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SELF BALANCING AUTONOMOUS ANDROID OPERATED MOBILE BOT

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ABSTRACT

We propose a economical semi-automated two wheeled robot with telepresence cum surveillance features using arduino nano and a Smart phone running an android operating system. These types of robots typically consist of a inertial measurement unit(gyroscope and accelerometer sensor) and a GPS/GSM module which together provides robots position in environment ,video camera provides vision and a wifi module for external interface. Android Smartphone comes with excellent hardware satisfying above needs. This can be leveraged by APIs(Application Programming Interface) provided by android operating system. Moreover the cost of building the above mentioned robot decreases to a great extent. Two wheels bots are popular as it takes minimal turn radius and are not power hungry. SEGWAY a personal transporter focuses on transportation application of TWSBR .We in this project focus on telepresence and automated telepresence applications of the same. We have used an android platform for sensor hardware and software development as it has great impact on cost and feasibility of project as new features are added. Cost is reduced as no extra sensors modules are required. Android Smart phone provides all the essential sensor hardware. Focus on customer demands and needs can help provide personalized mobile robot platform. Our focus on this thesis will be towards trying to engineer economical effective and efficient prototype for the same.

Keywords: Android, Aduino, Proportional Integral Derivative, Telepresence.

I. INTRODUCTION

TWSBR typically consists of a on board computer, micro-controller, a gyrosensor ,a motor driver and two encoded motors and are capable of moving in either direction while keeping itself in upright position. Below is a quick image of the same. New features can be added on above robot by adding some extra hardware such as camera, gps ,speaker, wifi etc modules but the cost of developing goes up as new features are added.we in this project provide a solution for the same problem by using a smart phone with android operating system which removes the need of

gyro sensor as android comes with fantastic hardware.Also by using android platform development and integration of additional features becomes easy. Some benefits of android hardware are OTG support(for connecting to the micro-controller),Camera(for obstacle avoidance and image processing) and any many other.we propose a economical feasible and cohesive robot capable of providing user with telepresence (BeThere! feature with VR capabilities) and Automated tour(deTour feature).This document provides the report on the same.

Figure 1.1: Self balancing autonomous android operated mobile bot.

Focus of this project is to develop Two Wheel Self balancing robot capable of automated navigation and has telepresence features such as vision for obstacle avoidance ,locomotion, audio, video deliver ,and is capable of performing automated tasks . The inverted pendulum system is naturally unstable. Therefore, a suitable control system technique and method needs to be investigated to control the system. The two wheel balancing robot is an application of the inverted pendulum that requires a controller to maintain its upright position.automated and semi automated robot guide functionalities can be developed using various open source libraries available .obstacle avoidance can be implemented using openCV algorithms in android app itself.

II. INDENTATIONS AND EQUATIONS

Proportional Integral Derivative-

(1) $u(t) = K_p e(t) + K_i \int_0^t e(t')dt' + K_d (de(t)/dt)$

III. FIGURES AND TABLES

3.1 System Architechture

Basic TWSBR works using data from gyro sensors attached to microcontroller as input for PID loop and runs wheels according to the output of the same. proposed system uses PID loop as control system for the robot. TWSBR Robot consist of an android smartphone,connected to arduino microcontroller,a motor driver and two encoded motors. android uses camera for obstacle detection passes control commands to arduino which then runs motor drivers through motor driver. a USB connection has to be established between arduino and android. Arduino

communicates with motor driver which then runs the motors. the architecture proposed focuses on three basic principles.

1. cost effective
2. ease of deployment and development of extra features
3. easy and entertaining interface.

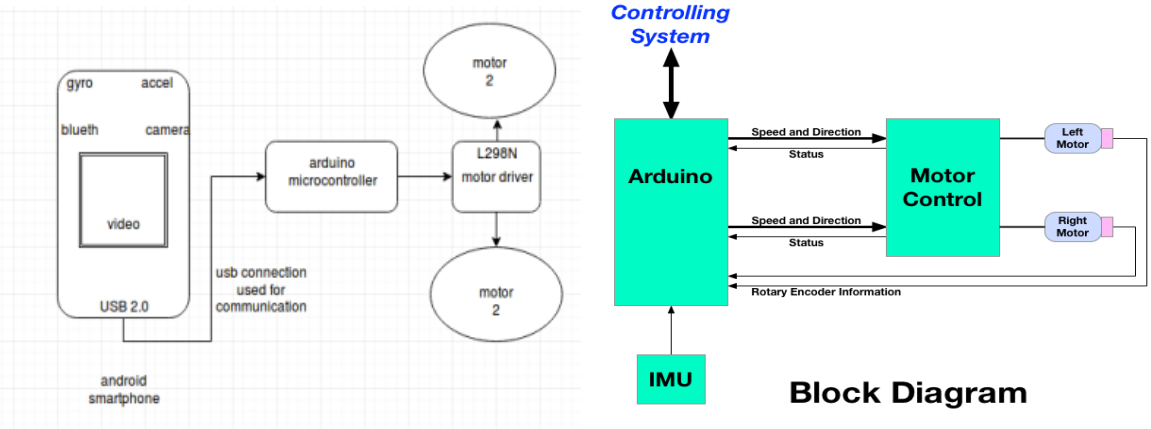

Figure 4.1: System Architecture Diagram

3.2 UML Diagrams-

1. Activity Diagram: The activity diagram represents the flow of activities and the positioning of the PID algorithm in the flow of computing.

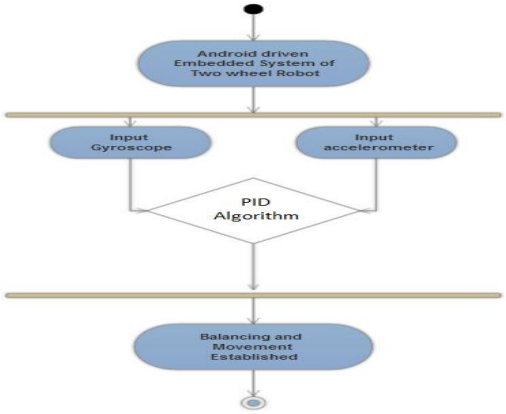

Figure : Activity Diagram.

2. Deployment Diagram: Deployment Diagram shows how the individual hardware parts of our system will be deployed, which modules are independent of each other, etc.

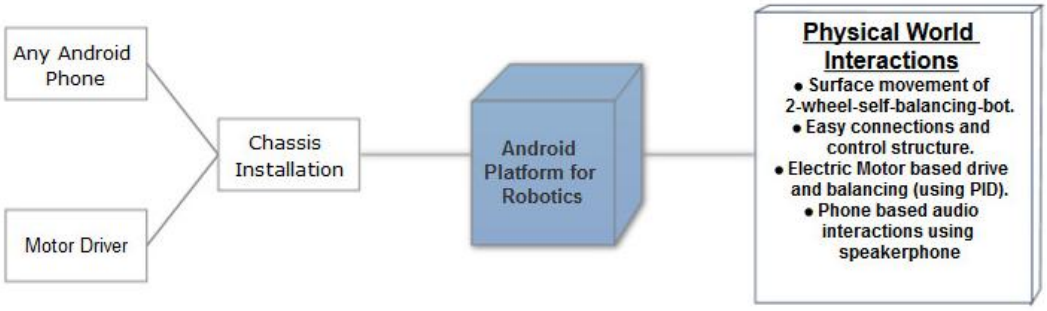

Figure : Deployment Diagram.

3. Communication Diagram: Communication Diagram shows which part of the system the user will be communicating with and which modules communicate with each other. e.g. User needs to open the application.

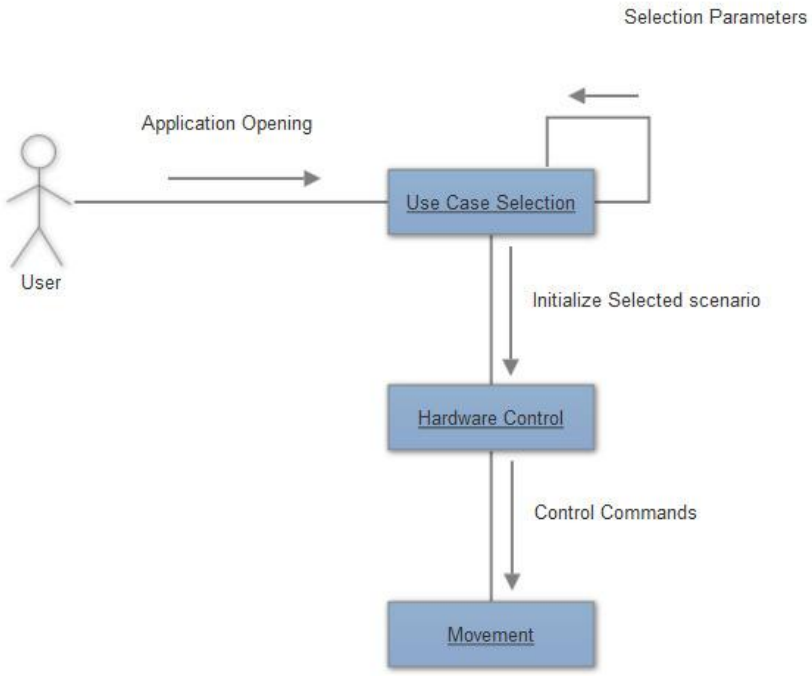

Figure : Communication Diagram.

4. Sequence Diagram: The sequence of control from layer of system to the next is represented by this diagram. The activities which take place between layers are also shown.

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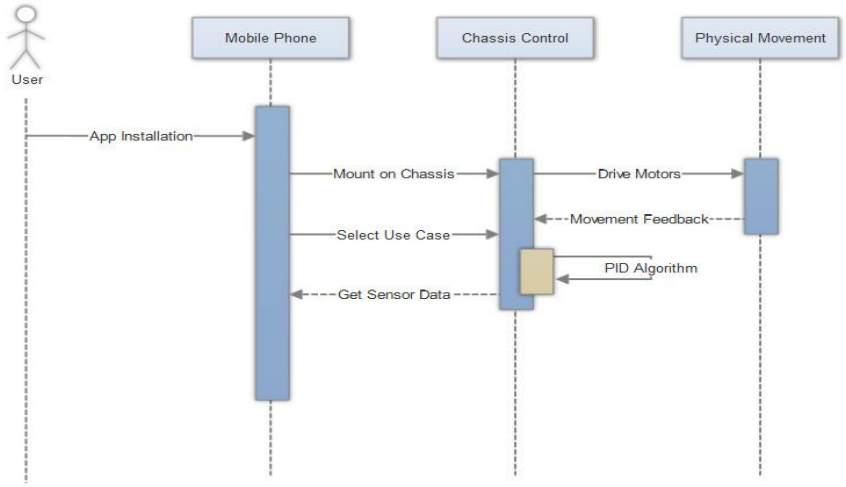

Figure : Sequence Diagram.

5. Class Diagram: Class diagram provides which provided abstraction of object classes along with its operations and attributes.

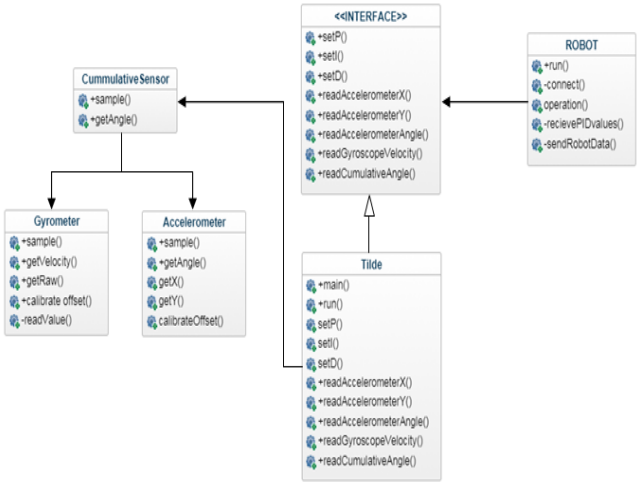

Figure : Class Diagram.

6. Use Case Diagram: Use case Diagram describes different users and the use case it is relevant to .

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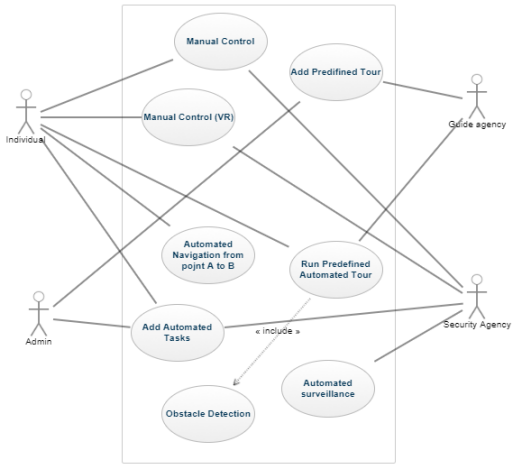

Figure : Use Case Diagram.

V. CONCLUSION

1. **Less hardware hungry:** we have focused on economical, feasible and cohesive solutions for our problem statement. As we have used android Smartphone as onboard computer instead of current available typical architecture android provides excellent hardware /sensors thus no extra sensors modules are required.
2. **TWSBR Properties:** As we have used two wheeled robot as our robot design it has inherent properties of TWSBR which consist of zero turn radius, minimum point of contact, compact size etc.
3. **Automation:** more and more jobs are automated nowadays as a result of many global factors. our robot is capable of providing user with pre de_ned tours acting as human and thus we intend apply automation principles to automate a tourist guide's job.
4. **Telepresence feature with VR functionality:** integration of manual control with VR technology provides with BE THERE experience as VR makes a person feel as if he/she himself/herself are there. this feature makes manual navigation easy and thus reduces stress on controller as robot control and navigation becomes easy. User can be anywhere in the world provided internet connection is available there.

To build a self-balancing robot we first derived the system equation then checked its real time response (both time and frequency). Then we designed a PID controller to control the close loop function to run on android smart phone and then We checked the controllability and set the pole location. Then we used kalman filter as estimator and predictor. Then by choosing the appropriate components we analyze their simulation successfully. The above test steps are successful, then we are near to build a BB. The easiest way to tune a PID controller is to tune the P, I and D parameters one at a time. It was done successfully. The stability of the SBB has to be improved by using a properly

designed gearbox that is having negligible gear backlash. Image processing using opencv algorithms done on android using andrid provided camera is done to avoid as well as detect obstacles in its way. GPS/GSM capabilities are added to aid auto navigation feature. video and audio capabilities were added in order to provide basic facilities for telepresence service. at last integration of different modules provides a simple user interface for given use cases. So by implementation all of these concepts and avoiding the errors that we came across the self-balancing bot is completely build.

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