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# Palmprint Acquisition using a Novel Line-Scan System

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***Abstract: Biometric recognition systems are widely used for personal identification systems. Biometric recognition of an individual means it is physiological or behavioural characteristics of the person. The Palm print captured by an individual means it is physiological characteristics of an individual .The palm print is unique to individuals. This type of systems provides effective and highly accurate biometric authentication, but this type of systems are used very rarely due to lack of small,user-friendly and flexible existing acquisition systems. This paper propose a novel palmprint acquisition system which is based on the line-scan image sensor. The acquisition systems consists of mainly four parts. They are line-scan sensor, synchronizing unit, and a field-programmable gate array controller. Compare to the volume of the proposed system is over 94% smaller than the volume of existing palmprint systems.***
***Keywords: Biometric identification, Sensors, Pattern recognization, Optical path.***

## I. INTRODUCTION

Unique identifiers are used for identifying a person by biometric authentication systems for example fingerprints, hand geometry, earlobe geometry, retina etc. The requirements of biometric systems mainly focus on a high recognition rate and robustness of the system. Widely used outdoor biometric applications are hand-held fingerprint capturing devices and iris capturing devices. Fingerprint sensors being integrated with laptops, embedded in locks and iris sensors being integrated with the steel safe. In both cases biometric systems provides high security. Current palmprint recognition systems are installed beside the door as a standalone device because they are too large to be embedded into a conventional door .This paper proposed a novel palmprint acquisition system. Palm is the inner part of a human hand and palmprint is the scan picture of human palm(eg.fig 1). Palmprint is unique for a person, so this uniqueness property makes it a biometric authentication scheme.

Now a days the corporate and public security systems, consumer electronics and point of sale applications are commonly used biometric verification for authentication. So the driving force behind biometric verification has been convenience for security reasons. Human palm consists of principle lines,wrinkles, ridges. These properties makes a palmprint unique. There exists numerous acquisition systems such as flatbed scanners, web camera-based systems and palmprint acquisition systems. Due to large size and the structure of the systems user interactions and applications were also limited. Palmprint capturing devices could save a large amount of space for a comfortable user interface and flexible structure if they using the line-scan technique. The line-scan sensor is also called the linear image sensor or 1-D image sensor. Because in this system pixels are placed in a linear array, it is totally different from area sensors. The advantage of using this layout of the pixel array is that an imaging structure can be simplified and space can be saved.

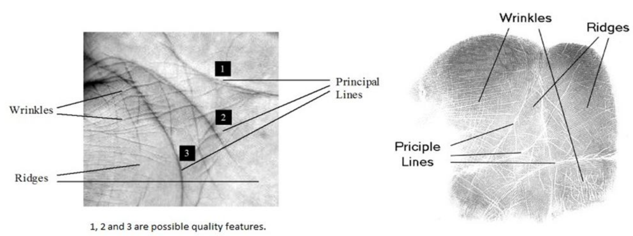


Fig.1 Palm and Palmprint

## II. EXISTING SYSTEMS

*A. Flatbed Scanner*

A flatbed scanners capturing pressed contact palmprint images[2].These images are of high resolution.For 300 dpi A4 size scan scanning time of a flatbed scanner is typically 10–20 s.

*B. Web Camera-Based Systems*

Web cameras are suitable for real-time video surveillance applications[3]. They are fast, flexible, and very compact. The WCBS was built in a simple case to protect the system against environmental light. The problem of the calibration of hand pose variations in 3-D space is challenging in case of WCBS.In WCBS the hand images were down-sampled using 2-D wavelet transform and ROIs extracted from hand images were normalized to 150 × 150.The false acceptance rate of this acquisition system is 0.17%.

*C. Palmprint Systems with Pegged Flat Platen Surface*

Palmprint systems with pegged flat platen surface keeps the hand stable[4].This platen surface avoids background interferences, that's why it can captures quality images and can achieves a good recognition performance from the captured image.

## III. LINE-SCAN PALMPRINT SYSTEM DESIGN

The line-scan image sensor which take the advantage of cutting-edge line-scan image sensors. The novel acquisition system consists of three main parts namely a synchronizing unit, an encoder and a field-programmable gate array (FPGA).A roller module which is composed inside the synchronizing unit is capable of synchronizes the motion of hands with the capturing of images of the line-scan image sensor[5]. Compared to the current area based systems, the resolution and quality of images are similar for the line-scan image sensors captured images. Based on an FPGA a control board is implemented inside the module. The Universal Serial Bus (USB) interface is also embedded on it. Works with USB interface the proposed capturing device works with either a desktop computer or an embedded platform. The system framework consists of three hardware parts 1) the line-scan image sensor;2) the synchronizing unit; and 3) the controller board.

*A. Line-Scan Imaging Scheme*

There is only one line of pixels in a line-scan sensor. To enlarge the imaging area pixels in a line-scan sensor can be extended[6]. The dynamic range could be improved by using a larger imaging area. This is totally different from area based sensors. There exists a tradeoff between resolution and dynamic range given a certain kind of pixels in area sensors. The optical path of area image sensor requires larger path, which is the most critical limitation of current palmprint area based sensor devices. A line-scan sensor requires a much smaller space for optical path. This will leads to smaller device size for line-scan sensor based devices. As,fig 2(a)[1] shows optical paths in area based and fig2(b)[1] shows line-scan sensor. Only one pixel long in the vertical direction field of view is present in line-scan sensor based systems. It is merely one of hundreds or one of thousands in the vertical direction comparing to the angle of view in horizontal direction.

The optical path which is required in a line-scan imaging system is the traveling of rays from the object to the sensor, which is a thin plane in 3-D space. The optical path in an area image sensor is a two-cone-shaped space, as Fig. 3(a)[1] shows. The sensor in the line-scan can be used to swipe the object without increasing the optical path. The optical path has to be increased for an area scan camera. Depending on the dimensions of objects, optical path is critical to the field of view in the area sensor system. The object is the palm in case of a palmprint acquisition system. To cover the palm the field of view has to be large enough. By increasing the distance between lens and objects or by extending the angle of view the field of view can be increased. This will leads to some problems. The problems are1) A longer distance between lens and objects brings a longer optical path, this will cause more space utilization.2) The angle of view is increasing, this will result to aberrations. Due to this reasons , the space taken by the line-scan sensor optical path is much smaller than the space taken by the area image sensor systems.

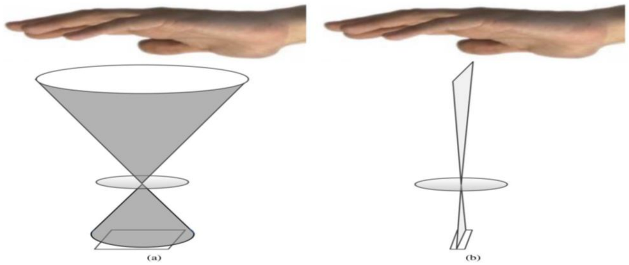


Fig 2(a)Optical path in area based sensor systems (b)Optical path in line-scan sensor system.

*B. System Framework*

A biometric system which is have both embedded and desktop versions. These types of acquisition systems deployed in handheld or mobile platforms. Both the desktop computation platform and the embedded platform are present inside the system framework which is compatible with the image-capturing device in line-scan sensor-based system. The regulation of all the device parts and communicates with the computation interfaces are controlled by embedded controller.

*C. Line-Scan Image Sensor—CIS Module*

The structure of a line-scan sensor is very simple. A linear array or a single line of simply arranged photodiodes are present. The camera or the object moving in a vertical direction is used by applications using line-scan sensors. This type of applications are used in object motion is under rigid control situations. The CIS is designed by traditional line-scan CCD or CMOS sensor chip, integrated CMOS line-scan sensor module. The LED lights, microlenses, and several CMOS line-scan sensors are integrated in CMOS line-scan sensor module. These parts are integrated into one package.

*D. Synchronizing Unit*

The motion of the hand with the CIS module capturing is synchronized by synchronizing unit. A pair of rollers, a gear set, and a photoelectric encoder are consists of the synchronizing unit. The synchronizing unit sends synchronizing pulse signals to the CIS sensor when the hand rolls through the synchronizing unit. The hand flattened and stretched with the help of rollers. If rollers is not present the palm could touch the surface of the CIS sensor. As a result the lines and texture of palm could be distorted from the captured images.

*E. Controller Board*

The controller is composed of a CIS driver, an A/D controller, a data buffer, and a USB interface these all are built in FPGA board. The core of this board is controls the CIS driver, the A/D controller, and the data buffer.FPGA made as core for the board.

fig(3) Proposed acquisition system.

*F. Acquisition System*

The proposed acquisition system is shown in fig(3)[1].The acquisition system consists of line-scan sensor, the synchronizing unit and the controller board.

## IV. EXPERIMENT AND COMPARISON

The most important criterion for evaluating an image acquisition system is the recognition performance of the overall system. When the systems are being used with different feature extraction, and matching methods in this cases the requirements for acquisition systems are quite different[7].To compare the recognition performance of proposed system with area based systems the verification performance is also need to be evaluated. For a complete palmprint verification system the proposed palmprint acquisition system is combined with a set of ROI extraction, feature extraction, and matching methods.

*A. Line-Scan Palmprint Database*

The database of the line-scan palmprint is built including 8000 LPS samples from 250 people.This database consists of 189 people are male and remaining are females.The males age group ranges from 20 to 63 years old. Two separate sessions collected samples of both hands . Each session collected eight samples from each hand. The 24.5 days on average was the interval between the two sessions.720 × 720 is the resolution of the samples collected.The palmprint images captured by the proposed device are

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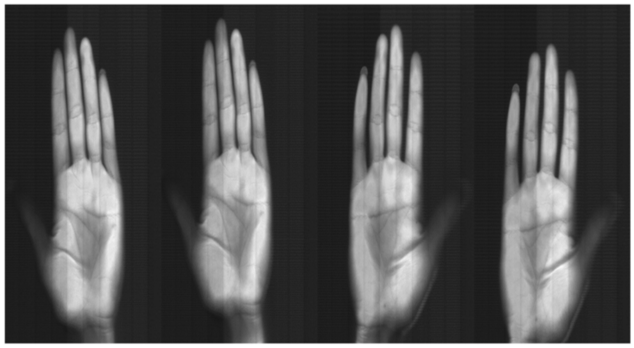
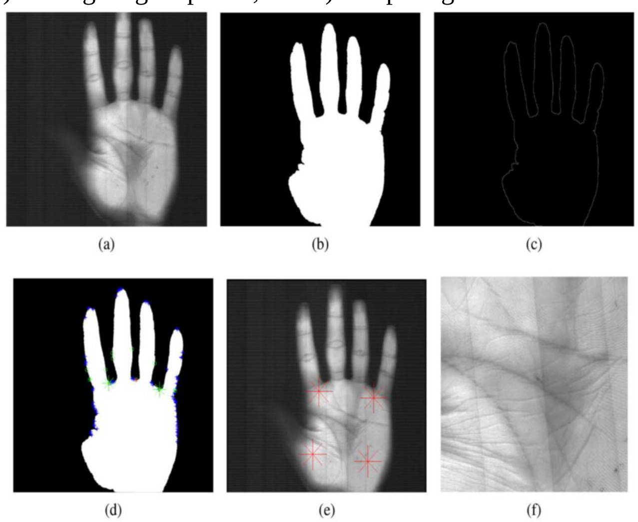
shown in Fig. 4[1].



fig(4) images captured by the proposed device

*B. Verification Experiment*

The verification experiment of proposed device consists of four steps 1)image capturing; 2) ROI extraction; 3)feature extraction; and 4) matching.The proposed device is used for image capturing.The ROI extraction consists of five steps. 1) preprocessing;2) binarization; 3) contour extraction; 4) finding tangent points; and 5) computing ROI location.This is shown in fig(5)[1].




fig(5).ROI extraction steps.a) preprocessing b) binarization c)contour extraction(d) Tangents points found. (e) Located ROI (f) Extracted ROI.

To extract features from palmprint and to encode the features of palmprint ROIs ,the competitive coding scheme is used in feature extraction step. The Hamming distance concept is used in the case of matching process.

*C. Comparisons with Current Area Sensor-Based Palmprint Systems*

The shape of acquisition system is 22 cm ×5 cm ×5cm.The current area image sensor-based systems is varies sizes from 32 cm × 16 cm × 19 cm 32 cm × 16 cm × 19 cm or 34 cm × 28 cm × 26 .From this the volume of proposed system is 6% smaller than current systems. Using the same imaging structure the volume of area sensor-based systems could not be reduced further.The synchronizing unit has improved the speed performance of the palmprint sampling process in case of novel proposed system. The verification performance is 0.048% comparable with most advanced area sensor-based systems.

## V. CONCLUSION

In this paper, to expand the application of palmprint biometrics,a novel line-scan sensor-based palmprint acquisition system is proposed . A customized and highly integrated line-scan sensor,a self-adaptive motion synchronizing unit, and a cross-platform control board are featured with in this LPS. Compared to volume of current palmprint systems, the volume of the proposed system is less than 6%. For online palmprint biometric applications this types of systems are suitable.

The LPS future research could go in three directions. First, a smaller system could be made if using further study on optimization of the mechanical structure of the current design and using the same structure of the proposed system .Second, the materials which are used for manufacturing of rollers and the structure of rollers could be improved. Third, motion of rollers can be integrated into the line-scan module for capturing perfect images.

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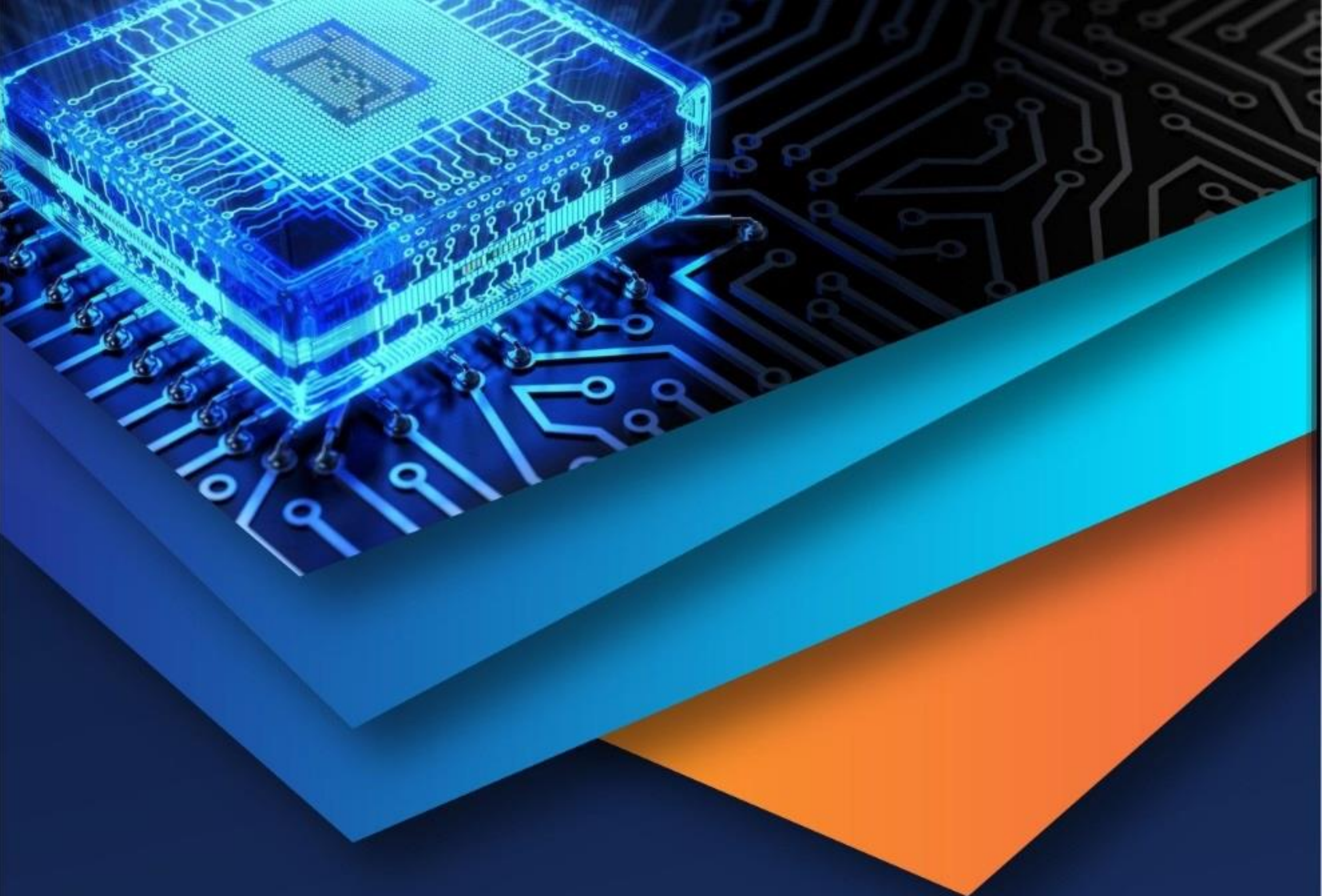


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