Automatic Object Control

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***Abstract*—** In many industrial applications, the ability to detect and adjust for imbalance is crucial. Many sectors rely on stabilizing mechanisms these days. The technology is utilized in a wide range of items, from camera stabilizing equipment to surgical instruments. This is accomplished by using platforms that measure the tilt of the platform to correct for angular variability. The main motive of this project is to design and build a self-balancing platform that uses a PID controller, accelerometers and gyroscopes, and a Kalman filter to stabilize it. This device determines how far the present position of the platform is from the intended balanced position, and then the direction controller activates the appropriate motor to return the platform to its original stable position.

***Keywords*—** Accelerometer, Gyroscope, Kalman Filter And PID Controller

I INTRODUCTION

Over the course of mankind's history, man has always sought ways to improve processes, as well as ways to control them using machines autonomously, since computers and industrialization were introduced. Thus, control system engineering, Robotics, and Automation were invented to lower the faults associated with these processes by limiting man's contribution. Control System Engineering is the use of various control systems to ensure that a process runs as effectively as feasible. This has progressed in recent years, with the creation of systems with increasingly complex architectures and handling complex jobs. Object self-balancing has received a lot of attention recently. With the balancing of an inverted pendulum, the principle of self-balancing was invented. Self-balancing methods are one such step that utilizes balancing approaches to make unstable systems stable. The self-balancing platform is utilized in a variety of industrial applications, including twowheeled self-balancing models and self-balancing wheelchairs, stabilizing cameras, and earthquake-proof buildings. As a result, the goal of this project is to design and prototype a self-balancing platform with multiple applications that are limited only by our vision. This balancing operation is accomplished by turning dc motors in the opposite direction and monitoring tilt with an IMU sensor (Inertial Measurement Unit), which is a combination of three accelerometers, three gyroscopes, and one magnetometer. The working mechanism of a self-balancing technique is based entirely on the notion of the "Inverted Pendulum." It is also necessary to solve the inverted pendulum issue in order to design it. In the discipline of control engineering, the inverted pendulum is one of the most complex systems to regulate. The Inverted Pendulum (IP) is used to vertically balance an inverted pendulum. A suitable controller is necessary to do this. So, in this project, we utilized PID as a feedback controller, and our major goal is to give a quick overview of the functionality and application of PID control using a self-balancing platform as an example. To better comprehend the usefulness of PID in the field of control systems, a self-balancing platform model is constructed. Furthermore, we conducted experiments and observations with merits and demerits highlighted, with the goal of future improvements.[1][2]

II. METHODOLOGY

The following figure shows the basic block diagram of a self-balancing platform using a PID controller. On the application of load platforms mean position changes; To measure how far the platform is from its mean position sensors are used which send the signal to the control system it uses the measurement taken from the sensor and compares them to the value given to the feedback controller that is the PID controller. The position sensor that we used is the IMU sensor which is a sensor fusion of accelerometer, gyroscope, and magnetometer. And this data will be fed as an input to the Arduino microcontroller and hence the PID controller. And motors are for to bring back platform to its original[5]

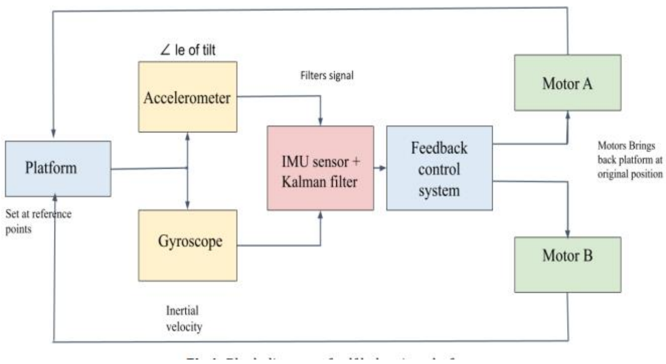


Fig 1 .Block diagram of Automatic Object control

III. HARDWARE REQUIREMENT

Mega 2560:

The Arduino Mega 2560 is an ATmega2560-based microcontroller board. A 16 MHz crystal oscillator, 54 digital input/output pins, 16 analogue inputs, 4 UARTs (hardware serial ports), a USB connection, a power connector, an ICSP header, and a reset button are all included. Most shields designed for the Uno are compatible with the Mega 2560 board.

BNO055:

Sensor BNO055 is a system in package (SIP) solution that incorporates a triaxial 14 accelerometer, a tri -axial 16-bit gyroscope, and a tri-axial geomagnetic sensor. By combining sensors and sensor fusion in a single device, the BNO055 optimizes integration and eliminates the need for extensive multivendor solutions.

Servo Motor:

Motor selection for the balancing robot prioritizes torque output rather than velocity because it has to oppose the rotating moment that gravity exerts on the platform. To compensate for the platform's inclination, motors are employed. A servo motor is a rotary or linear actuator that provides for exact angular or linear position, velocity, and acceleration control. A servo is made comprised of a suitable motor and a position feedback sensor.[4]

IV. DESIGN AND MODELING

Concept Dimension:

o Balancing Platform: 150*150*10mm

o Base Platform: 200*200*10 mm

o Motor Dimension: 40*19*42 mm

o Holding plate: 50*25*10 mm

o Height of the overall system (H): 220mm

o Distance Between two plates: 200mm

Design consideration:

o Weight of floating platform (Wm): 150 gram

o Weight of base platform (Wb) :250 gram o maximum weight to be applied (Wb): 150 gram

o Maximum angle of tilt (θ): 50 degree

o Weight of Entire system (M) : 800 gram

o Maximum Torque requirement : H*g*M*sin(θ)[11][13][5]

IV MODELING

The CAD-software CREO PARAMETRIC was used to create all mechanical designs.[9]

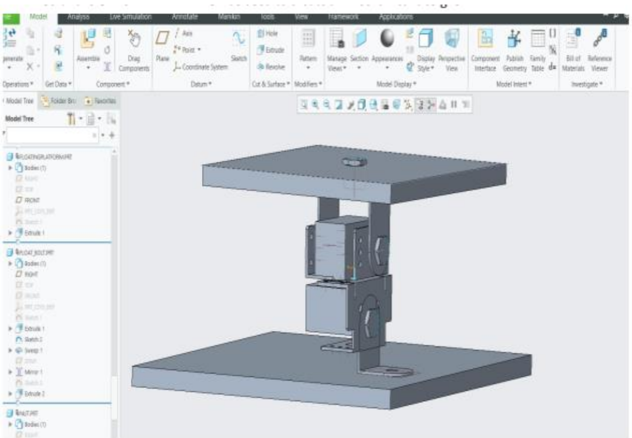
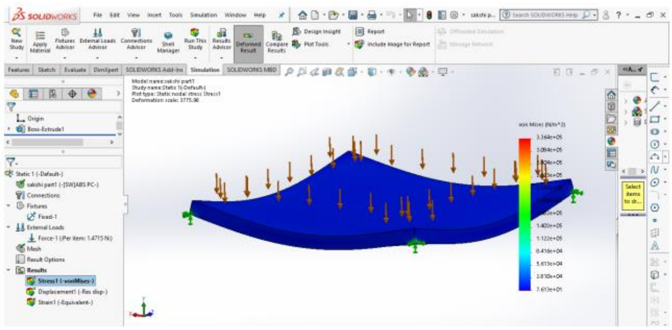


Fig 2: CAD Model of self balancing platform

V. ANALYSIS AND SIMULATION

The following are the findings of an analysis performed on a floating platform. Various testing with different parameters have been conducted on the design. The experimental layout has been set up, and experiments have been conducted to test the constructed prototype in order to meet the intended objectives[10]



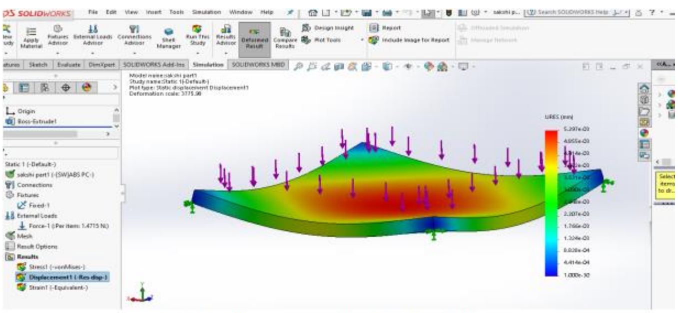


Fig 4: Deformation Analysis of floating platform

VI Simulation

Simulation: The simulation was performed in order to obtain the intended outcomes. The simulation results achieved using TinkerCAD software are described in considerable depth below.

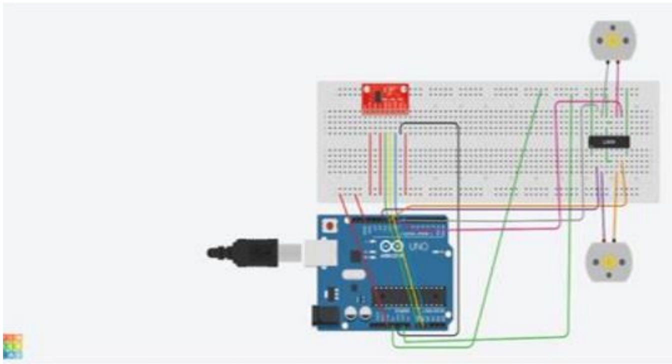


Fig 5: Simulation of self balancing Platform in Tinker CAD software

VI. FINAL MODEL

Fig 6: Motor assembly and Finalized model

VII. RESULTS AND DISCUSSION

To meet the project's goal, we conducted many tests in order to make the system more compatible. The findings acquired from the Arduino uno programmed after a PID is calibrated are detailed in this chapter. The results of the test cases are shown below, with the red line indicating the tilt angle detected by the IMU sensor and the yellow line indicating the displacement[12][13]

VIII. CONCLUSION

The project used the fundamental issue inverted pendulum challenge and expanded its application to create a self-balancing platform. Using this idea, the platform balances itself when pushed down or moved upward. The components' needs, functions, and connections have all been thoroughly described. The system, as well as the demonstration, might be upgraded significantly in the future. We may also go for the moving robot now that we have established a robust base. The same technology is also being utilized to produce self-balancing vehicles, self-balancing wheelchairs, and Segway. In order to increase the system's performance and reaction time, a different controller than PID might be used. One may utilize a dc motor instead of a servo motor to boost speed and efficiency. It is recommended that stepper motors should not be used since they increase system rise time.[11]

IX. REFERENCES

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