yet

III. PROGRESS OF PROJECT PRACTICES AND MEASURES

Task #	Task Description	Responsible Team Member	Start Date	Finish Date	Success Criteria	Task Succeeded?
1.1	Mathematical modelling of system	*Hülya Şermin *Ufuk Şentürk	16.10.2017	03.11.2017	Observing the mathematical models of the system by graphs	Successfully done
1.2	Physical modelling of system	*Emre Dağıstan	16.10.2017	23.10.2017	Completing the visual models of the project	Successfully done
2.1	Learning computer vision (OpenCV) methods	*Hülya Şermin	16.10.2017	03.11.2017	Being able to use Computer Vision methods	Successfully done
2.2	Learning the concepts of the servo motors	*Emre Dağıstan	16.10.2017	03.11.2017	Being able to use servo motors by arduino programming	Successfully done

3.1	Connecting servo motors to arduino	*Emre Dağıstan	03.11.2017	13.11.2017	Completely connecting servo motors with X and Y axis movements.	Servo motors connected but don't represent X and Y axis yet
3.2	Arduino programming					
3.2.1	Linking the position values coming from camera to arduino	*Hülya Şermin	03.11.2017	13.11.2017	Arduino should understand the position of the ball with minimum delay	---
3.2.2	PID system programming	*Ufuk Şentürk	03.11.2017	01.12.2017	The servo motors should be able to balance the ball by the values coming from camera	---
3.2.3	Using of servo motors by arduino programming	*Emre Dağıstan *Hülya Şermin	13.11.2017	20.12.2017	The servo motors should make their job by the calculations of the PID system	---
3.3	Physical montage of the project	*Emre Dağıstan	20.12.2017	01.12.2017	The physical montage of the project should be complete	---
4.1	Performance and optimization savings	*Ufuk Şentürk	01.12.2017	29.12.2017	The performance and optimization saving which will observe during project process should improve	---

Team Member	**Task # Under Responsibility**	**Description of the Work Done**
*Hülya Şermin *Ufuk Şentürk	Mathematical modelling of system	Calculating physical equations of systems such as kinetic energy of ball, inclination of plate with servo motors by using physical model of system.
*Emre Dağıstan	Physical modelling of system	A physical model of the system provided in figures. 2DOF shown clearly in these figures.

*Hülya Şermin	Learning computer vision (OpenCV) methods	Learning computer vision task is started with the working on the OpenCV library with using python. After that, the learning process evolved to looking to separating the colors in the camera datas. After that, for the task, process continued with working on the bitmap methods which detects the specific color other than in the screen. The implementation of those methods to the code and after all, the project is able to detect the ball in the screen.
*Emre Dağıstan	Learning the concepts of the servo motors	Concepts of servo motors learned successfully. This concepts includes working principle, advantages, disadvantages, types, characteristic and how to configure it.
*Emre Dağıstan	Connecting servo motors to arduino	Servo motors connected to arduino and ruled successfully

IV. PROGRESS OF PROJECT BUDGET

Item #	Description of Income	Date of Income	Planned Amount	Actual Amount	Amount Difference
1	Money collected from each team member	19.10.2017	240 □	115 □	125 □
2.	Sponsorship / not agreed yet.	--	115□	--	--

Item #	Description of Expense	Date of Expense	Planned Amount	Actual Amount	Amount Difference
1	Arduino Mega	21.10.2017	85 □	45 □	40□
2	Jumper / Krokodil	21.10.2017	10 □	15 □	5□
3	Servo Motor x 2	21.10.2017	30 □	20□	10□
4	Camera	21.10.2017	30 □	25 □	5□
5	Platform	21.10.2017	10 □	10 □	---

Overall Balance	Planned Amount	Actual Amount	Amount Difference
Income	240 □	240 □	0 □
Expense	240 □	115 □	125 □
Total	0 □	125 □	125 □

V. PROGRESS OF PROJECT RISKS

Risk Item #	Description	Probability	Effect	Did It Happen?	How did you (or will you) handle its occurrence? (Plan-B)
1	Miscommunication between team members	Medium	Medium	No	We meet right after the previous delivery and make a plan of the new tasks' process to handle that risk.
2	Lateness of the income	Low	High	No	To handle this risk, we are planning to gather money two day before the expense day.
3	Delay of the reaching time of position values which comes from the camera	High	High	No	To handle this risk, we are planning to make performance optimizations. In the worst case, we are planning to make project by using touchscreen.
4	Final delivery takes longer than expected	Low	High	No	To handle this risk, we will try to finish tasks two days before delivery date.
5	Specification breakdown of a team member	Medium	Medium	No	To handle this risk, we started to plan and manage the software at the very beginning of the project.

VI. PROGRESS OF RESEARCH AND DEVELOPMENT (R&D) ACHIEVEMENTS

While we work on OpenCV, we try to add some R&D features to project. Distinguished from other ball balancing systems, our project works with image processing and computer vision techniques instead of touchscreen and sensors.

In addition, we are planning to add some modes like path following feature of the ball to carry project into different place after ball balancing PID system finishes.

VII. OVERALL PROGRESS OF YOUR PROJECT

From the beginning of the project development process, we could work together easily with the balanced work sharing and good communication. Also, we tried to help each other when one of us had some trouble with his/her task.

Besides, we are planning to make a sponsorship agreement, but we have not completed it yet. We still keep in touch with the companies and we hope to find a sponsor for the project.