HACETTEPE UNIVERSITY
COMPUTER ENGINEERING DEPARTMENT

UNDERGRADUATE PROJECT PROPOSAL

Project Name	Proposed Term
Ball Balancing PID System	2017 Fall

Student Number(s)	Student Name(s)
21427435 21327862 21591198	Ufuk Umut ŞENTÜRK Emre DAĞISTAN Hülya Şermin KARAKAŞ
Supervisor(s)	**Expertise Area(s)**
Prof. Dr. M. Önder EFE	☒ Software ☒ Hardware ☐ Computer Science ☐ Other _____

Owner(s) of intellectual property	Does the Project require ethics approval?
☒ Student(s) ☐ Supervisor(s) ☐ Company	☐ Yes ☒ No
Company Representative	**Is the Project supported by a formal body?**
Company Name: Contact Name: Contact Email:	☐ Yes ☒ No If yes, name of body: _____

Project Coordinator	Proposal Approval
Ayça TARHAN Date: 13.10.2017	☒ Yes ☐ No If no, rational of rejection: _____

A. PROJECT VISION

I. PROJECT SUMMARY

Balancing a ball on the plate with camera which sends position of the ball to the Arduino which calculates PID and adjusts servomotors to balance a ball.

II. PRODUCT FEATURES

-Image Processing

-Balancing ball on the plate by using PID (Partial, Integral, Derivative) controller

-Using Arduino as microcontroller

III. SUMMARY OF STATE-OF-THE-ART

Since the foundation and up to the current state-of-the-art in control engineering, the problems of PID control steadily attract great attention of numerous researchers and remain inexhaustible source of new ideas for process of control system design and industrial applications. PID control effectiveness is usually caused by the nature of dynamical processes, conditioned that the majority of the industrial dynamical processes are well described by simple dynamic model of the first or second order.

There are some of the recent research articles on PID control system;

- Predictive PID Control of Non-Minimum Phase Systems [1]
- PID Controller Using FPGA Technology[2]
- PID Application: RTLS [3]
- PID Tuning: Robust and Intelligent Multi-Objective Approaches[4]
- Air-Conditioning PID Control System with Adjustable Reset to Offset Thermal Loads Upsets[5]

IV. INNOVATIVE ASPECTS

We will use camera to perceive position of the ball on the plate so we do not need any other sensor.

V. POTENTIAL CONTRIBUTION(S) TO INDUSTRY AND ECONOMY

PID loops are one of the simplest yet most effective means to achieve that control on almost anything measurable and regulable e.g pH, temperature, pressure, flow rate, speed, level, position.

A PID controller improves process efficiency, operability, and compliance for sustainable manufacturing. The main benefit of any PID loop is that a designer can "set it and forget it" while still maintaining a well-regulated system. If PID didn't already exist, factory automation would be very limited.

VI. TECHNOLOGIES TO DEVELOP/USE AND UNIQUE ACHIEVEMENTS

1. OpenCV
2. Arduino
3. Matlab
4. Resistive touchscreen
5. Servo motor

VII. METHOD TO FOLLOW

Planning : Planning schedule, risks, resources. This phase marks a clear assignment, responsibility for project team members.

Modelling : Mathematical and visual modelling of project.

Implementing : Implementing required algorithm to modelled structure.

Monitoring and Control : Collecting progress updates, test results and discussing by team members on each stage.

VIII. REFERENCES

- http://www.machinedesign.com/sensors/introduction-pid-control Accessed 13 October 2017
- https://link.springer.com/chapter/10.1007/978-1-4471-2425-2_14 Accessed 13 October 2017
- http://zilicus.com/Resources/blog-2014/6-Steps-To-Effective-Project-Management.html Accessed 13 October 2017
- Fırat Tansu, Teksav Teknoloji A.Ş. R&D Engineer, Control Engineer, Mechatronic Engineer
- [1] Kenny Uren and George van Schoor (2011). Predictive PID Control of Non-Minimum Phase Systems, Advances in PID Control, Dr. Valery D. Yurkevich (Ed.), InTech, DOI: 10.5772/18888.
- [2] Abdesselem Trimeche, Anis Sakly, Abdelatif Mtibaa and Mohamed Benrejeb (2011). PID Controller Using FPGA Technology, Advances in PID Control, Dr. Valery D. Yurkevich (Ed.), InTech, DOI: 10.5772/18295.
- [3] Jae Ho Hwang and Jae Moung Kim (2011). PID Application: RTLS, Advances in PID Control, Dr. Valery D. Yurkevich (Ed.), InTech, DOI: 10.5772/22720.
- [4] Hassan Bevrani and Hossein Bevrani (2011). PID Tuning: Robust and Intelligent Multi-Objective Approaches, Advances in PID Control, Dr. Valery D. Yurkevich (Ed.), InTech, DOI: 10.5772/20717.
- [5] Takanori Yamazaki, Yuji Yamakawa, Kazuyuki Kamimura and Shigeru Kurosu (2011). Air-Conditioning PID Control System with Adjustable Reset to Offset Thermal Loads Upsets, Advances in PID Control, Dr. Valery D. Yurkevich (Ed.), InTech, DOI: 10.5772/18818.

B. PROJECT PLAN

I. PROJECT GOALS

The goal of this project is to develop a ball and plate balancing system to observe the PID system on a real-time hardware which is specified for ball and plate by usage of computer vision techniques.

II. PROJECT ORGANIZATION

We are planning to develop the project with minimum major subject mastering. We are trying to do separate the main task into 3 parts. The project has both software and hardware parts. In addition, three of us will be in both parts.

The group has 3 member.

1. Emre Dağıstan - Developer / System Administrator
2. Hülya Şermin Karakaş - Developer / Project Manager
3. Ufuk Umut Şentürk - Developer / Tester

III. PROJECT MILESTONES AND OBJECTIVES

Milestone #	Primary Objective	Due Date	Project Deliverable
1	Detecting the position of the ball by using OpenCV	Nov 3	--
2	Implementing the PID System and mechanics to arduino	Dec 1	Prototype of the project
3	Converting the working principle of the project computer to arduino	Dec 29	Final project delivery

IV. PROJECT PRACTICES AND MEASURES

Task #	Task Description	Responsible Team Member	Start Date	Finish Date	Success Criteria
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
1.2	Visual modelling of system	*Emre Dağıstan	16.10.2017	23.10.2017	Completing the visual models of the project
2.1	Learning computer vision (OpenCV) methods	*Hülya Şermin	16.10.2017	03.11.2017	Being able to use Computer Vision methods
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
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.
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 optimization saving which will observe during project process should improve

V. PROJECT BUDGET

Item #	Description of Income	Date of Income	Amount
1	Money collected from each team member	19.10.2017	240 ₺

Item #	Description of Expense	Date of Expense	Amount
1	Arduino Mega	21.10.2017	85 ₺
2	Touchscreen	21.10.2017	60 ₺
3	Servo Motor x 2	21.10.2017	30 ₺
4	Camera	21.10.2017	30 ₺
5	Platform	21.10.2017	10 ₺
6	Jumper	21.10.2017	10 ₺

VI. PROJECT RISKS

Risk Item #	Description	Probability	Effect	How to handle its occurrence? (Plan-B)
1	Miscommunication between team members	Medium	Medium	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	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	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	To handle this risk, we will try to finish tasks two days before delivery date.
5	Specification breakdown of a team member	Medium	Medium	To handle this risk, we started to plan and manage the software at the very beginning of the project.