AuraPlay

Fluid User Interface Device build over Raspberry Pi

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***Abstract*—Augmented reality technology is revolutionizing the way we interact with computers. Today digital information is no longer adhered to computer screens. In this paper, we introduce - Pi Lamp, an Augmented reality desktop lamp running on Raspberry Pi. It consists of Camera-Projector system and an articulated lamp structure, the combination of these enables the user to manipulate as well as reposition projected information with simple gestural interface. Pi lamp uses computer vision techniques in collaboration with micro-controller based articulation system to provide a very intuitive way of interaction. The paper also explains detailed hardware and software implementation of the prototype system.**

***Index Terms*—Raspberry Pi, Arduino, table lamp, fluid interface.**

I. INTRODUCTION

Raspberry Pi is a credit-card sized single board computer developed with the intention to promote teaching basic computer science in schools. It has also been a great prototyping platform for hobbyists and engineers alike. Also many research has been carried out in reality augmentation on table surfaces. One such project by MIT Media Labs involved the use of table lamps as a way to project digital information onto the physical world. Inspired from this we thought to build a similar version using Raspberry Pi.

So we came up with AuraPlay- Playing with light. It consists of a camera-projector system mounted on an articulated robotic arm. AuraPlay is an intuitive approach to interact with technology. The whole system looks like a table lamp equipped with a computer. It projects desktop screen of Raspberry Pi and user can interact with it using a simple LED pen. User can interact with elements on the screen by simply taking the pen to that point and lighting the LED. We have also made an experimental app for the device, it provides a sketch board like interface and user can scribble on it just like a normal paper.

The articulated arm is capable of moving the screen anywhere on the desk. The screen can be dragged anywhere across the desk by simply moving the pen to the desired location.

II. MOTIVATION BEHIND THE PROJECT

We wanted to use Raspberry Pi in a different way. LuminAR- an MIT Media Labs project provided us a platform to use our idea. So we decided to make a prototype of LuminAR.The purpose was to create a GUI which is more intuitive to user and we can play with it as if it's is not a screen but just a imagination. We make wanted to make a new system for user to make it put on a table top and make things more handy at use

III. BACKGROUND THEORY

When we first thought of Auraplay it was inspired by the very basic component on a study table - a table lamp. The idea was not to make just a basic system to use as a computer, but to optimize it for a better use when we have no place for any "pixel screen". A screen so intuitive and fluid that working with it just not feels like it is computer. Making it to be comfortable assistive and at the same time equally good as a computer. The processor for such design should be small open-sourced and easy to work on . Raspberry Pi was the answer to almost all needs, it is cheap and easily available, small as a credit card and light weight, plus the use of Raspberry Pi made easier to use Pi-Cam that is designed for it specifically.

IV. HARDWARE IMPLEMENTATION

A. Mechanical Design

To cover the whole desk area, we thought to use a cylindrical robotic arm structure for the lamp. The arm is has 2 degrees of freedom for the structure and 1 degree of freedom is for the camera-projector system. Combination of these constraints makes the motion of projected screen very intuitive. We have used Autodesk Inventor and Google sketch up to design the arm.

Figure1: Conceptual design of articulated arm.

The arm is mainly made of aluminum. We have used water jet cutting facility at IIT Kanpur, to cut out desired parts according to our need.

At the base, the arm is constrained to move in tangential direction. We have used thrust bearing needle washers to make it rotate freely and also to uniformly distribute the downward force. A 1cm wide ring is used as a mount to hold bearing in place. We have made the base out of two parallel circular discs which provide a stable platform for the rest of the structure. A servo is firmly mounted between the plate. It provides necessary angular motion. Servomotor is coupled with 2 parallel vertical supports.

- Diameter of Discs: 25 cm.
- ID of Thrust bearing washer: 12 cm.
- Servo Type: Restricted; Torque: 15.6 Kg/cm.
- Length of vertical supports: 60 cm.

figure2a: Base; Figure2b: Thrust bearing washer

Simple Rack and Pinion mechanism is used for linear motion of the arm. There are two pinions to support the rack. One of them is free to rotate and the other one is coupled with a continuous rotation servomotor.

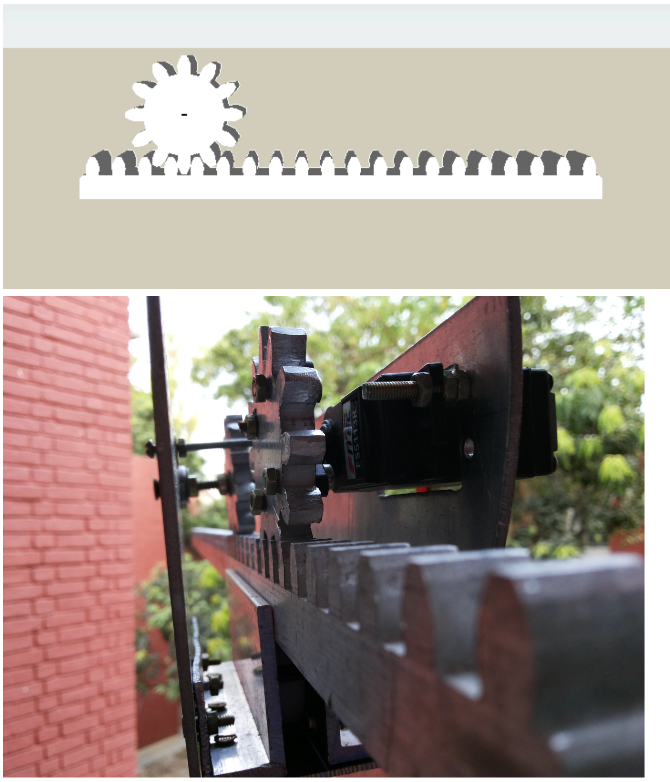
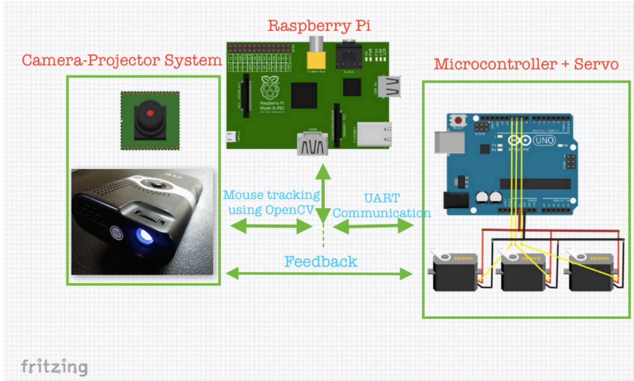


Figure3: Rack and Pinion mechanism for linear actuation.

The rack is support from the beneath by two rollers mounted on the vertical support.

B. Electronic Circuitary



Electronics can be mainly divided into 2 parts, Camera-Projector system and Micro-controller-Servo motors articulation system. Projector projects the Raspbian environment of Raspberry Pi on the table surface whereas the camera takes input of the position of laser pen. Real time changes are projected back by the projector.

We have used open source Computer Vision libraries to track position of pen. In the first stage of detection we track the contours of the projected display to set our coordinates and calibrate our code accordingly. After that mouse tracking is done. Position of pen is then used to move the cursor to that location. For virtual emulation of mouse we have used "Xdotool" library .

The basic algorithm for supervising the screen was to divide it into 8 small blocks. When the pen is taken to one of these blocks, the servos adjusts their position until the pen comes to the central block. There are two modes involved in this, first being the screen dragging and latter is mouse controlling the swap is made by just making a 5 second pause in the center of the screen . Using this feedback mechanism the screen moves wherever the pen goes. For actuation of arm we have used 3 Servo motors which are operated using micro-controller. We have used Arduino UNO development board with ATmega328 micro-controller for the same. UART communication is set up between Arduino and Raspberry Pi using the Wiring Pi library. We assign a character to each of the grids. On pointing the laser on the grids the character corresponding to that grid is sent to arduino using the function SerialPutchar(). On receiving the character the arduino moves the servo motors accordingly and the screen is dragged on the table with the laser.

C. Software Implementation

Open Computer Vision libraries have been used in the codes of mouse tracking to detect the boundary of the projected screen using Contour Detection and to calibrate so that we can get the exact position of the mouse pointer. For that we firstly detect the contour of our projected screen of the projector. In contour detection the coordinates of one of the diagonally opposite vertices are marked and the remaining two are calculated. These coordinates are in respect to the captured frame of the Pi-Cam. Then as the laser is pointed inside this frame, its coordinates are marked for the threshold. It is then send to XDOTOOLS for calibrating the mouse pointer to the laser pointer. The screen drag software handles all the functions allocated to be performed on when we place pointer on any particular area on screen. We divided the screen in grid system and a particular motion is performed on pointing a particular grid. When we point the laser in a grid, a character is sent to the serial communication port of arduino. Like this the Arduino identifies the grid. For example when we point on right most upper corner on screen we made a character 'A' to be sent to the Arduino and code was made to make a motion such that the servos rotate clockwise and arms moves out. Like this all grids had their own assigned motion.

V. LIMITATIONS

The main limitation to our project is the processing speed of Raspberry Pi. The Pi camera board gives a mere 2fps. Thus OpenCV does image processing slowly and we get a noticable time lag. We have only provided 2DOF so it is somewhat less intuitive for a user as there can't be zoom in or zoom out option. Projector does not provide a good resolution and brightness screen as compared to the real pixel screen.

VI. FUTURE SCOPE

We can make the user interface more friendly by implementing touch. We can do that by finger tracking. We can also add zoom in and zoom out mode to our screen by modifying the hardware. In that case we have to add another degree of freedom to move the arm in vertical direction. A higher resolution projector also needs to be installed.