HACETTEPE UNIVERSITY
COMPUTER ENGINEERING DEPARTMENT

UNDERGRADUATE PROJECT PROGRESS REPORT - 2

Project Name	Report Date
Ball Balancing PID System	02.12.2017

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: 02.12.2017	☒ Yes ☐ No If no, rational of rejection: _____

A. TECHNICAL PROGRESS

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. ARCHITECTURAL GOALS

Main idea is that calculating PID with received position of the ball to balance the ball. To do that, we will implement mechanical architecture that is moved by calculations are made in the software.

- System shall move along the x-axis and y-axis. Servo motors and u-joint are used for this purpose.
- System shall detect position of the ball. Camera and OpenCV library(native Python) are used.
- Servo motors shall move the arm with given angle. Arduino is used for connection between computer and servo motors with serial USB port.
- PID calculations must be made to balance ball. PID is implemented in Python.

Critical points are setting threshold value to identify ball correctly and constructing solid physical system. If Arduino is changed with any other processor, big part of implementation remains same.

III. ASSUMPTIONS AND DEPENDENCIES

- Arduino is an open-source electronics platform based on easy-to-use hardware and software. It is easy to use and cheap so good tool to start with.
- Python is one of the most popular scripting programming language. It can be used to implement anything desired and can run almost every machine.
- Other mechanical parts of the system can be found and implemented.
- Things mentioned above are chosen by our experience. We tried to be pick efficient and easy to learn tools.

IV. DECISIONS, CONSTRAINTS, AND JUSTIFICATIONS

- It was decided that calculations should be done on the computer because arduino mega can not handle that much process.
- In the physical modelling, the plate should be as light as possible because each sg90 servomotor can only carry 1kg.
- Image, that captured by camera, converted to binary image. In this way, algorithm will response quicker and ball position will obtained precisely.
- The servomotors are connected at the center of the plate edges, so each servomotor directly represents X and Y axis.

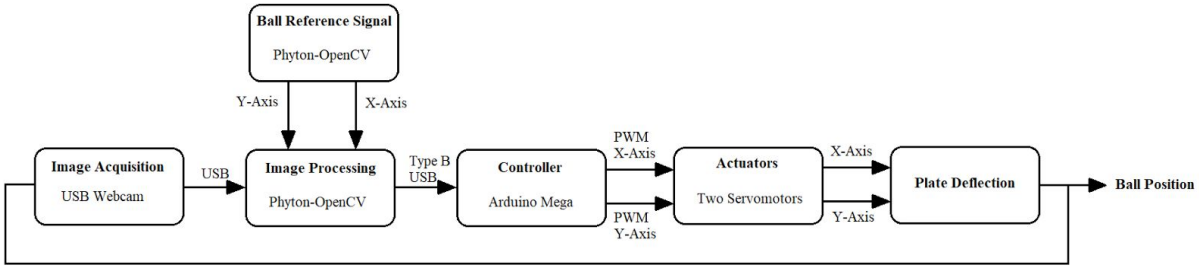
V. ARCHITECTURAL MECHANISMS AND KEY ABSTRACTIONS

Architectural Mechanism 1: Calculating PID. With given reference point and ball positions, system calculates PID and send angles information which servo motors will do.
Architectural Mechanism 2: Detecting ball with OpenCV. System detects a ball with certain color which is adjusted by threshold value and sends position information.
Architectural Mechanism 3: Moving servomotor arms. System sends an angle information to Arduino via USB port and Arduino moves the servo motors.

VI. LAYERS OF ARHITECTURAL FRAMEWORK

This project includes hardware implementation of Proportional-Integral-Derivative (PID) architecture using arduino for the position control of servomotors. Closed loop system is simulated using Phyton. Comparison of simulation results with the experimental results will show the efficacy of the proposed PID design.

VII. ARCHITECTURAL VIEWS



B. PROJECT PROGRESS

I. CHANGES TO PROJECT PLAN

Project plan has not been changed since initial plan.

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	Yes
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	Responsibility	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.	Successfully done
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	Successfully done
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	Successfully done
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	Successfully done
3.3	Physical montage of the project	*Emre Dağıstan	03.12.2017	29.12.2017	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 Karakaş	Linking the position values coming from camera to arduino	The position of the ball was detected in the previous delivery. In this delivery, The position values which coming from python code linked to Arduino. While doing that, the serial port of the Arduino is used to real time value transfer.
*Ufuk Umut Şentürk	PID system programming	Received positions of the ball are used as input for PID model and different reference points for different modes are set to calculate feedback in the system.
*Emre Dağıstan	Connecting servo motors to arduino	Servomotors connected to arduino and represent X and Y axis
*Emre Dağıstan *Hülya Şermin Karakaş	Using of servo motors by Arduino programming	Servomotors which are connected to arduino were rotated with values that coming from openCV using serial port.

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.