Implementation of Touch Detection With Virtual Keyboard Using Raspberry Pi

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Abstract— In this paper, we propose a novel interactive projection system (IPS), which enables bare-finger touch interaction on regular planar surfaces (e.g., walls, tables), with only one standard camera and one projector. The challenge of bare-finger touch detection is recovering the touching information just from the 2-D image captured by the camera. In our method, the graphical user interface (GUI) button is projected on the surface and is distorted by the finger when clicking it, and there is a significant positive correlation between the button's distortion and the finger's height to the surface.

Therefore, we propose a novel, fast, and robust algorithm, which takes advantage of the button's distortion to detect the touch action. The proposed touch detection algorithm is performed in three stages: 1) region of interest extraction through a homography mapping, by which the computational complexity of the following processing is reduced; 2) the button's distortion detection using a special edge detection algorithm, which greatly reduces the errors due to the influence of the finger's shadows and edges; and 3) touch action judgment by the button's distortion. Several applications (e.g., virtual keyboard, power point viewing), which use the proposed touch detection method based on the buttons, are shown in this paper. An evaluation is performed on the virtual keyboard and the results demonstrate that the proposed approach can detect bare- finger touch in real time with the missed detection rate of 1.00%, false detection rate of 2.08%, and touch detection rate of 96.92% at the typical projected distance.

Index Terms- Edge detection, human–computer interaction, projector–camera system, touch detection, triangulation.

I. INTRODUCTION

Mobile Devices (e.g., mobile phones, pads) with significant computational power and capabilities have been a part of our daily life. Benefiting from the small size of these devices, they are easy to carry. However, the screen real estate of today's mobile devices is limited by their small sizes. This greatly diminishes their usability, functionality, and comfort. A Pico-projector can be used to significantly increase the limited screen size of the mobile devices. With the development of the projection technology, we believe that embedded projectors in the mobile phones will be very common in the future, and people will enjoy a way of displaying digital contents on everyday surfaces. Meanwhile, the interactions (e.g., touch, gesture) on the projected display are thought to be appealing. To achieve the touch interaction, the biggest challenge lies in how to determine whether the fingers touch the projected surface or not. Most of the researchers in this area use multi cameras or a depth camera to obtain the relative position between the fingertip and the projected surface.

The existing keyboards used keys based keyboard for typing on the computer. These keyboards are working on the mechanical push principle. But for the small devices like mobile phones and tablets it is impossible to carry big keyboard with them. The touch screen based keyboards available in such devices are very inconvenient to write because the size of people finger is big and the size of the keys on the touch screen is small. So typing work on the small devices is not convenient and on computer our fingers get pain after doing long time typing work because of mechanical vibration of the keys.

II. PROPOSED METHOD

In the proposed method, we propose an interactive projection system (IPS), which enables bare-finger touch interaction on regular planar surfaces (e.g., walls, tables), with only one standard camera and one projector.

The challenge of bare-finger touch detection is recovering the touching information just from the 2-D image captured by the camera.

In our method, the graphical user interface (GUI) button is projected on the surface and is distorted by the finger when clicking it, and there is a significant positive correlation between the button's distortion and the finger's height to the surface.

Therefore, we propose a novel, fast, and robust algorithm, which takes advantage of the button's distortion to detect the touch action.

We design a hardware system on interactive projection system. Our system is designed by using ARM 32-bit micro controller which supports different features and algorithms for the development of automotive systems. Here the camera and projector are connected to ARM controller.

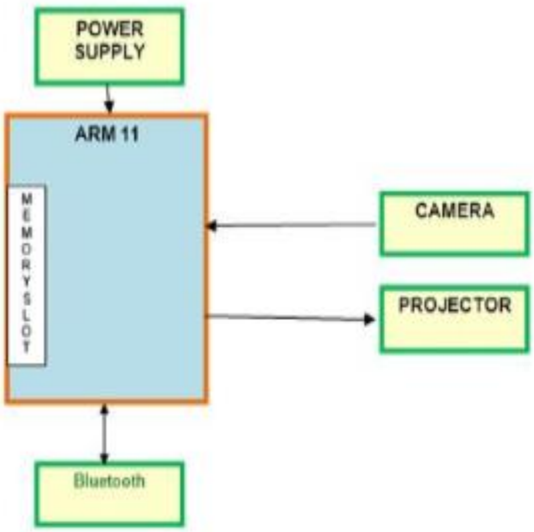
We are projecting a GUI on surface by projector and camera for capturing GUI, The camera will capture the places where user put his finger and the movement of the finger.

Fig.1: The Proposed System Architecture

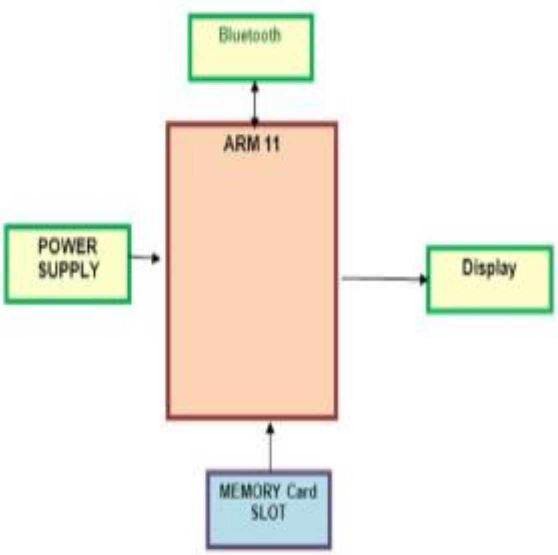
The camera capture images are analyzed by the algorithms and programs present in the ARM micro controller and then detect exactly which key pressed by user. The only requirement is that the face of the camera should be in the direction of projection.

III. BLOCK DIAGRAM

Transmitter Section



Receiver Section:



IV. HARDWARE IMPLEMENTATION

A.Raspberry Pi Board:

Fig.2: Raspberry Pi Board

The **Raspberry Pi** is a credit-card-sized single-board computer developed in the UK by the Raspberry Pi Foundation with the intention of promoting the teaching of basic computer science in schools. The Raspberry Pi is manufactured in two board configurations through licensed manufacturing deals with Newark element14 (Premier Farnell), RS Components and Egoman. These companies sell the Raspberry Pi online. Egoman produces a version for distribution solely in China and Taiwan, which can be distinguished from other Pis by their red coloring and lack of FCC/CE marks. The hardware is the same across all manufacturers. The Raspberry Pi has a Broadcom BCM2835 system on a chip (SoC), which includes an ARM1176JZF-S 700 MHz processor, Video Core IV GPU, and was originally shipped with 256 megabytes of RAM, later upgraded to 512 MB. It does not include a built-in hard disk or solid-state drive, but uses an SD card for booting and persistent storage.

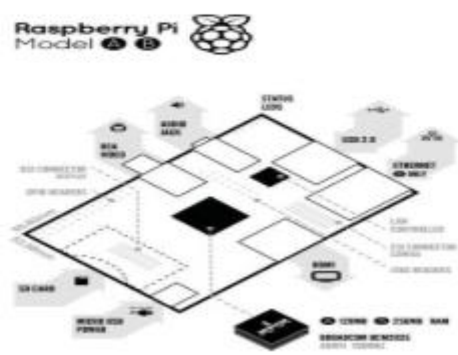


Fig.3: Board features

The Foundation provides Debian and Arch Linux ARM distributions for download. Tools are available for Python as the main programming language, with support for BBC BASIC (via the RISC OS image or the Brandy Basic clone for Linux), C, Java and Perl.

B.TFT display unit:

TFT stands for Thin Film Transistor, and is a type of technology used to improve the image quality of an LCD. Each pixel on a TFT-LCD has its own transistor on the glass itself, which offers more control over the images and colors that it renders. While TFT-LCDs can deliver sharp images, they also tend to offer relatively poor viewing angles, meaning they look best when viewed head-on. If you view a TFT-LCD from the side, it can be difficult to see. TFT-LCDs also consume more power than other types of cell phone displays.

C. Bluetooth:

Bluetooth is a wireless technology standard for exchanging data over short distances (using short-wavelength UHF radio waves in the ISM band from 2.4 to 2.485 GHz) from fixed and mobile devices, and building personal area networks (PANs). Bluetooth is a standard wire-replacement communications protocol primarily designed for low-power consumption, with a short range based on low-cost transceiver microchips in each device. Because the devices use a radio (broadcast) communications system, they do not have to be in visual line of sight of each other, however a *quas optical* wireless path must be viable. [6] Range is power-class-dependent, but effective ranges vary in practice; see the table on the right.

V. SOFTWARE REQUIREMENTS

A.Linux Operating System:

Linux or GNU/Linux is a free and open source software operating system for computers. The operating system is a collection of the basic instructions that tell the electronic parts of the computer what to do and how to work. Free and ***ISSN 2048- 1069***pen source software (FOSS) means that everyone has the freedom to use it, see how it works, and changes it. There is a lot of software for Linux, and since Linux is free software it means that none of the software will put any license restrictions on users. This is one of the reasons why many people like to use Linux.A Linux-based system is a modular Unix-like operating system. It derives much of its basic design from principles established in UNIX during the 1970s and 1980s. Such a system uses a monolithic kernel, the Linux kernel, which handles process control, networking, and peripheral and file system access. Device drivers are either integrated directly with the kernel or added as modules loaded while the system is running.

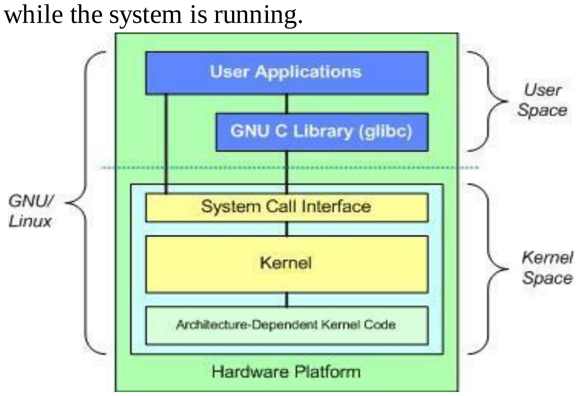


Fig.4: Architecture of Linux Operating System

B. Qt for Embedded Linux:

Qt is a cross-platform application framework that is used for developing application software with a graphical user interface (GUI) (in which cases Qt is classified as a widget toolkit), and also used for developing non-GUI programs such as command-line tools and consoles for servers. Qt uses standard C++ but makes extensive use of a special code generator (called the Meta Object Compiler, or moc) together with several macros to enrich the language. Qt can also be used in several other programming languages via language bindings. It runs on the major desktop platforms and some of the mobile platforms. Non-GUI features include SQL database access, XML parsing,thread management, network support, and a unified cross-platform application programming interface for file handling. It has extensive internationalization support.

C. Open CV Library:

Computer vision is a rapidly growing field, partly as a result of both cheaper and more capable cameras, partly because of affordable processing power, and partly because vision algorithms are starting to mature. Open CV itself has played a role in the growth of computer vision by enabling thousands of people to do more productive work in vision. With its focus on real-time vision, Open CV helps students and professionals efficiently implement projects and jump-start research by providing them with a computer vision and machine learning infrastructure that was previously available only in a few mature research labs.

VI. RESULT

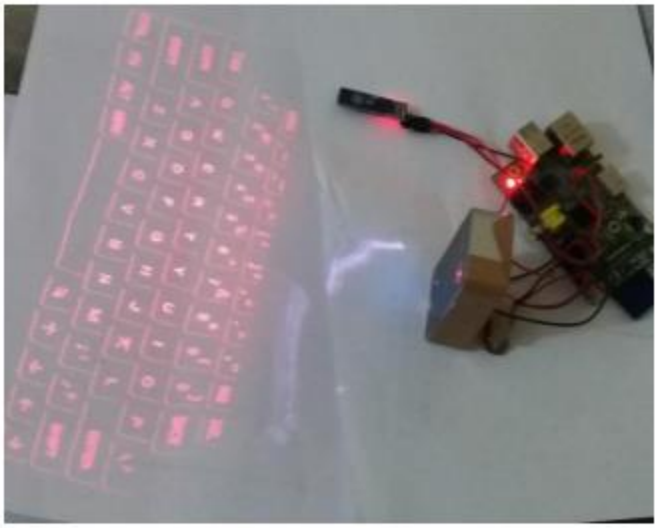


Fig.5: Virtual Keyboard display unit

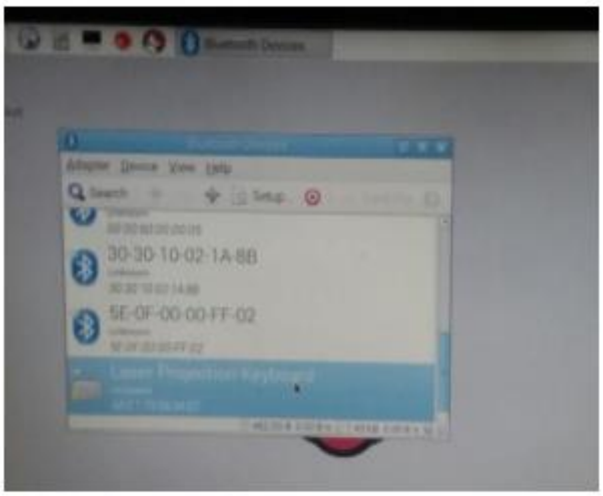


Fig.6: Bluetooth connecting

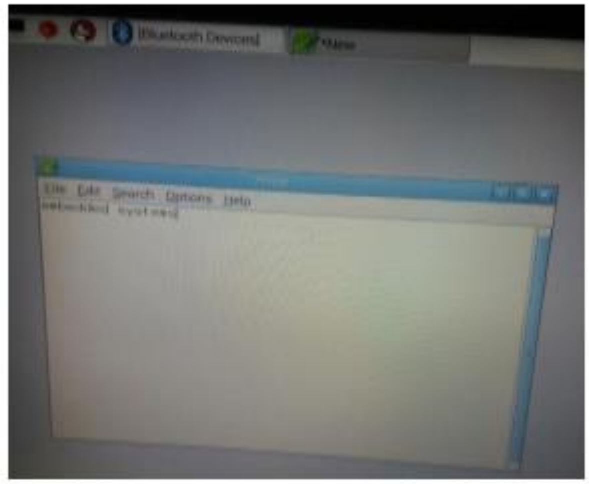


Fig.7: Display Unit

VII. CONCLUSION

The project **"**Implementation of Touch Detection with Virtual Keyboard Using Raspberry Pi" has been successfully designed and tested. It has been developed by integrating features of all the hardware components and software used. Presence of every module has been reasoned out and placed carefully thus contributing to the best working of the unit. Secondly, using highly advanced ARM9 board and with the help of growing technology the project has been successfully implemented.

VIII. REFERENCES

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