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An Architectural Design Proposal to Implement Li-Fi Framework

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Abstract: ***Harald Haas, a German physicist, invented the concept of Li-Fi abbreviated to Li-Fi. Li-Fi is the communication between two LED light sources by transmitting information through light in a speed faster than a human eye can detect. This paper explores the usage of LED light to act about as a Li-Fi source to transmit data. The information is caught utilizing the receiver device which is attached to an Android cell phone. This paper proposes a methodology on working up a Li-Fi based framework to facilitate the navigation inside a shopping mall using visible light.***

***Keywords*: *Li-Fi Transmitter, Photodiode* Arduino Uno, Light Emitting Diode (LED).**

I. INTRODUCTION

With the increasing number of shopping centers, it has become confound and troublesome for the customers to find out the shops and services they are in search of. The proposed work aims at providing all this information at customer's fingertips. This can be achieved using indoor navigation. Indoor navigation abilities are empowered by a wide range of advances, and most indoor navigation framework utilize a mix of technologies to achieve their capacity. A portion of the technologies are more seasoned, however have developed after some time. The proposed indoor navigation system is designed to provide
navigation inside shopping malls. Typically used GPS will not be able to provide the exact navigation within the building and that is where the Indoor Positioning System (IPS) comes into picture. The light sensitive device attached to the Android mobile device is used as a receiver to capture the data. These features can be combined in an application and the customers are required to install this application in their mobile phones so that they can use it in navigating inside the shopping malls.

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Indoor navigation can be effectively achieved by Visible Light Communication (VLC). VLC also called Light Fidelity (Li-Fi), provides an alternative way to deal with the drawbacks of radio frequency (RF) and wireless transmission frequency bandwidth. To make a correspondence line between node, a Li-Fi will require a transceiver to transmit what's more,
get the information. This transceiver will have a modulation procedure to make the LED empower to carry the information utilizing the light. The development of Li-Fi is to conquer the deficiency of the present innovation.
The visible light wavelength ranges from 375nm to 780nm and its theoretical bandwidth ranges from 400 THz to 800 THz. Li-Fi utilizes LED lighting as like the ones at present being used in numerous energy cognizant houses and places of work. Optical data transmission is done by modulating light imperceptibility by setting up a chip outside the LED bulbs. This project aims at a wireless system that enables to find out the present location of a person inside a shopping mall. The proposed work uses the concept of visible light communication transmission control in order to provide indoor navigation. The transmitting and receiving circuits are outlined by the visible light communication system. The application installed in the receiving device enables the transferring of the messages at user end.

II. LITERATURE SURVEY

Monica Leba et al [1] proposed LiFi- the path to a new way of communication in their paper. The paper summarizes maximum of the research, trends and applications carried out to date and appears at the exceptional aspects of the strength and weakness, implementations, demanding situations, VLC IEEE popular and facts modulation strategies of VLC and specific LiFi's new coined optical wi-fi communication technology. They have listed out the strengths of the use of LiFi technology. They are high speed, Security, Low cost, Low energy consumption, No electromagnetic smog, Safe for health, Licence free bandwidth, Distance and interferences, No standard yet. Many areas where LiFi system provide a cheaper, secure, reliable and ultra-high-speed communication infrastructure have already been launched worldwide, so we can summarize some of them as follows: Airplanes, Hospitals, Petrochemical industry, Nuclear power plants, In home and office appliances, Smart lighting, Vehicle and traffic lights, Underwater, in health surveillance, indoor navigation.
Alexis Duque et al [2] proposed the image processing algorithm to perfectly detect the LEDs and decode their signal. Encoding and decoding methods are proposed to enable flash-to-LED communication on non-rooted smartphones. They proposed bright mechanisms and protocols which cope with the flashlight signal jitter and detect its clock rate.

The bidirectional LED-smartphone VLC system and the experimental platform is described in this paper. The proposed algorithm finds out the LED position and decodes the signal on average in 18.4ms, for each frame, on Nexus 5 unrooted smartphone. Trong-Hop Do et al [3] clarifies the qualities of the obvious light correspondence framework utilizing moving shade system of CMOS sensor. It peruses out the information push by column. Photo diode and image sensor are utilized for VLC to get the light. In the paper, framework execution as far as data rate and signal to noise proportion is depicted.

Ya-Hsin Hsueh et al [4] proposed the robot indoor navigation framework utilizing visible light communication (VLC) system. The framework concocts a Robot control APP, a server, VLC LED lights and a Robot. Robot movement control module and VLC correspondence module of VLC Robot is portrayed in this paper. Most brief course calculation on APP is utilized to compute the separation between the client's area and the destination dependent on the client's decision and the chose point which gives the course with least weight. The determined outcome is passed to the Server and sent to the VLC LED Lamp to explore the development of the robot. They have played out a VLC robot which can move to the predetermined areas utilizing the Robot control APP.

Laura Filardo et al [5] proposed low cost solution to perform an indoor localization system. The position of the user in the indoor environment is predicted using smartphone embedded inertial sensors. The algorithm introduced in this paper is based on the Dead-Reckoning systems especially on the Pedestrian Dead Reckoning (PDR). In order to track the user during motion, Complementary Indoor Positioning System (C-IPS) is used. Two components of Android architecture namely, the activity and the Background service, is used to implement the C-IPS. Activity is the visual representation of an android application, and background service collects the data continuously and logs it. Result obtained from the experiment is encouraging and effective.

Sakshi Juneja et al [15] illustrated the indoor positioning system using visible light communication in the paper. On the subsisting lighting framework trilateration is connected to confine any signal utilizing LED bulbs as host and utilizing its light detecting capacity. On-off keying approach is received to permit the believed area originating from many light sources which are ungraceful over the common optical medium. They have used trilateration technique which utilizes visible light sources as Epsilon. In this paper the framework design of the Epsilon is shown. Epsilon is a visible light-based localization framework. It has two segments, namely the LED bulb and the device which will receive like a cell phone.

III. DESIGN

If you are using *Word*, use either the Microsoft Equation Editor or the *MathType* add-on (http://www.mathtype.com) for equations in your paper (Insert | Object | Create New | Microsoft Equation *or* MathType Equation). “Float over text” should *not* be selected. The key components for the development are an Arduino Uno board, wavelength unique LED and photodiode. Aside from the issue reliable of manufacturing and catching the light indicators, greater tool is predicted to channel and translate these signals. As an example, the suitable band pass channel can be utilized to filter approaching alerts with frequencies apart from those ideal; an optical channel can be a very good technique to clear out light of various wavelengths; a focus to middle drawing close light may be affordable if the mild pressure is low. On account of digital facts transmissions, a complicated signal processor at the 2 ends of the framework is needed to system incoming and outgoing data.

A. *Light Emitting Diode*

LED is a light producing semiconductor. At the point when electrons enter the semi-conductor, they start bonding with the holes present in the substrate and energy is discharged as photons. There are several factors that should be viewed as while picking a LED and these factors must be compared against one another. The most intensity of the LED impacts the rise time. A low power makes it possible to have a shorter rise time and expanding the intensity fabricates the rise time. The increase in intensity of the LED requires more power which in turn generates greater heat. The Arduino has a most extreme voltage output of 5 V, greatest current output of 1 A and can send a square wave with the most extreme recurrence of 50 kHz. To meet these criteria the OSRAM LED was picked.

B. *Photodiode*

The photodiode is a semiconductor changing over light into an electrical front line. The vast greater part of the photodiodes in the market are made for the reason for fiber optics. In bundles concerning fiber optics, the radiant sensitive location of the photodiode is little and the upward push/fall time is brief. With accelerated radiant sensitive spot, the response time may be slower. Without fiber optics bigger radiant sensitive vicinity enables additional light to be stuck with the aid of the receiver. On along these lines, the determination of photodiode is kept. The states of the photodiode are fast reaction time, spectral sensitivity in the obvious variety and immense radiant sensitive area.

C. *On – off keying*

The simplest form of data modulation is used in this project which is known as On-off keying. On-off keying is one of the most commonly used encoding methods. The logic value zero matches to LOW and HIGH is matched by the logic value one. In the case of VLC system, the LED is turned on to transmit a one and turned off to transmit a zero. This process takes place at such a high speed that the on and off of the LED is invisible to the human eyes.

D. *Li – fi transmitter*

The transmitter converts digital data into visible light. LED is appropriate to accomplish this due to its direct connection among current and force. The essential thought here is to differ the force of the LED. Intensity of the light relates to the symbol that is transmitted. We use Arduino board to accomplish this objective. The transmitter gets a sign from the PC utilizing USB Cable, at that point from GPIO pins on the Arduino, this sign controls the transistors which ON and OFF the power supply. The Arduino ports alone are not satisfactory to pass on the ideal proportion of current to make the power strong and speedy. To vanquish this, we use a transistor as a switch which makes it possible to switch greater proportion of current in less time.Li-Fi transmitter is shown in Fig 1.

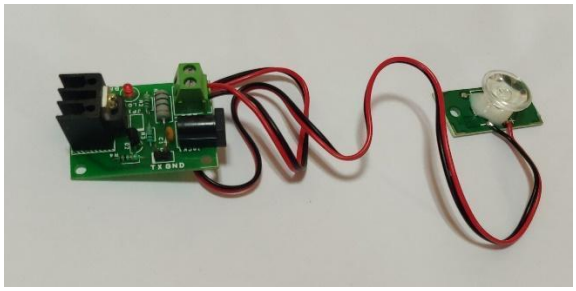

Fig. 1. Li-Fi Transmitter

E. *Li-fi receiver*

The CMOS camera of an Android gadget gets the signal sent from the transmitter. It, by then, changes over the moving toward light into an electrical signal using a photodiode and feeds it into the microcontroller. It channels and upgrades the signal. For a computerized signal Arduino can't get a voltage higher than 5V. To deal with this the circuit between the photodiode and Arduino should process the signal so it will in general be interpreted really. The current conveyed by the photodiode is of low value; thusly we use a high value resistor to change over it to voltage. This voltage is also upgraded to give the most ideal transmitted bits. Li-Fi receiver is as shown in Fig 2.

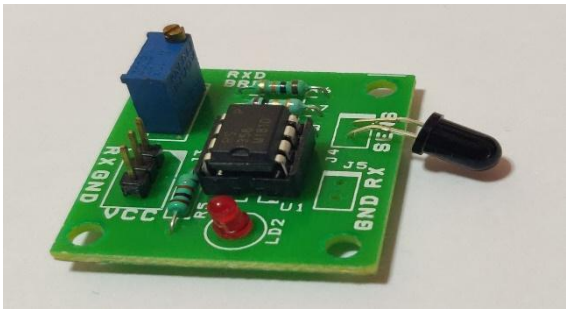

Fig. 2. Li-Fi Receiver

F. *Arduino UNO*

The Arduino UNO is an open-source microcontroller board primarily dependent on the Microchip ATmega328P microcontroller and created by Arduino.cc. The board is progressed with sets of analog and digital input/output pins that may be interfaced to various expansion boards (shields) and different circuits. The board has 6 analog pins,14 digitals pins and programmable width the Arduino IDE (Integrated Development Environment) by methods for a TYPE B USB interface. Arduino is shown in the Fig 3.

Fig. 3. Arduino UNO

IV. PROPOSED SYSTEM

The proposed system aims at solving the ambiguity of the user's when they enter a shopping mall by providing indoor navigation on the fingertips. This is achieved through the LEDs which are deployed across the building. Each LED connected to Li-Fi sensors which help in transmission and reception of messages. In the proposed system, LEDs are deployed across the building of the shopping mall fitted with the Li-Fi sensors which communicates with the receiver device. An application will be installed in user's phone through which he can select the section he wants to visit to inside the mall. The navigation to the destination is set on the application as soon as the user confirms his selection. Implementing a real-time map inside a building is the purpose of the proposed system. An external receiver is connected to the smart phone if the phone is not compatible with the features needed by the receiver.

A. *Flow Chart*

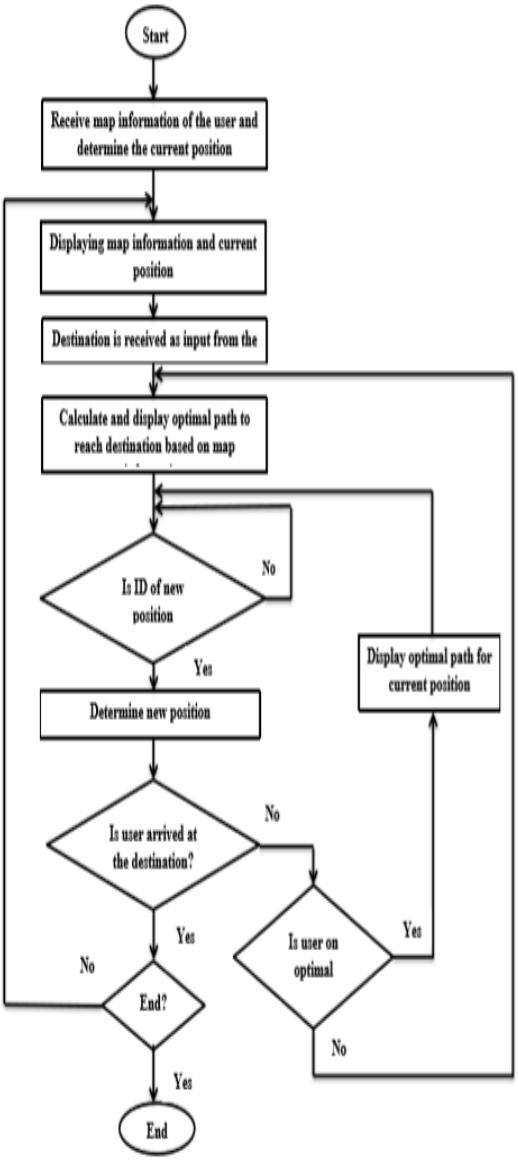

Fig. 4. Flowchart

B. *Modules*

- **Android Application:** ShopView is an Android application which must be pre-installed in the Android Mobile Phone of the User, with the goal that we can play out the tasks. This provides navigation to almost all shops present inside the mall. In this app the user can select the destination based on the category or he can also shop based on the offers present. The current offers present in the shops will be notified to the user based on his location.
- **Database:** The storing of the necessary data about the application and the users is done with the help of the SQLite database, a Google platform. This will also help the merchants to know about the behavior of their customers. This data will also help in improving the facilities provided for the customers. This plays a major role in the data analytics part.
- **Tera term:** Tera term is utilized as an interface to transmit strings between the transmitter and the receiver. Tera Term is a free, open-source, terminal emulator program. Different kinds of work stations, from DEC VT100 to DEC VT382 can be emulated by this. It underpins telnet, SSH 1 and 2 and serial port connections. Serial messages sent or received can be shown here as indicated by the com port chose.

C. *The Circuit*

The transmitter is constructed using an Arduino Uno board and a Li-Fi transmitter module which in turn is connected to a light emitting device, preferable an LED. The block diagram of this circuit is as shown below:

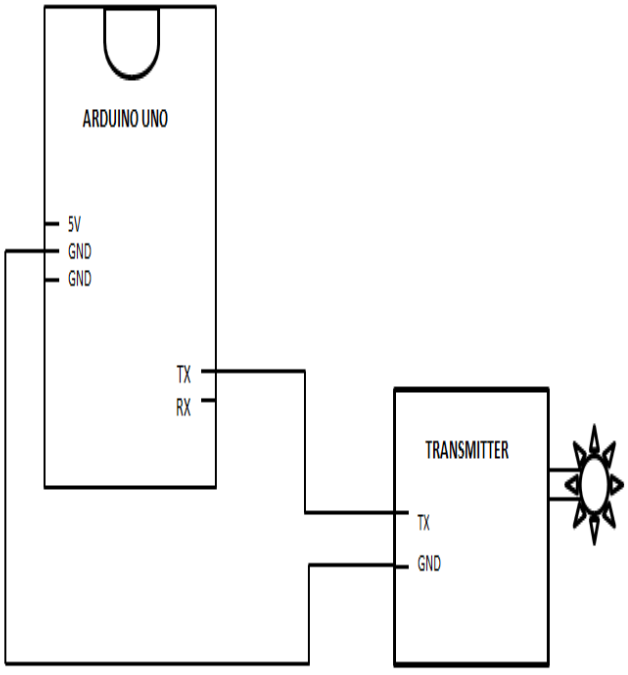

Fig. 5. Block diagram of Transmitter

The receiver circuit consists of an Arduino Uno board, a USB to Serial convertor board and a Li-Fi receiver module. Li-Fi receiver module is attached to a light sensitive device which receives the data sent from the transmitter.

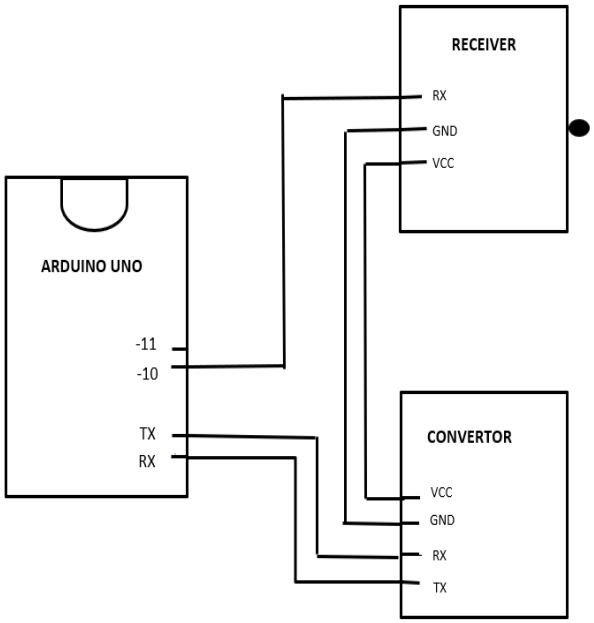

Fig. 6. Block diagram of Transmitter

V. RESULTS

The android application ShopView is developed for the user to interact with the Li-Fi circuit. User has to install and login to the application before using it. Various pages developed are as follows:

A. *Login Page*

Before the commencement of the navigation the admin needs to login into the server with the unique username and password that confidential to the shopping mall. Login page is shown in Fig. 7.

Fig. 7. Login Page

B. *Home page*

This section contains a brief introduction of the mall along with the images. The navigation bar in the top-left provides link to various other pages. Home page is shown Fig. 8.

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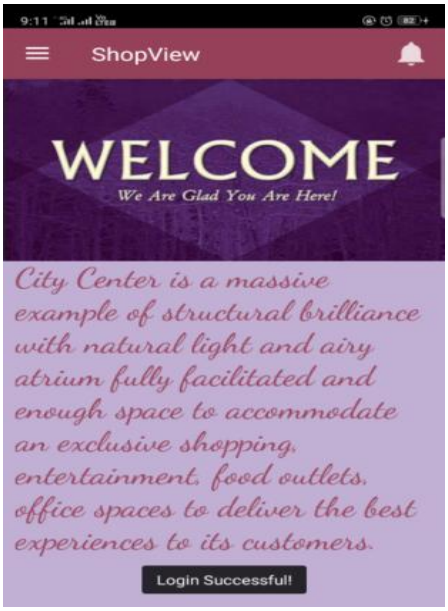

Fig. 8. Home page

C. *Offers page*

Various offers available currently in the mall are displayed in this section. The user can select the offer and get navigated to the shop offering that offer. Offers page is shown in Fig. 9

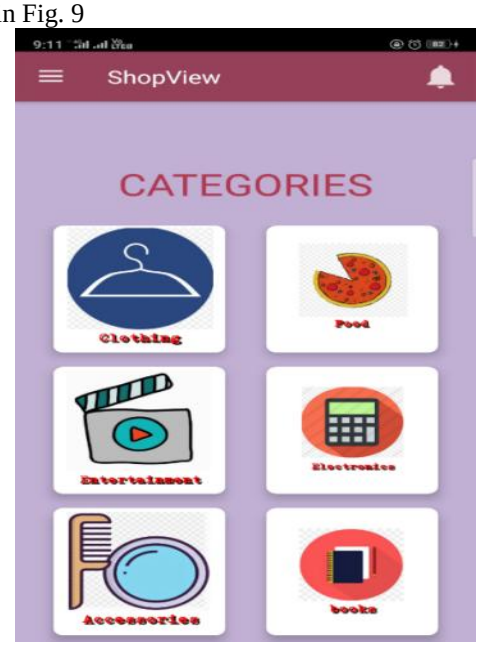

Fig. 9. Offers Page

D. *Categories Page*

The different categories of shops present inside the mall are displayed in this section. The user can choose and category he desires to visit. Categories page is shown in Fig. 10

E. *Shops Page*

This page contains the list of various shops under the selected category and few of the optional questions to know the user's interest better. Shops page is shown in Fig. 11.

F. *Navigation Page*

The route from the current location of the user to the selected destination shop is shown on the phone screen using which the user will easily get to know how he has to go to reach the shop faster. This is shown in Fig.12.

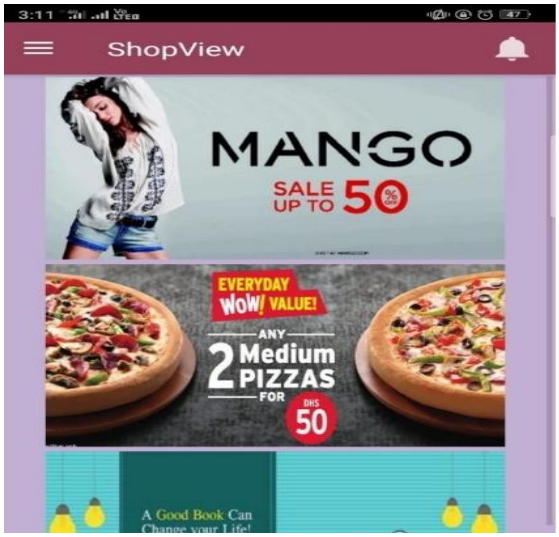

Fig. 10. Categories Page

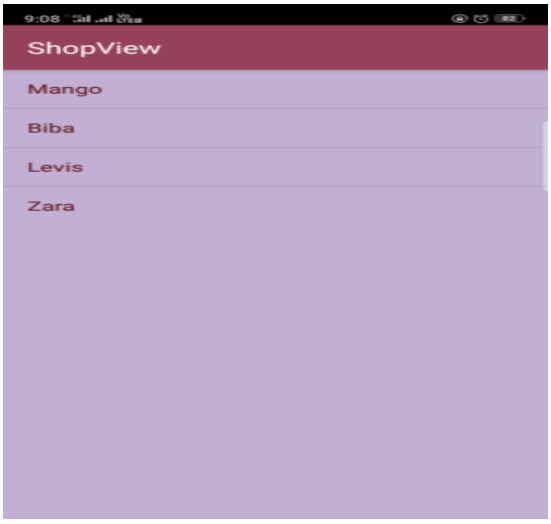

Fig. 11. Shop View Page

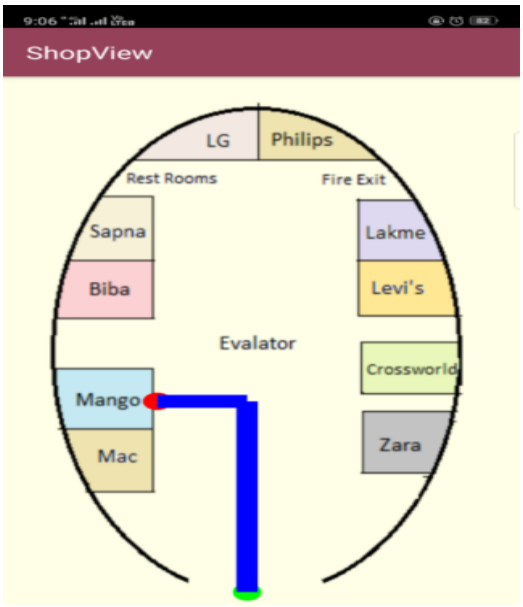

Fig. 12. Navigation Page

The hardware setup is done as per the connections shown above.

Fig.13. Transmitter device

Fig.14. Receiver device

Since the receiver device is external, it must be attached to the android device with the ShopView application installed. USB adapter is used to connect the receiver setup and the android device as shown below:

Fig.15. Interfacing receiver and the android device

VI. CONCLUSIONS

The effective utilization of the good side of LED's acting as energy saving, extended strength, roughness, eco- friendly and high reasonability is the main aim of the proposed work. The proposed work uses Visible Light Communication to widen the usage of an LED by transmitting digital data through it. The CMOS camera of the Android device is used as the receiver. The application installed in the Android mobile device helps the user by detecting his current position and redirecting him to the store he desires in the mall. The application can be made more user friendly by displaying the offers available in different stores inside the shopping mall and option to compare them. This work can be further improved by preventing the loss in the camera frames by maintaining synchronization between the mobile device and the hardware setup. The application can be made user friendly by giving voice input and voice outputs to give the instructions. Data mining can be used as well to provide suggestions to the users based on their previous searches and visits.

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