**Project Pepper**

**MRDP**

A differential drive mobile robot that can perform SLAM (Simultaneous Localization and Mapping) and avoid obstacles in a room. Equipped with the Microsoft Kinect and powered by ROS, MRDP tries to emulate what Willow Garage's Turtlebot does, in a fraction of the cost.

**Elbot**:

An interactive robot capable of recognizing faces and character strings. The robot assists in reading documents and interacts with the user, responds to the pre-defined questions from the database.

Ongoing Work:

We are currently working on merging MRDP and Elbot under a project called Project Pepper. The robot will be able to react to voice commands, identify the speaker, and reply back to him whenever necessary.

**Air Hockey**

The Air hockey project is basically an autonomous air hockey platform involving a serial manipulator that can play air hockey with a human competitor.

The autonomous air hockey platform involves design and fabrication of an air hockey table and a 2 link serial manipulator to control the mallet. The table consists of 2 levels, the lower one to host the blower fans and the upper one acts as the table surface to play the game

The location and movement of the puck is perceived using image processing algorithms from the real time video feedback from a camera placed above the table. Based on the obtained values, the precise trajectory of the puck is found. Based on the calculated position at the given time, the motors actuating the links are given predetermined angles and speeds using inverse kinematics algorithms. Thus, the end effector hits the puck with the required force.

The future prospects include using machine learning algorithms to improve tracking of the puck in diverse conditions and to reduce the error in trajectory calculations and inverse kinematics algorithms and faster response times.

**3D Printer:**

3D printing or additive manufacturing is a process of creating a three-dimensional solid object of virtually any shape from a digital model. It is achieved using an additive process, where successive layers of material are laid down in different shapes.

Started as a educational project and as a aid for future projects, this has grown into a 3D printer startup - “bolt3d” (<https://www.bolt3dprinters.com/>) . Reprap Prusa i3 was taken as the base and improvements were made from there on. Close to 80% of the new design was indigenous and made in house.

From a builder's perspective it has a rigid structure made out of metal. Rigidity plays a major role in determining the accuracy of a print. Even the slightest of the disturbance can be a problem. HIgh torque stepper motors ensure there is nothing stopping it from doing its job.

With SD card support and a LCD display this makes sure this is a stand alone. Just plug it in and power it up and insert the SD card, you will see the printer in action. With a fast printing speed, high build volume of 8000cm3 ,60 micron layer thickness and a 0.4mm nozzle it plays its role to perfection.

Auto bed leveling, metal hot end and heated build plate and few of its notable features. It supports any spool (PLA/ABS) and is compatible with WIndows/Mac/Linux.

**Quadcop:**

Quadcop is fundamentally a quad copter that is equipped with an HD camera and GPS and controlled by a BeagleBone Black.

The objective of our quadcop is to detect and recognize criminals in large crowds using image processing algorithms and then ask the user (police or person in surveillance room) for permission to follow that criminal autonomously.

The quadcop acts as a replacement to conventional stationary CCTV cameras as it gives us the exact position of a criminal using GPS when in pursuit.

This GPS information can be used by the police to plan and arrest the criminal, and until the police intervene, the quadcop is made to follow the criminal.

An extension of this project is Cloudrone, a quadcopter controlled by Raspberry Pi 3. The Raspberry Pi acts as a Wifi hotspot providing internet services to people on the ground during disaster times.

**Slat-Hex:**

As a human, you are capable of walking, jumping, climbing and moving through a difficult terrain. But there will come a situation, when you, as a human, are helpless. You need assistance from someone or from something. And that is exactly what our bot is going to be capable of doing. It is going to traverse through the difficult terrain for you, it is going to get to the place which is unreachable for you, it acts as a portable eye for you.

Having six actuators and a three point contact, SLAT-HEX acts as your ideal all-terrain vehicle. It acts as a platform, capable of performing special operations which separates it from its competitors, and these features include ramp climbing, inverted operation (capable of functioning normally, even when toppled) and even step climbing. Thus our platform could be extended to perform these operations if fabricated according to the correct specifications.

Video Link : https://youtu.be/vtBr4nC57y8

**Mind Over Matter:**

Bio-signal detection and processing is a field whose myriad applications are as yet unexplored. We will develop an easily usable electrode frame and demonstrate two of its uses in particular.

Firstly, we will acquire and process the EOG signals associated with eye movements and use these to control a web interface where the user can select the required function by mere eye movements. The functions available will include controlling basic appliances, sending emergency mails, controlling a helper bot.etc. This is specifically intended to help patients with Locked In Syndrome(LIS) attain a degree of independence.

Secondly, we will judge the mental fatigue of a user based on the

1) frequency and duration of eye blinks detected by EOG signalS

2) power spectrum analysis of EEG signals

This is designed to help people in jobs that require long durations of concentration, like driving.

**EXOS:**

The objective of project – ‘EXOS’ is to create a novel design of a hand exoskeleton which amplifies normal hand actions. In this venture we intend to create an exoskeleton for rehabilitation of stroke patients, people recovering from fractures and for power grasp in military and industrial purpose. We adopted a design which allowed maximum dexterity of the fingers by analyzing the trajectory of the fingers and creating a closed-loop control system for accuracy and fast response. It detects the smallest kinetic stimulus by the human palm and actuate those, externally using high torque servos.Our hypothesis was that with this project we could create a breakthrough in the field of medical robotics by providing better medical assistance at lower cost.

**ARES** - Assistive Rehabilitation ExoSkeleton

Abstract:-

Rehabilitation of patients recovering from post-stroke trauma, degenerated muscles due to old age or other neuro-muscular disorders are some of the unsolved challenges faced by medics all over the world. Most patients lose muscle strength which degrades their grasping and lifting capabilities causing severe hindrance to the person’s day-to-day activities. The need for additional care and support is needed round the clock. Utilising advancements in robotics we aim to aid in combating this difficulty by developing a wearable 3 DoF upper body exoskeleton for patients, empowering them to help themselves, so that they may lead a normal life, without the need for extensive assistance. We use EMG (Electromyograph) signals as the control mechanism for the exoskeleton, requiring the patient to only start contracting their muscles, the exoskeleton immediately begins to assist the user, getting faster response times, for a more natural experience. Integration of Machine Learning utilising Artificial Neural Networks aims to provide a more accurate and personalised response of the assistive system.

**ASCON -** American Sign Language to Speech Converter

We believe that communication is a basic right. The better we communicate and share ideas, the faster we progress as a society. The project aims to bridge the gap between people who are speech impaired and the people who don’t know sign language.

The hand gestures, as defined in the American Sign language, are converted to speech output based on the input from the Inertial Measurement Unit and the flex sensors.

A three layered Artificial Neural Network has been implemented with keras as the front end and theano as back end for classification of gestures. The processing has been done on a Beagle Bone Black.

The project is an effort to try and assist the 70 million people who can't communicate vocally.

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**Detection and Localization of Epileptic Seizure :**

The prime motivation of the project was developing a telemedicine service

for the rural clinicians where lack of expertise and facilities is a major problem resulting in the misdiagnosis of the type of epilepsy. Here,128 channel of EEG data sequences was segmented into 1024 data points and pre-processed using de-noising techniques, ICA and Complex Dual Tree wavelet transform. Next, we classified the Ictal and Interictal regions using machine learning algorithms and boosted its performance using Phase Amplitude Coupling (PAC). For localizing the origin and distribution of seizure activity, sLORETA algorithm was implemented and the results were superimposed on an MNI head model. The accuracy of localization was further improved using compressive sensing.The above results were incorporated into an user friendly MATLAB GUI. This is an affordable alternative for the poor sections of the society.

**SOCCER BOTS**

*Play Soccer the Engineers’ Way*

The system comprises of a set of four omnidirectional mobile robots (two per team) which is endowed with the ability to play soccer. These robots can perform various functions including passing, shooting, dribbling and goalkeeping.

They are equipped with indigenous mechanisms for shooting and dribbling which enhance their ability to play the game. The master computer localises the robots using feedback from an overhead camera. The master communicates the control variables to its slaves using wifi. This multi agent system is used to test algorithms in path planning and artificial intelligence.

**Robot Design**: The robot is a 3 wheel omnidirectional robot. The chassis is made

up of acrylic, with aluminium L clamps to couple different parts.

**Shooting and Dribbling Mechanism**: The shooting mechanism is actuated using a solenoid kicker powered using a boost converter.

The dribbling mechanism consists of a dribbler actuated using a 200 RPM DC motor through a gear system. The dribbler induces a backspin on the ball, so that the ball is within the robot’s control..

**Control**:

The kinematic model of the robot was found from existing literature and was used to control the

robot.The system is partly autonomous - one robot autonomously goalkeeps whereas the other is manually controlled.

**Robot and Ball Localisation**:

To find the present location of the robots and the ball, image processing was done in OpenCV. A wide angle camera was mounted at a height of 2.3m from the ground. A pattern was fixed on top of every robot to uniquely identify it. The image from the camera is first converted to a gray image, thresholded and the required contours are chosen based on area.

Ball localisation is done by converting the image from the camera to a HSV image and finding the position of the ball using HSV value of the ball’s colour (The ball used is lemon yellowish and its HSV value is first calculated and given to the algorithm for it to detect the ball from the full image). Ball’s trajectory is also needed for autonomous goal keeping. The trajectory is found by finding the position of the ball in 2 consecutive frames and extending the line formed by it..

Youtube Link: https://youtu.be/hr0JUzrCq2U