AIR HOCKEY 2.0

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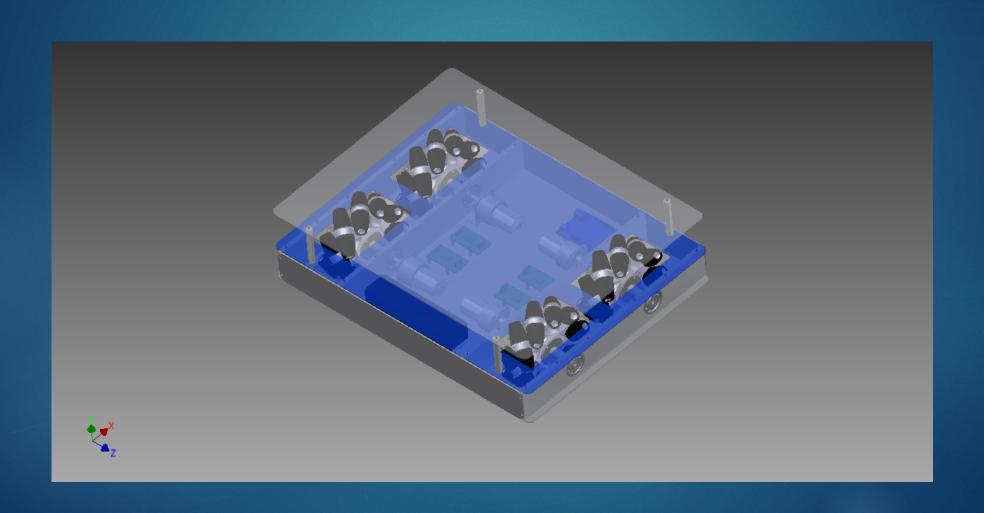- Video Links

OBJECTIVE

The project is recreation of the game of air hockey with two bots. An automatic bot and a manual bot. The game will be played using these bots on a specially designed arena.

Our project is basically an improvement of the previous year Air Hockey project(2013) where we will improve on the trajectory prediction of the ball and the kicking mechanism used last year.
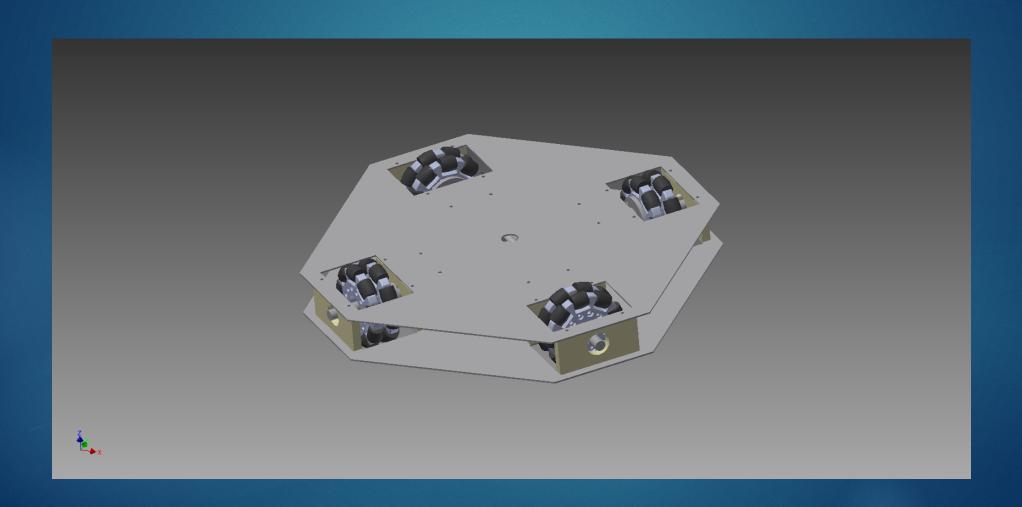
MECHANICAL DESIGN

▶ The main Chassis of both the manual and automatic bot are partially made of 2 mm thick Aluminium sheets . Aluminium was the ideal material for providing the bots the ability to withstand the weight of the final assembly and hold the heavy duty motors used for driving the bots.

▶ The motor holders in automatic bot are made of 10 mm thick aluminium sheet and 10 mm thick nylon sheet in the case of manual bot.

▶ The images of the Autodesk Inventor design of the manual and automatic bots(On the next page)
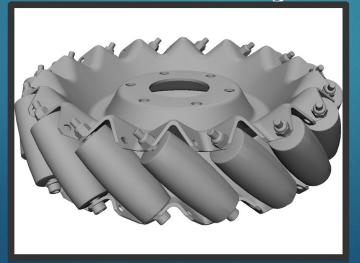
THE AUTOMATIC BOT

THE MANUAL BOT

THE WHEELS

▶ Mecanum Wheels

These wheels are very different from the conventional wheels used in machinery and vehicles. It has the basic geometry of a wheel but it has several more rollers attatched to the circumference at an angle of 45 degrees to the axis of the main wheel. This allows the wheel to move in a direction which is 45 degrees from the axis of the wheel and a combination of such wheels allows the bot to move in any direction from where it's standing.
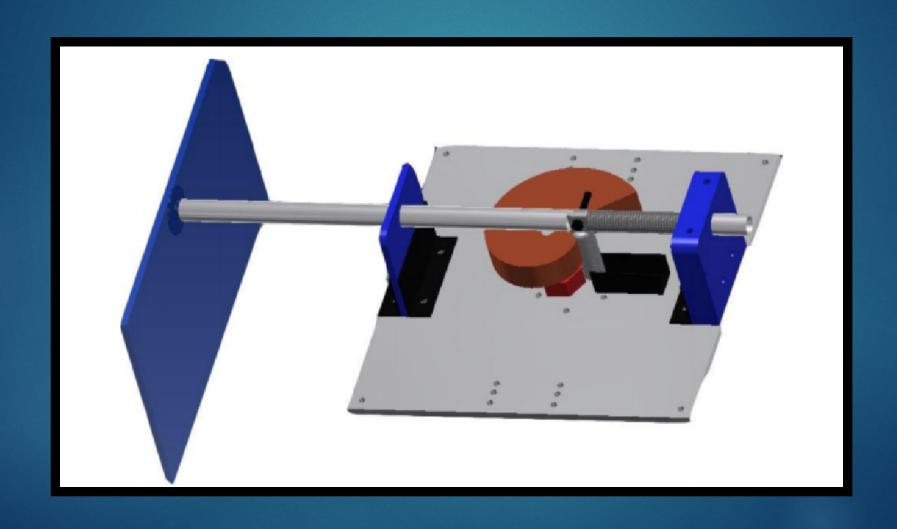
- Omni Wheels

These wheels are also different from the conventional wheels. The main difference between the mecanum wheel and omni wheel is that in omni wheels the rollers are perpendicular to the axis of the wheel which allows the wheel to move perpendicular to the conventional direction. Combination of Omni wheels in an arrangement known as holonomic drive train allows the bot to move in any direction similar to the mecanum wheels.

CAM BASED KICKER

- Components
- Cam
- Rod
- Spring
- High torque 200 rpm motor
- Aluminium flap
- Nylon frame

CAM BASED KICKER ASSEMBLY

KICKING MECHANISM

The motor rotates the cam. The aluminium rod is mounted on Nylon support. There is a spring attached to the aluminium rod.

As the cam rotates the radius of the cam changes, this stores potential energy in the spring. There is a point when there is instantaneous change in the radius of the cam, releasing the potential energy stored in the spring. This makes the Aluminium rod move forward with high speed.

The hitting plate attached to the Aluminium rod hits the incoming ball.

ELECTRONICS

- ► Arduino Uno

We are using Arduino Uno board as our microcontroller. It receives the signals from a laptop using serial communication and applies the automation algorithm which sets the motion of motors(both direction and RPM) and the bot moves accordingly. It also controls the required PWM (Pulse Width Modulation required for controlling the RPM) for the motors so that the bot turns perfectly and aligns itself accordingly for hitting the ball.

- Motor driver

Hercules Lite 6V-36V, 8Amp Motor Driver can take up to 30A peak current load and can be operated up to 10KHz PWM. Motor driver can be interfaced with 3.3V and 5V logic levels. Motor driver has built-in protection from under / over voltage, over temperature and short. Motor driver has terminal block as power connector and 7 pin relimate connector for the logic connection. It is suitable for high performance robots.

- Battery : we have used a lithium ion polymer (Li-Po) battery providing 11.1 volt potential & 3.3 amp-hour.

- Relay : We have used a DPDT relay in the manual robot to operate high torque motor. They have maximum current rating of 6A on 12V potential and have logic pins operating on 12V.

SOFTWARES USED

▶ Arduino IDE

The Arduino Integrated Development was used to write the code for the Arduino. This was only for the autonomous bot. It consists coding similar to C programming . The code for automation algorithm and specific PWM to the motors is written in this. It supports the choice of Serial COM ports for uploading the code to the arduino board. It has a serial monitor which is used for serial communication.

▶ Dev C++

 it is IDE for development in C & C++ . We configured its compiler to include open cv header files and used it for image processing.

CODING

For driving autonomous bot we have used Image Processing. For doing image processing we have used an overhead camera which continuously sends digital images(video) to computer. Computer then processes this data and filters out the colors of bots and ball using their HSV values. Image processing is done by OpenCV library. We have used OpenCV 2.1 For this purpose. Algorithm is written in C++ language and compiler used is Dev-C++ 5.3.0.3 . Algorithm uses CVBLOB library for determining position (coordinate) of moving ball as well as autonomous bot.

PROBLEMS FACED

- The Solenoid Kicker

The initial kicking mechanism was a solenoid based kicker.

The estimated weight of the kicker arm was 0.5 kg, so to propel it at a velocity of around 1 m/s(a decent kick) we needed energy around 2 Joules.The efficiency of the solenoids is around 1% so we needed 200 J of energy(ideally calculated).

for this problem we rectified the 220V AC mains to 350V DC but still the capacitors needed were not available in india and playing with 350 V was very risky so finally we abandoned the idea and switched back to the cam based kicker.

- The weight of the bots

According to our estimation, our automatic bot would have weighed around 10 kgs which was pretty heavy.

the main contribution to the weight was due to the 1x43x5 cm Aluminium sheet used for the motor holder and the bearing holders.

for the manual bot we used nylon instead of the Aluminium sheets which considerably reduced the weight of the bot.

SOME INNOVATION

The bots can be improved and some innovation can be added to make it even better

▶ Attacking mode : in simple words the bot will move forward to kick the ball.

▶ Defensive mode: the bot will move along a line(parallel to the width of the playing arena) to kick the ball.

The coding for the attacking mode will rely very heavily on the constantly changing velocity vector(due to errors) and the coding for the algorithm will be extensive.