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Preface

Research is the important part for the academic development of Faculties and the students of the college. The college has established a committee known as Research Journal Committee for Science (includes physical and biological science) as well as research journal committee for arts). During the academic year students of undergraduate level of science and arts are performing various projects or research activities under the guidance of faculty. Students are necessarily required to get oriented towards research through such projects. The committee not only publishes the research but also make the students aware of the methodology of publication of any research in the journal.

I am happy to present the second consecutive issue of the **Student Research Journal of Arts and Science** for the year 2018-19. It includes research work of students in physical and biological sciences as well as from the arts. Our research journal has separate subject expert committee and Advisory committee which looks after the plagiarism of papers .The selected papers are published in the research papers . Our teachers are encouraging the students to take up research project and involve students too.

The objective of the journal is to provide a platform to research scholars and undergraduate students to highlight new knowledge, innovation, technology usage and latest tools of research in the areas of science and arts. The journal aims to follow standard practice in papers selection, refereeing, editing, proofing and production as per the latest methodology and standards.

Dr.P.B. Buchade
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Table of Contents

Sr. No.	Paper Title and Author/s	Page no.
1.	**Qualitative And Quantitative Analysis of Eugenol Andterpeniol from Clove (*Syzigiumaromaticum L.*) and Nutmeg (*Myristica Fragrans*, Houtt) Leaf Essential Oils** ***Tambe C. S., Das S. A., Damle M. S.***	**02**
2.	**Virtual Personal Assistants: An Emerging Trend in Artificial Intelligence** ***Bharti M. Hattale***	**13**
3.	**Academic Assessment with Automated Question Paper Generation and Evaluation** ***Vinayak Dethe, Aditi Satpute and Mrs. Khadtare Madhuri***	**20**
4.	**Servomotor Interfacing Using PIC Microcontroller** ***Rashmi Mate***	**27**
5.	**Edge Avoider Robot Using PIC Microcontroller** ***Snehal Zade***	**29**
6.	**Retro-Reflective Fiber Optic Displacement Sensor for Performance Optimization Using Taguchi Method** ***Asmita Pawar and Supriya Patil***	**32**
7.	**Design, Development and Experimental Study Of Novel Configuration of Reflectivity Invariant Retro Reflective Fiber Optic Sensor for Measuring Of Surface Roughness** ***Rashmi Mate and Supriya S. Patil***	**41**

Qualitative and quantitative analysis of Eugenol andTerpeniol from Clove (*Syzigiumaromaticum* L.) and Nutmeg (*Myristica fragrans*,Houtt) leaf essential oils

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ABSTRACT

This study was conducted with the aim to extract and purify the essential oil from the dried clove(*Syzigiumaromaticum* L.) flower buds, seeds of nutmeg(*Myristicafragrans*,Houtt) (commercially available in the local markets of Pune) as well as from fresh and dried leaves of clove and nutmeg(from nursery) which contains eugenol as a major component (clove) and terpeniol as a minor content (nutmeg). The essential oil from both the plant materials were extracted using hydro-distillation method. The essential oils were analyzed by Gas chromatography to estimate the relative concentration of eugenol and terpeniol in all samples against standard eugenol and terpeniol. Antimicrobial activity of the essential oils was checked against Gram-positive(*Staphylococcus aureus*, *Bacillus spp*.) and fungus (*Aspergillus niger*). The de-oiled meal of clove and nutmeg was subjected to biomolecule(Carbohydrates, Fats, Protein) and phytochemical (Flavonoids, Tannins, Terpenoid, Saponin, Glycoside, Steroid, Anthraquinone) detection.

Keywords: Clove*(Syzigium aromaticum* L.), Eugenol, Nutmeg(*Myristicafragrans*, Houtt), Terpeniol, Hydro-distillation, Essential oil, Gas chromatography, Antimicrobial, Biochemical, Phytochemical.

INTRODUCTION

The dried flower bud of clove and seeds of nutmeg are commonly used as spices in home kitchens. Clove is the tropical evergreen tree with a small, reddish-brown flower bud of the family Myrtaceae, which is indigenous to the Moluccas, or Spice Islands, of Indonesia[9]. Clove is one of the most ancient and valuable spices of the orient and holds a unique position in the international spice trade. The Strong aroma and pungent taste makes it useful in flavouring, garnishing the food, and preservation.[1].Nutmeg is a dioecious evergreen aromatic tree with dark green and lustrous leaves,which is known to have been a prized and

costly spice incuisine as a flavouring, medicinal, and preservative agent.[16].Essential oils refer to the subtle, aromatic and volatile liquids extracted from the flowers, buds, seeds, leaves, stems. Clove essential oil is useful in dental formulations, tooth paste, breath freshner, mouth washes, soaps, cosmetic items and insect repellent also possess anthelmintic ,analgesic, antibacterial, antifungal and anticarcinogenic properties.[2].Nutmeg oil has warm, spicy, sharp aroma which has analgesic, antiseptic, digestive properties. In aromatherapy it is used for the treatment of arthritis, gout, nausea, anxiety, fatigue and many other health conditions[15]. Clove and Nutmeg oil is commonly extracted by hydro distillation[1], steam distillation, or solvent extraction method. Clove oil is a mixture of different constituents, with three main active ingredients being eugenol, caryophyllene, and acetate eugenol and it contributed to the antimicrobial andantioxidant properties of the oil.[2],[4].The major component of nutmeg essential oil are sabinene (21.38%), 4-terpineol (13.92%) and myristicin (13.57%) [22].A gas chromatography, with nitrogen gas as the carrier gas and a flame ionization detector and Software provided with it is used to analyze the constituents of the volatile sample with respect to retention times, peak areas, and peak heights. One major component is used as a standard and the values of this standard are compared with the unknown samples so as to estimate the quantity of that component in the unknown sample. Co-GC is the simple technique to identify the standard major component in the unknown sample.[4],[18].In well-diffusion procedure for antimicrobial activity, the suspension of the test microorganism is spread on a sterile media plates. The test compound at a desired concentration is placed within the wells which are bored on media. Generally, antimicrobial agent diffuses into the agar and inhibits germination and growth of the test microorganism and then the diameters of inhibition growth zones are measured.[13],[25].De-oiled meal is the leftover extract obtained after the extraction of an essential oil from a plant source. The biomolecules of the de-oiled meal of clove and nutmeg seeds are screen by the biochemical (Carbohydrates, Fats, Protein) and phytochemical (Flavonoids, Tannins, Terpenoid, Saponin, Glycoside, Steroid, Anthraquinone) tests.[37].

MATERIALS AND METHOD:

Collection of plant materials: Commercially available dried flower bud of clove and nutmeg seeds were purchased for this study from Pune. The young plants and fresh leaves of clove and nutmeg were purchased from a nursery, near Dapoli, Konkan.

Extraction of essential oil by hydro-distillation method: Essential oils from dried flower bud of clove, nutmeg seed and dried and fresh leaves of clove and nutmeg was extracted by hydro-distillation method using Clevenger apparatus. Each sample was weighed 100 g for extraction. The obtained essential oils were purified with anhydrous sodium sulfate and yield(%) of oil was calculated. The oil was stored in a refrigerator with temperature 4 °C in a sealed vial prior to analysis.

Gas chromatography: Perkin Elmer Clarus 500 GC was used for the study. The GC of clove oil samples and standard Eugenol(1gm/ml) was performed with, Maximum temperature - 220ºC; Oven program – 60 – 220 ºC at 5 ºC/min, Hold time-15 min at 220ºC,Injector temperature - 250ºC, Detector temperature - 300ºC, Carrier gas – 11 psi. 100 µg/µL of Eugenol stock was prepared.For GC of nutmeg oil samples and standard Terpineol (1gm/ml) - The Isothermal temperature - 160ºC, Oven program - 160ºC - 10 minutes, 160ºC-250ºC - 15ºC/min, Hold time - 5 minutes at 250ºC, Injector temperature - 220ºC, Detector temperature - 250ºC, and Carrier gas - 11psi, Attenuation - -3 was used.

Antimicrobial activity:

Test organisms- Gram-positive organisms - (*Staphylococcus aureus*, *Bacillus spp.*)and Fungus (*Aspergillus niger*).Pure culture of bacterial test organisms were subcultured on a sterile MH agar plate by streak plate method and fungal test organism on a sterile sabouraud agar slants.The bacterial culture was incubated for 24 hours at 37 ºC and fungal culture at room temperature (24-25 ºC) for 4-5 days.

Antimicrobialassay : Sterile MH agar media and sabaoraud agar media plates were used. From the prepared bacterial cell suspension and fungal spore suspension, 0.1 ml of cell suspension for each microorganism *Staphylococcus aureus*, *Bacillus spp.*, and *Aspergillus niger* was spread on media plates and wells were made in a plate using sterile borer. Different concentrations of clove oil extracts and standard eugenol (10%, 5% and 2.5%) as well as nutmeg oil extract and standard terpineol (60%, 70% and 80%) was prepared.20 µL of diluted oil extracts and standard were added into the wells of respective plate. The bacterial test culture plate was incubated at 37 ºC for 24 hours and fungal test culture plates at room temperature 23-24 ºC for 4-5 days.

Detection of Biomolecules and Phytochemical screening of de-oiled meal of clove and nutmeg :

Tests for biomolecules: Carbohydrate test, Starch test, Proteins test, Fats test.

Phytochemical tests: Flavonoids, Tannins, Terpenoids, Saponin, Glycosides, Steroid, Anthraquinone[37].

RESULT AND DISCUSSION:

Sensory evaluation of essential oils from both plant materials.

Characteristics	Clove bud/dried/fresh leaves	Nutmeg seeds	Nutmeg fresh leaves	Nutmeg dried leaves
Color	Pale yellow	Pale yellow	Colorless	Pale yellow
Clarity	Clear	Clear	Clear	Clear
Odor	Spicy and pungent smell	Spicy	Spicy	Spicy
Odor intensity	Strong	Strong	Mild	Strong
Solubility	Slightly soluble in water. soluble in organic solvents (acetone,DMSO)	Insoluble in water. soluble in acetone, DMSO	Insoluble in water. soluble in acetone, DMSO	Insoluble in water. soluble in acetone, DMSO

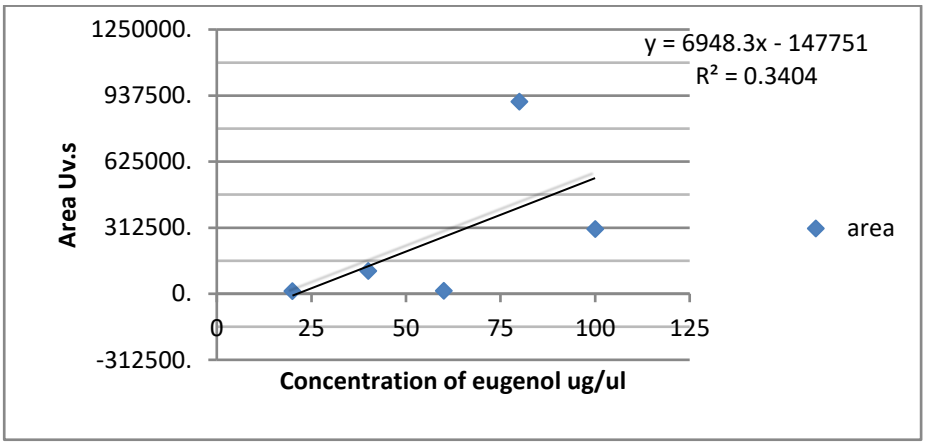
Yield percentage

Essential oil samples	Yield %
Clove Dried flower bud	3.5310
Clove Fresh leaf	0.3077

Clove Dried leaf	7.3742
Nutmeg Seeds	0.4675
Nutmeg fresh leaves	0.1155
Nutmeg dried leaves	0 . 2 8

Analysisof essential oils with respect to standard Eugenol and Terpineolby GC -

Image1Concentration of terpeniol and eugenol (µg/µl) vs Area (µV.s)



From gas chromatography it can be said that Eugenol is present in more concentration in dried and fresh leaf than dried flower bud. GC analysis was done to match the peak position between the clove oil extract and eugenol standard. After GC analysis the highest peak was observed at same position as compared to standard eugenol. Thus, the GC analysis of oil extract of clove indicated the presence of eugenol because of similar peak at same time was observed for both eugenol standard and clove oil. In case of nutmeg, it can be understood that Terpineol is present in more concentration in Nutmeg seed oil. It is present in Fresh leaf oil and dry leaf oil but in very low concentration which cannot be detected by Gas chromatography. The concentration of unknown i.e., terpineol in seed oil is measured from the graph and it is 270.230 µg.

Chromatograms – for nutmeg

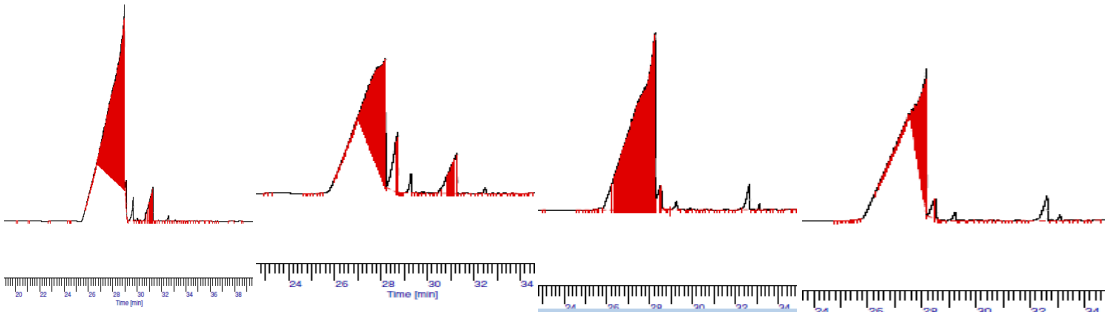
1.Co-GC2.**Driedseed 3.Fresh leaf oil 4.Dried leaf oil**

Image1Image1Image1

Image1

For clove-

1.Co-GC 2.Flower bud oil 3.Fresh leaf oil 4.Dried leaf oil



Antimicrobial activity:

The following graphs showed results for antimicrobial activity – Graph 1 and 2- concentrartion(%) vs zone of inhibition(mm) for nutmeg oil extracts for test organisms *S.aureus* and *Aspergillus niger* respectively. Graph 3 and 4- concentrartion(%) vs zone of inhibition(mm) for clove oil extracts for test organisms *Bacillus spp*. and *Aspergillus niger* respectively.

1.*S. aureus*2. *Aspergillus niger*

3.Bacillusspp.4.Aspergillusniger

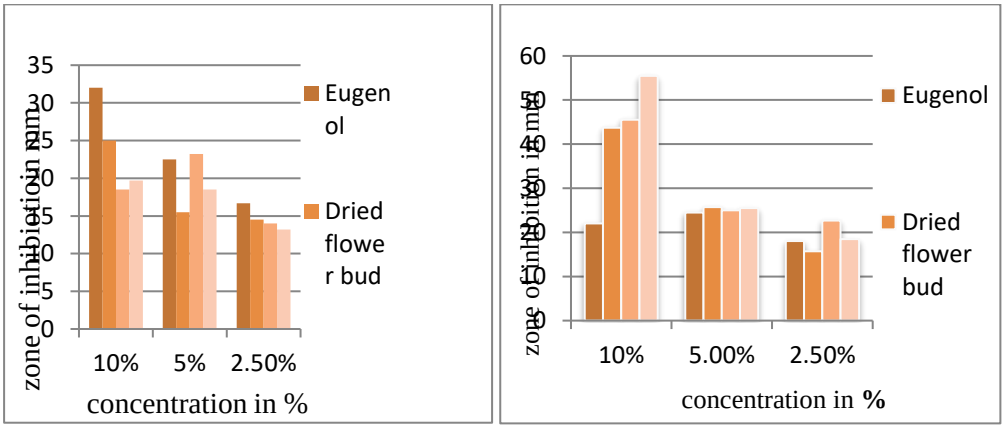


Image1

Biomolecules and phytochemical detection of de-oiled meal of clove and nutmeg-

Plant constituents	Aqueous extract of de-oiled meal of clove	Aqueous extract of de-oiled meal of nutmeg
Glucose	+	+
Starch	_	-
Protein	_	-
Fats	+	+
Flavonoids	_	+
Terpenes	_	-
Terpenoids	+	-
Saponin	_	+
Glycoside	+	-
Steroid	_	-
Anthraquinone	_	-

Phytochemical analysis helps in identification of source which are available therapeutically and industrially. The secondary metabolites were qualitatively analysed. The aqueous extract of de-oiled meal of clove dried flower bud and nutmeg dried seeds showed few plant constituents.

CONCLUSION:

The essential oils from fresh and dried leaves of clove plant showed the similar antimicrobial and anti-fungal activity. This antimicrobial activity was due to eugenol as both eugenol

standard and essential oils from clove showed same results for zone of inhibition. GC analysis of clove oils showed that Eugenol, the main component of clove oil which mainly obtained from clove dried flower bud was also present in fresh and dried leaf oils. It highlighted that one can use essential oils from fresh and dried leaves instead of dried clove flower bud. The amount of oil present in seeds is more than that of the oil present in fresh and dried leaves. Out of fresh and dried leaf, fresh leaf has the lowest amount of oil. This may be because it has more water content and more tissue is required to get large amount of oil. From the Gas chromatographic analysis, it is concluded that nutmeg seed has highest concentration of terpineol whereas the concentration of terpineol is very less in fresh and dried leaf essential oil. Because of their low concentration it did not get detected. Terpineol is not the inhibitory component of the nutmeg essential oil. There may be some other compound which is present in the essential oils that has antimicrobial activity. This can be detected by GC-MS, where each of the components of essential oil is identified.The de-oiled meal of clove flower bud and nutmeg dried seeds also showed presence of biomolecules and phytochemicals which revealed that after extraction of oil from plant material remaining waste product can be used further.

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Virtual Personal Assistants: An Emerging Trend in Artificial Intelligence

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ABSTRACT

Artificial intelligence in today's world is progressing rapidly with new advanced innovations day in day out. Today's computer systems are designed to perform small tasks, for instance, facial recognition, car driving, and performance of other minor duties. However, the primary goal of artificial intelligence is to develop advanced and more complex systems that would outperform humans at whatever way. This includes the performance of more complicated tasks like playing chess and solving equations. Therefore, the future goal of AI is to perfect all human activities and provide better solutions to problems than the human can do. The development of a super AI will mark the greatest invention in the human history. Consequently, the invention of more advanced technologies has significantly helped in war eradication, proper means of fighting diseases and developing appropriate prevention measures. Artificial Intelligence is the link between sensing of the world, perception of the world, and intelligent action in the world.

Keywords: Artificial intelligence, Personal assistance, virtual personal assistance

INTRODUCTION

I. VIRTUAL ASSISTANT:

A virtual assistant is a software agent that can perform tasks or services for an individual. Sometimes the term "chatbot" is used to refer to virtual assistants generally or specifically those accessed by online chat. In this paper we tried to study virtual Environment and virtual Assistant Interfaces, and the paper presents applications of virtual assistant that helps in providing opportunities for humanity in various domains.

Virtual Assistant technology has been a promising technology applicable in various domains of application such as training simulators, medical and health care, rehabilitation , education, engineering , scientific visualization , and entertainment industry.

The technologies that power virtual assistants require massive amounts of data, which feeds artificial intelligence (AI) platforms, including machine learning, natural language

processing and speech recognition platforms. As the end user interacts with a virtual assistant, the AI programming uses sophisticated algorithms to learn from data input and become better at predicting the end user's needs.

Any virtual Assistant basically consists of three layers:

1. Speech to text
2. Text Analysing
3. Interpret commands

Virtual assistant capabilities:

Ten tasks for a virtual assistant

1) Add events to calendar
2) Add items to to-do lists
3) Control smart home devices
4) Make and receive phone calls
5) Create text messages
6) Get directions
7) Hear news and weather reports
8) Find hotels or restaurant
9) Check flight status
10) Request songs

II. Top Intelligent Personal Assistants or Virtual Assistants/Agents:

1. Google Assistant:

Google Assistant is an artificial intelligence-powered[2] virtual assistant developed by Google that is primarily available on mobile and smart home devices. Unlike the company's previous virtual assistant, Google Now, the Google Assistant can engage in two-way conversations.

In 2017, Google Assistant was installed on more than 400 million devices. The features include:

- letting third-party device makers incorporate their own "Actions on Google" commands for their respective products
- It allows you to basically enquire about anything, be it questions about the weather,

flight status, or places; making a reservation, setting a remainder etc.

- Google Assistant allows users to activate and modify vocal shortcut commands in order to perform actions on their device (both Android and iPad/iPhone) or configuring it as a hub for home automation.

In addition to these new flight capabilities, you can also now book a hotel room in the US via your Android or iOS smartphone with a simple command like,"Hey Google, I"d like to book the Cambria Hotel in New York on January 12th," which will pull up availability, pricing, booking and payment using existing Google Pay credentials.

III. Latest Google Assistant Device:

Nest (A home security system) - With the Google Assistant update, Nest Cam IQ owners will be able to access the same version of Google"s voice-based AI that lives on Android, iOS, and Google Home devices. You can ask Google Assistant basic web queries, create calendar appointments, set reminders, and also control other Nest and Nest-compatible products like the Nest Thermostat and Philips Hue smart lights.

GE'S KITCHEN HUB - The Kitchen Hub is a 27-inch smart hub display that can be installed above your oven and also works as a functioning ventilator. You no longer need a middleman to use Google Assistant to give voice commands to your Wi-Fi-connected GE Appliances. The manufacturer announced today that its appliances would work directly with Google's voice-activated assistant without the need to use the Geneva Home Action. That means you no longer have to say, "Hey Google, ask Geneva Home to preheat the oven to 350 degrees." Instead, you can just say, "Hey Google, preheat the oven to 350 degrees" to devices that include Google Assistant, such as the Google Home smart speaker. "Working with Google, we have created a more natural way to communicate with your appliances that allows you to speak your request like you would with any friend or family member who's helping around the house," said Shawn Stover, vice president of GE Appliances' SmartHome Solutions team, in a press release.

The change applies to all of GE Appliances' connected appliances, including ovens, dishwashers and

washing machines. To enable the integration, you link your Google Home account to U+ Connect, GE

Appliances' platform that connects appliances and internet services.

Siri:

One may be familiar with Siri, or at least the concept of it. Apple introduced this voice-activated feature in 2011, and they‟ve been adding features ever since.Siri will answer your questions and give you sports updates. She‟ll give you reminders and set alarms or timers, navigating areas, finding information on entertainment, Send texts and place calls or FaceTime just by using your voice. Siri makes it easy for you to life your life hands-free. It‟s available on all Apple devices, including iPhone, iPad, Mac, Apple Watch, Apple TV etc.

Cortana:

Cortana is a virtual assistant created by Microsoft for Windows 10, Windows 10 Mobile, Windows Phone 8.1. Cortana can set reminders, recognize natural voice without the requirement for keyboard input, and answer questions using information from the Bing search engine. Cortana is currently available in English, Portuguese, French, German, Italian, Spanish, Chinese, and Japanese language editions, depending on the software platform and region in which it is used.

Amazon Echo:

Amazon Echo (shortened to **Echo** and known colloquially as **"Alexa"**) is a brand of smart speakers developed by Amazon. Echo devices connect to the voice-controlled intelligent personal assistant service Alexa, which responds to the names "Alexa", "Echo", or "Computer".

The features of the Amazon Echo

The features of the device include: Voice interaction, music playback, making to-do lists, setting alarms, Connect your music and listen to your favourite songs on command, streaming podcasts, and playing audiobooks, in addition to providing weather, traffic and other real-time information. It can also control several smart devices, acting as a home automation hub.

Device makers introduced many new products with Alexa -- ranging from pianos to bikes to bed frames to routers to vehicle navigation systems. Some new products are listed below.

- **Smart Home Devices with Alexa: LG** announced their connected TWINW ash washing machines and dryers will work with Alexa. **Hamilton Beach** announced a new smart coffee maker with Alexa. **Hisense** announced it would add Alexa into its smart TVs
- **Alexa Auto**: **Byton** announced its new electric SUV will incorporate Alexa for voice control. **Luxoft** announced Alexa will be integrated into vehicle dashboards, infotainment, and navigation systems. **Telenav** announced Alexa will be integrated into its automotive navigation system.

- **Ring(A Home Security)** - Ring is the smart security solution that lets you watch over your home from anywhere. Now you can use the Ring skill to manage all your Ring devices, including Ring Alarm, doorbells, cameras and any locks connected to your Alarm Base Station. Simply enable the Ring Skill in the Alexa App, and link your Alexa and Ring accounts to get started.

- **Numi 2.0 Intelligent toilet with KOHLER Konnect** - Numi 2.0 intelligent toilet with KOHLER Konnect is Kohler‟s most advanced toilet. The Numi 2.0 offers personalized experiences that let users fine-tune every aspect of their experience to their exact preference, from ambient colored lighting to wireless Bluetooth® music sync capability to the heated seat. Numi 2.0 delivers hands- free control, personalized cleansing functionality, and exceptional water efficiency.

Numi 2.0 will come equipped with embedded Amazon Alexa for easy voice control to active toilet features as well as Alexa commands such as checking weather, traffic, accessing news, etc.

Features of Numi 2.0 with KOHLER Konnect can be controlled through voice- command, the KOHLER Konnect app, the remote or through internal sensors that created an automated experience.

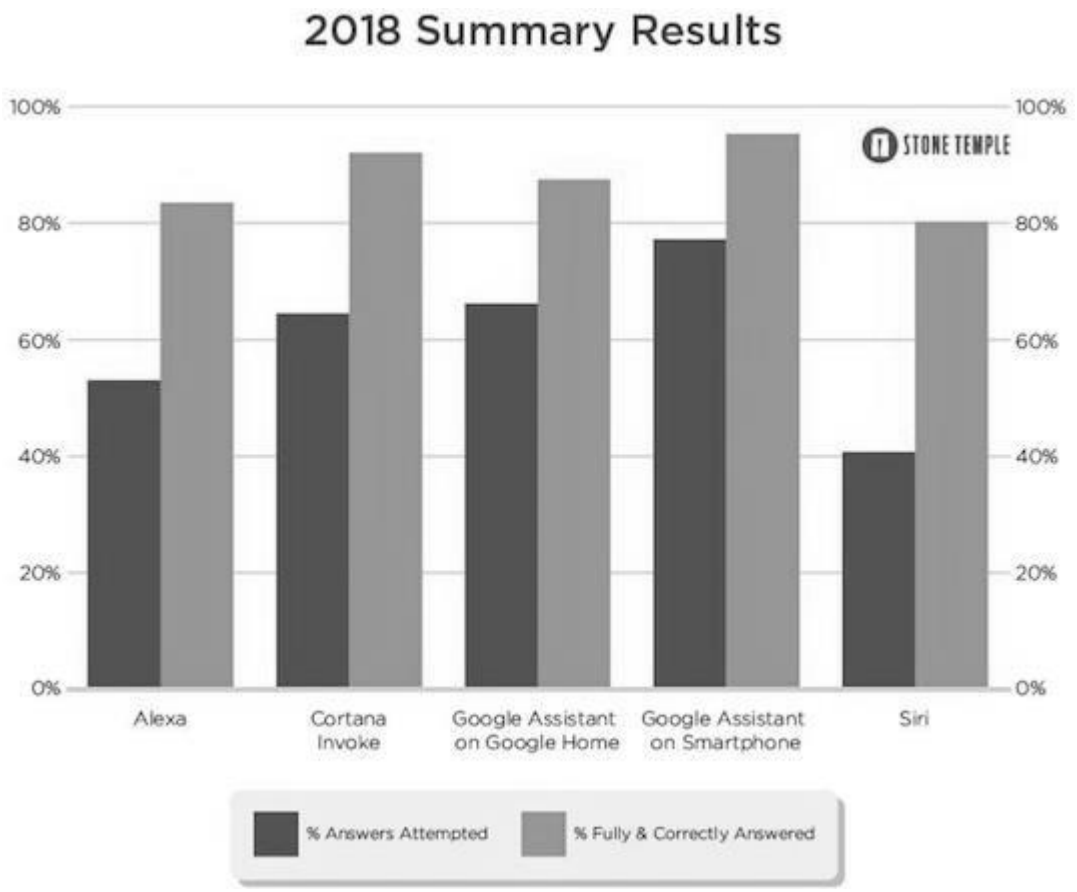
Research by Gartner has predicted 20% of smartphone user conversations will happen with virtual personal assistants (VPAs) by 2019. As the usage of VPAs such as Siri and Google Now increases, such platforms will become more intelligent, helping smartphone user‟s complete tasks in more intuitive ways. At present, 42% of people in the US and 32%

in the UK have used a VPA on their smartphone over the last three months, while 37% use the feature on their smartphone at least once a day.

SEO firm Stone Temple says that Google Assistant continues to outpace Amazon Alexa, Apple Siri and Microsoft Cortana in terms of both the number of questions answered and answered correctly. The company asked each assistant 4,952 questions again in 2018 and even differentiated performance between Google Assistant on a smartphone and through Google Home. The results show Google Assistant on smartphone significantly outperformed all other voice assistants in terms of question answer attempts and correct answers.

The study methodology asked each voice assistant identical questions and determined if it:

- Answered verbally
- Whether the answer was from a database (e.g. Knowledge Graph)
- If the answer acknowledged third-party source (e.g. “According to Wikipedia.”)
- Understood the question
- Attempted to answer the question and did so incorrectly or correctly



"All four of the personal assistants include capabilities to help take actions on your behalf (such as booking a reservation at a restaurant, ordering flowers, booking a flight), and that was not something we tested in this study. Basically, we focused on testing which of them was the smartest from a knowledge perspective."

The future of virtual assistants :-

Tomorrow's virtual assistants will be built with more advanced cognitive computing technologies, which will allow a virtual assistant to understand and carry out multistep requests and perform more complex tasks, such as making a plane reservation. Education is another area where we can create virtual environment and can be used for learning of the kind expected to occur in schools, colleges and universities. Personal assistants can change

your life, but they can be pricey. If you‟re working for yourself or for a small company, or if you‟re just feeling overwhelmed in your everyday life, hiring a personal assistant might sound like a pipe dream.

Hospital uses intelligent virtual assistant for more accurate order entry:

When physicians juggle a lot of tasks, they can forget to place a necessary order. Artificial intelligence is helping one hospital system remedy this and avoid medical mistakes. When patients are very sick, physicians need to order multiple medications and lab tests, Sagel said. For a physician, this juggling act can be a challenge and, he added, often, physicians don't remember to order all the necessary medications and lab tests a patient needs. To remedy this problem, Landmark decided to use an intelligent virtual assistant. With the help of Nuance's intelligent virtual assistant, Florence, Landmark is working to ensure patient medications and lab tests are not forgotten. And progress is being made: With the help of Florence, over the course of 18 months Landmark has been able to reduce physician order entry errors by about 30%.

Voice assistants are driving new forms of advertising –

Robb Hecht, adjunct marketing professor at Baruch College, called voice assistants “the true first interactive tool in the home that provides brands the capability to dynamically offer up ads in the future that could be user controlled.” In other words, he said, “Today, Alexa and Google Home don't offer much advertising outside of allowing brands to build content and sponsor skills or apps within Alexa. Skills are functions that allow Alexa to react to a customer‟s audio commands.”But, he added, that may soon change if Amazon allows brands to sponsor skills directly.

“In the future, we can imagine „pick your story‟-type advertising,” he said. “So, for example, if Ford wanted to advertise on Alexa, they might do so within a skill about „how to buy a new car.‟ As the user answers various questions, Alexa responds with differing answers or information choices, based on how the user responds.

Voice assistants are enhancing personalization –

Per Tyler Riddell, vice president of marketing for eSUB Construction Software, the specificity of a voice search helps give details about a user‟s context, which yields a more

personalized result.In addition, both Google Assistant and Alexa can recognize individual voices, offering catered results for things like messaging, briefings, shopping and music.

And Pete Meyers, marketing scientist at SEO software firm Moz, said Google has been pushing toward individual voice print identification on all of its devices, which has even more implications for personalization, like using someone's voice to access their own settings, search history, etc., just as logged-in search normally does. But, he said, it‟s still early.

“Unlike a computer or phone, where profile switching takes a couple of steps, this would be automatic,” he said. “I could ask for something like, „My flights,‟ and my wife could turn around and ask the same question ten seconds later and get an entirely different answer.”

Meyers said there‟s also been talk about factors like a user‟s accent or emotional tone triggering different

results from a voice assistant, but, he said, “that's longer-term and there are a lot of potential issues to overcome.”

Virtual assistants are quickly evolving to provide more capabilities and value to users. As speech recognition and natural language processing advances, so too will a virtual assistant's ability to understand and perform requests. And as voice recognition technology improves, virtual assistant use will move deeper into business workflows.

CONCLUSION:

Nowadays, VR technology has been applied in various domains such as training simulators, medical and health care, education, scientific visualization, and entertainment industry. Virtual assistant can lead to state of the art technologies like Second Life, too. Virtual Assistant (VR) is a term that applies to computer-simulated environments that can simulate physical presence in places in the real world, as well as in imaginary worlds. Like many advantageous technologies, beside opportunities of Virtual Assistant and Second Life, unavoidable challenges appear, too. In this paper, Virtual assistant types and structural elements of a virtual assistant system are described. Two main of these elements: Virtual Environment and Virtual Assistant Interfaces are explained further. Then applications of virtual assistant that providing us opportunities in various domains are

described and at last, challenges of applying virtual assistant technology are presented. Of course, efforts are underway to overcome the challenges in future to use the advantages of this technology as more as possible.

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Academic Assessment with Automated Question Paper Generation and Evaluation

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ABSTRACT

We have introduced an automated way which would permit the operation of generating exam paper to be further well organized and productive and it would also aid in developing a database of questions which could be further classified for blending of exam question paper. Currently, there is no systematic procedure to fortify quality of exam question paper. Hence, there appears a requirement to have a system which will automatically create the question paper from teacher entered description within few seconds. We have implemented a modern evolutionary path that is able to manage multi- constraints issue along with creating question papers for examinations in autonomous institutes from a very vast question bank database. The utilization of randomization algorithm in an Automatic Question Paper Generator System which has been implemented specially for autonomous institutes are described. The endeavour needed for generating question paper is diminished after the implementation of this advanced system and because of this advanced system there is no obligation for humans to ponder and employ time which can be utilized on some additional important duty instead of designing question paper.

KEYWORDS

NLP, POS Tagging, Answer Evaluation, Random Question Generator, keyword extraction, Descriptive Answer verifier.

INTRODUCTION

The examination committee in an institute works in a very conventional manner. This way it is time consuming and makes all instructors tired of doing these same activities frequently. Question paper generator is a special and unique software, which is used in school, universities and colleges.

Test paper setters who want to have a huge database of questions for frequent generation of question can use this too. This software can be implemented in various medical, engineering and coaching institutes for theory paper. You can create random question papers with this software anytime within seconds. You can enter questions based on units, chapters and subjects depending upon the system storage, capacity and as per the requirement. For entering questions, you have to first specify the subject and you can enter unlimited questions in a unit. Examinations predominantly use question papers as a vital constituent to discover the calibre of students. A good exam gives all students an equal opportunity to fully demonstrate their learning.

A. SCOPE

We are aiming to develop an automated question paper generator and evaluator. The system must minimize the human errors. The question paper is to be generated using automation so as to avoid repetition. The evaluation must be to replace the manual checking of answer sheets. This is to reduce biased correction. The system must be reliable and efficient. It will also save the human labour and time.

B. STATE OF ART

Various modules like admin module, user module, and question entry and question management are mentioned. From the entered input the paper is generated and saved as .pdf file[1]. Usage of Stanford Parser for parsing as well as a parts of speech tagger. Then adjectives are separated and relationship of the words will be determined[2]. Answers are converted into graphical forms to apply some of the similarity measures, WordNet and spreading process to calculate similarity score[3]. The systems developed to correct assignments primarily use short-text matching, a similarity score[3], template matching[4], an answer validation system[5].

C. SYSTEM DESIGN

a. Architecture

It consists of three tiers: User Interface, Business Logic and Database. The two main users are Faculty and Admin. Faculty will get access to Add and Evaluate module. Admin will have access to Evaluate and Generate module. The three modules: Add, Generate and Evaluate will manipulate the database.

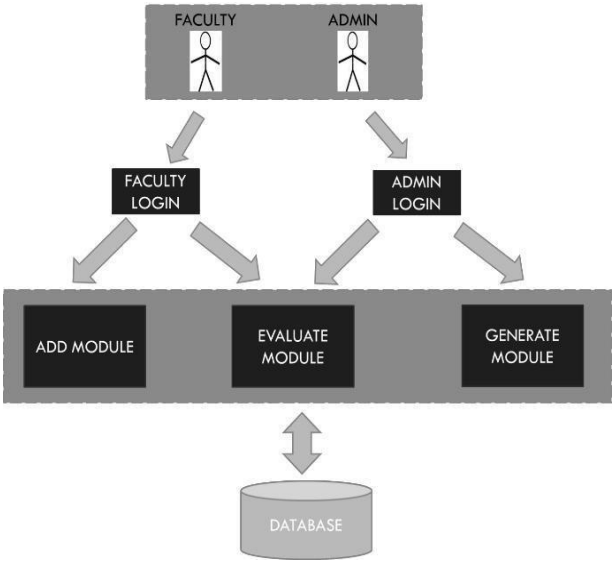

Figure 1: System Architecture

b. DFD (Data Flow Diagram)

There are three major modules: Add Questions, Question Generation and Evaluation of Papers.

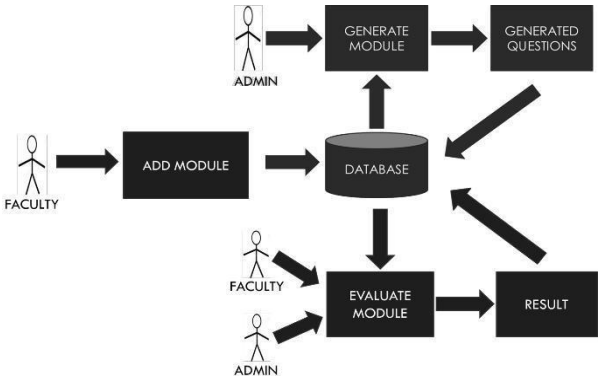

Figure 2: Data Flow Diagram

In the first module faculty will add the questions which are stored in the database by the faculty itself. These questions can be generated randomly using the randomized algorithm. Questions will be stored in the database by the faculty and whenever the add questions module will be used questions will get added to generate the question papers. In the second module admin will generate the question papers. Admin will set some parameters like difficulty level of the questions. Questions can be generated unit wise. After setting all the required parameters question paper will be generated. In the third module faculty or admin both can verify the answer sheets of the students. Students

write the answers on the sheets those answer sheets will be scanned by the admin or faculty using OCR and then evaluation of the answer sheets will take place. For evaluating subjective answers system will match the keywords of the student's answer with the standard answer to check the correctness of the answer. Also synonyms will be considered for keyword matching. For checking the grammar of the answers lexical analysis will be used.

Add module

Faculty will enter the question, subject, topic, difficulty level, keywords for answer evaluation etc. in the database.

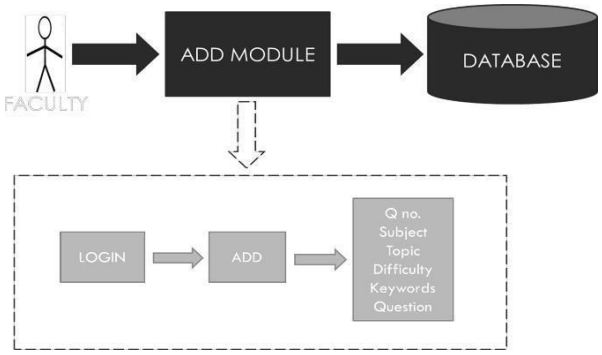

Figure 3: Add module

Generate module

Admin will select subject, difficulty level, marks distribution, no. of questions etc. and generate the required question paper. Questions can be selected by using either random algorithm or manual selection.

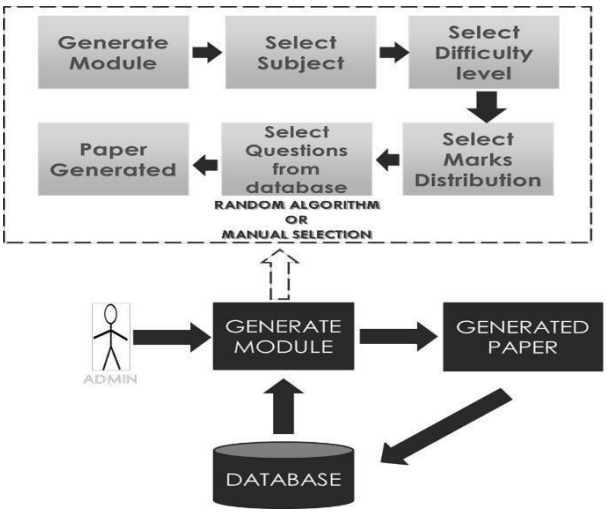

Figure 4: Generate module

Evaluate module

Answer sheets are converted into text file using Image recognition and OCR. The text file is further analyzed using grammar analysis, Keyword extraction, Synonym replacement for keywords and keyword matching is done to collectively evaluate the result.

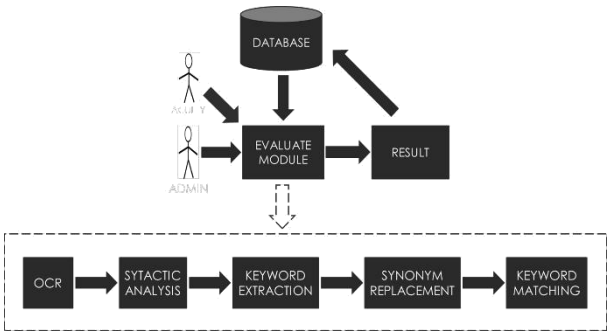

Figure 5: Evaluate module

Mathematical model

The score will be calculated as:

P(QST, Keywords, Grammar) = P(QST) * P(Keywords) * P(Grammar)

QST is Question Specific Term.

Here, there must be presence of Question Specific Terms, Keywords and Grammar collectively. Absolute absence of any one (say value 0) will result in the score to become 0. It can be understood like a simple multiplication with the number 0 which results in 0.

D. ADVANTAGES

- Question can be selected using difficulty levels.
- Admin can use automated test paper generator module to save a lot of time.
- Randomization algorithm for selection of questions.
- With the use of this system for exam paper generation there are zero chances of exam paper getting leaked as paper can be generated few minutes before the exam.
- With this system fewer human efforts time and resources.

- Unbiased evaluation of answer sheets.

E. LIMITATIONS

- Problem of recognizing a wide variety of handwritten answer sheets.
- Keyword matchings must support the usage of synonyms too.
- Difficult to evaluate the diagrams in the answer sheet.

F. APPLICATIONS

- In schools, colleges, universities and other educational institutions with huge databases to generate question papers frequently.
- In various medical, engineering and coaching institutions for theory examinations.
- Students are the most important group of indirect users as they are the ones who are impartially being evaluated.

CONCLUSION

The proposed work narrates an automated system that heads away from the traditional process of paper generation to an automated process, by giving controlled entry to the resources that is attained by involving users and their roles in the colleges. We have also considered the significance of randomization to avoid duplication of questions. Hence the resultant automated system for Question Paper Generation will yield enhancement of random creation of question papers and automated evaluation.

FUTURE WORK

- Addition of a module that would accept voice data from a microphone and correct the same without any human assistance.
- Scanning for diagrams, figures and blocks.
- Behavior prediction and vocabulary of the student can be checked based on the writing style.
- A module can be constructed wherein it simulates all the answer sheets and displays the most ideal sheet and compares it with the original and shows similarity ratio.

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Servomotor Interfacing using PIC microcontroller

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ABSTRACT

The aim of developing this project is to control the speed of Servo motor. The servo motor is most commonly used for high technology devices in the industrial applications like automation technology. It is a self-contained electrical device, that rotates parts of machine with high efficiency and great precision. Moreover the output shaft of this motor can be moved to a particular angle. Servo motors are mainly used in home electronics, toys, cars, airplanes and many more devices.

Keyword: Servomotor, Interfacing microcontroller, speed of motor

1. INTRODUCTION

A servo motor is an electric device used for precise control of angular rotation. It is used where precise control is required, like in the case of control of the robotic arm. It consists of a suitable motor with control circuitry for precise position control of the motor shaft.It is a closed loop system.The rotation angle of the servo motor is controlled by applying a PWM signal to it. By varying the width of the PWM signal, we can change the rotation angle and direction of the motor.

2. EXPERIMENTAL

Figure 1 shows block diagram of system for driving servomotor for different application circuits

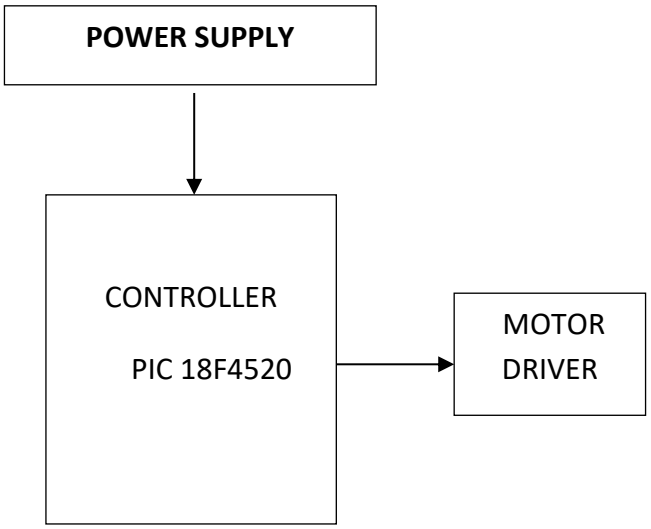

Figure 1: Block diagram of servomotor system

Power Supply:

All digital circuits require regulated power supply**.** The Servo Motor generally requires DC supply of 4.8V to 6V.

The steps involved in the power supply are as follows,

1) Determine the total current that the system sinks from the supply.
2) Determine the voltage rating required for the different components.

CONTROLLER:

PIC Controller is used for control the whole process of Servo-motor by CCP1CON register for PWM.

SERVO MOTOR:

The Servo Motor basically consists of a DC Motor, a Gear system, a position sensor and a control circuit. The DC motors get powered from a battery and run at high speed and low torque. The Gear and shaft assembly connected to the DC motors lower this speed into sufficient speed and higher torque. The position sensor senses the position of the shaft from its definite position and feeds the information to the control circuit. The control circuit accordingly decodes the signals from the position sensor and compares the actual position of the motors with the desired position and accordingly controls the direction of rotation of the DC motor to get the required position.

Controlling a Servo motor

A servo motor is controlled by controlling its position using Pulse Width Modulation Technique. The width of the pulse applied to the motor is varied and send for a fixed amount of time.The pulse width determines the angular position of the servo motor.

Generating PWM:

- SG90 servo has practical duty cycle time for -90° to +90 rotation that is different from ideal.
- At 0.6ms (3% duty cycle) we get shaft position at -90° of its rotation.
- At 1.4ms (7% duty cycle) we get shaft position at 0° (neutral) of its rotation.
- At 2.4ms (12% duty cycle) we get shaft position at +90° of its rotation.
- To control servo motor in between -90° to +90° rotation.

- We need to generate PWM waveform of 50Hz with duty cycle variation from 0.6ms to 2.4ms.

- We can use fast PWM mode of PIC18F4520 using Timer2.

Applications:

Servomotors are used in applications requiring rapid variations in speed without the motor getting overheated.

- Machine tools, packaging, factory automation, material handling, printing converting, assembly lines, and many other demanding applications robotics, CNC machinery or automated manufacturing.
- Radio controlled airplanes to control the positioning and movement of elevators.
- Robots because of their smooth switching on and off and accurate positioning.
- Aerospace industry to maintain hydraulic fluid in their hydraulic systems.
- Many radio controlled toys.
- They are used in electronic devices such as DVDs or Blue ray Disc players to extend or replay the disc trays.
- They are also being used in automobiles to maintain the speed of vehicles.

Edge Avoider Robot using PIC Microcontroller

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ABSTRACT

Robotics is the field which occupies vast section in today's world. Most of them are autonomous, self-intelligent, and they reduce most of human work. Here we have designed a robot that will avoid edge or absence of surface underneath automatically without any control. So human life is saved while driving an automobile if this arrangement is placed in front of driving automobile. IR Sensors are used for detecting the surface below the robot. L293D motor driver is used for controlling the motors in the robot.

1. INTRODUCTION

Edge Avoider Robot is the robot which keeps moving on a platform and as soon as it detects an edge, it turns in opposite direction i.e., if it detects the edge of platform in its front, it starts moving backward, if it detects an edge in its left then it turns to its right and vice versa. In these types of robots, we generally use behaviour of light at black and white surface. When light fall on a white surface it will almost full reflects and in case of black surface light is absorbed by black surface. This behaviour of light is used in an line follower robot as well as edge avoider robot.

2. EXPERIMENTAL SETUP

Figure 1 shows block diagram for edge avoider

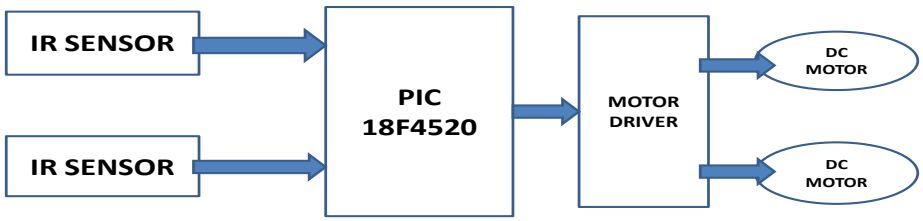


Figure 1 :Block diagram for edge avoider

- **SENSOR SECTION:** This section contains IR diodes, potentiometer, Comparator (Op-Amp) and LEDs. Potentiometer is used for setting reference voltage at comparator's one terminal and IR sensors are used to sense the line and provide a

change in voltage at comparator's second terminal. Then comparator compares both voltages and generates a digital signal at output. Here in this circuit we uses two comparators for two sensors.

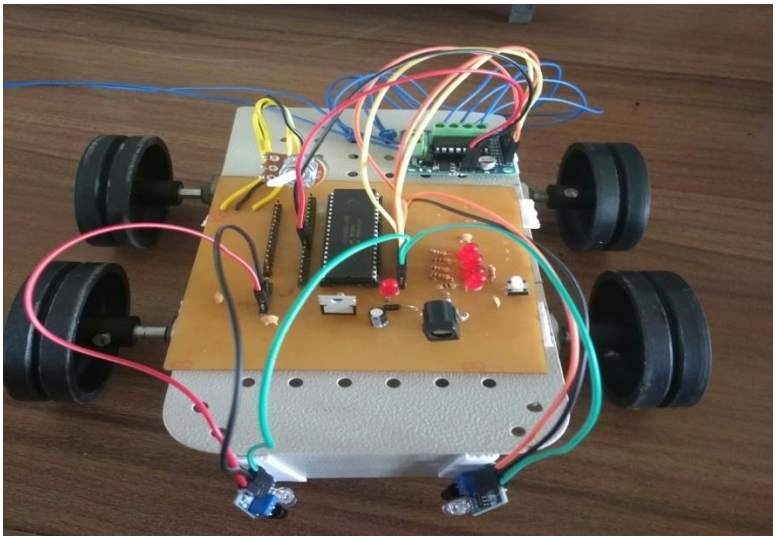
- **CONTROL SECTION:** PIC Controller is used for controlling whole the process of edge avoider robot.
- **DRIVER SECTION:** Driver section consists motor driver and two DC motors. Motor driver is used for driving motors because microcontroller does not supply enough voltage and current to drive the motor. So we add a motor driver circuit to get enough voltage and current for motor. Microcontroller sends commands to this motor driver and then it drive motors.

3. RESULTS AND DISCUSION

There are four conditions in this edge avoider robot.The two sensors namely left sensor and right sensor are used.

- 1st condition: If the robot is kept at the centre of the table, the IR will transmit and send the rays and the photodiode will receive it,then the robot will move in forward direction.
- 2nd condition: If the robot is at edge of the table, first it will stop and then will get reversed at 90deg & then again will move in forward direction.
- 3rd condition: If the robot is at left side of edge, then it will detect and gets backward and then will move at right side.
- 4th condition: If the robot is at right side of edge, then gets backward and then will move at left side.

EDGE AVOIDER ROBOT MODEL



APPLICATIONS

- The modification of this logic has been specially designed for vacuum cleaner.
- Just by making small changes in software this system can be used for avoiding concealed paths.
- With proper programming we can use it as a weight lifter, auto parking assistance.
- It can be used in automobiles while driving on hills and mountains.

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Retro-Reflective Fiber Optic Displacement Sensor For Performance Optimization Using Taguchi Method

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ABSTRACT

Fiber optic displacement sensors are widely used in industry. Retro reflective fiber optic displacement sensor consists of parallel fibers with a reflector at a distance. Light is launched into the transmitting fiber which gets reflected by reflector. This reflected light is collected by the receiving fiber. The received light is function of the displacement of the reflector from the fiber end faces. This paper is targeted to obtain a robust design for the fiber optic displacement sensor (FODS) using well known Taguchi method. The design takes care of all noise parameters within constraints of manufacturing tolerances. The statistical data analysis is performed on the simulated results. The larger the better signal to noise quality characteristics is used to find the effect of control parameters in the data analysis. Taguchi analysis suggests dominant parameters which affects the sensitivity of the FODS and causes immunity to noise. A source fiber inclination angle is chosen as an adjustment parameter. Other control parameters are used for fine tuning of the FODS design for achieving three qualities viz. best robustness, optimized sensitivity and robustness and best sensitivity.

KEYWORDS*:* retroreflective fiber optic sensor; Taguchi method; optimization of sensor geometry

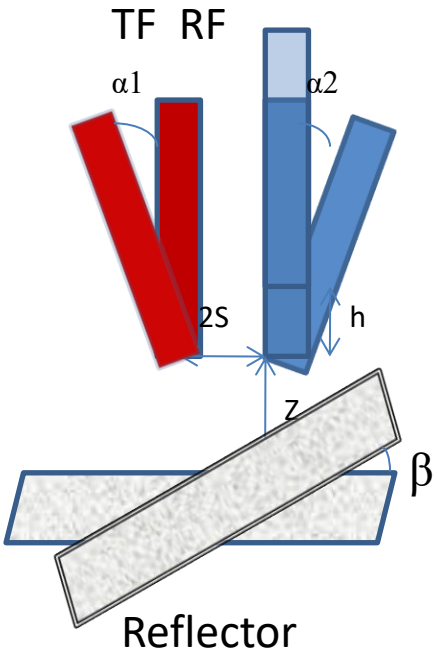
INTRODUCTION

Fiber optic sensors are used to measure different physical and chemical parameters such as pressure, temperature, strain etc in a variety of industrial environments including oil wells, jet engines, on line and off line measurement of in flight parameters, power transformers, civil structures [1]. These sensors has number of unique advantages such as immunity to electromagnetic interference, small size, high temperature capability, ability to isolate the sensor head from the electronic components by very large distances and ability to multiplex number of sensors along single fiber cable[2]. In present work intensity modulated retro reflective parallel two fiber sensor probe is developed for measuring the displacement. The sensor consists of light source (LED), photo-detector, source fiber and receiving fiber with a

reflector at a distance. This sensor is well studied and number of geometries of this sensor is reported [3]. The sensor performance and accuracy of measurement strongly depends on the geometrical parameters of the probe [4]. Optimization of the sensor geometry uses series of experiments (simulations or physical) to find the parameter settings for the design that yield the predicated performance. The design is said to be robust if it is insensitive to the effects of noise variations. Taguchi techniques are most known and recurrently used for quality product design. This technique is used for robust parameter design of retro reflective fiber optic displacement sensor (FODS).

Sensor Geometry and Operating Principle:

Fiber optic displacement sensor (FODS) consists of single pair parallel fibers with a reflector placed at a distance Z as shown in Fig. 1. Light is launched into source fiber (TF) from LED which is carried up to the reflector in the form of cone. This cone of light is reflected from the reflector which is placed at a distance Z. Part of this reflected light enters the receiving fiber (RF). Amount of reflected light entering the receiving fiber (RF) depends on the distance Z between the fibers and reflector. Cross section of this reflected cone of light is circular which overlaps the core of receiving fiber. The area of overlap depends upon the distance Z. For smaller values of Z overlap area is almost zero causing zero received intensity. This region is called as blind region



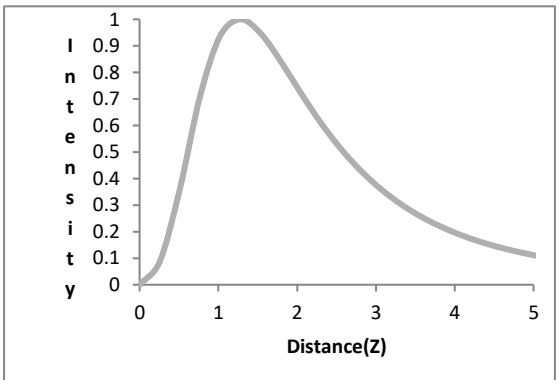


Fig. 1Control and noise factors **Fig. 2. Sensor response**

As distance Z increases, area of overlap increases causing partial overlap. The region over which this continues is called linear region. This region is called as non linear region. Blind region, linear region and non linear region are shown in Fig. 2.

Influence of Manufacturing Tolerances on the Performance

Performance of FODS depends on the geometrical and fabrication parameters of FODS[5]. While fabricating the FODS for a given application it is necessary to consider the manufacturing tolerances. These are related to the geometry of the FODS as shown in Fig. 1. This affects the target value of the desired performance parameter of FODS for instance sensitivity in case of FODS. In addition to this there are certain parameters which are not directly related to the manufacturing process but related to the alignments and aging effects. These are called noise parameters. Sensor performance also gets affected by these parameters. Thus one has to design a FODS which is immune to noise factor variations. Taguchi technique is used to optimize the FODS design for immunity to noise factors. This technique is useful in determining the control factors so that the sensitivity of FODS does not get affected by noise factors and its value will not diverted from the target value. The design of FODS is considered as dynamic problem. In the present study, five control factors are considered at 5 levels and two noise factors are considered at 3 levels. There values are given in Table I. Performance of FODS is analyzed by monitoring the sensitivity of sensor to decide the robust design.

For robust design first orthogonal array of control factors is chosen which comprise inner array. At the same time noise factors are chosen to form the outer array. These arrays specify the test cases to conduct the experiments i.e. used for design of experiments (DOE). These experimental results are summarized into metric called signal to noise ratio which considers how effectively the mean value (signal) of parameter has been achieved and amount of variability that has been experienced. Thus parameter having greatest effect on the performance of the product is identified. After experiments are conducted, signal to noise ratio is calculated for each test case.

Table I Control Factors And Noise Factors

Control Factors	**Level 1**	**Level 2**	**Level 3**	**Level 4**	**Level 5**

Horizontal offset (s) in mm	“0”	“0.2”	“0.4”	“0.6”	“0.8”
Vertical offset(h) in mm	“-1.0”	“-0.5”	“0”	“0.5”	“1.0”
Source fiber angle in degrees	“0”	“5”	“10”	“15”	“20”
Receiver fiber angle in degrees	"0"	"5"	"10"	"15"	"20"
core radius in mm	"0.1"	"0.2"	"0.3"	"0.4"	"0.5"

Noise Factors	**Noise level 1**	**Noise level 2**	**Noise level 3**
Inclination of reflector in degrees	"-2"	"0"	"2"
Source intensity function	"Linear"	"Uniform"	"Gaussian"

This data is then analyzed statistically by using the analysis of variation (ANOVA) techniques. A parameter having largest signal to noise ratio is identified as significant contributor for achieving the best performance characteristic while others having small signal to noise ratio are considered as insignificant contributors. A comprehensive design is suggested for getting the best performance. A range of results is suggested along with the expected value taking into account the error. One has to simulate or physically conduct the experiment for the suggested design and check whether result is within the expected range.

Robust Design of Fods Geometry using L-25 Array of Taguchi Method

Table II shows the complete L-25 orthogonal array for the FODS optimization. Lower part of table II shows the noise factors representing 9 combinations for each row of upper part of table II.

Tilt of reflector is one of the noise factors. It is considered as the noise factor because reflector must be exactly parallel to the end face of the fiber

Table II L-25 Outer Arrays Of Noise Factors

Noise repetition factors	1	2	3	4	5	6	7	8	9
Inclination of reflector in degrees	I1	I2	I3	I4	I5	I6	I7	I8	I9
Source intensity function	S1	S2	S3	S4	S5	S6	S7	S8	S9

With the defined control factors and noise factors simulations are carried out for the 25 experiments using the developed model to find the effect on the sensitivity of fiber optic displacement sensor due to variation in control factors along with noise factors.

Results and Discussion:

These experiments are carried out by running complete set of noise factor setting for each combination of control factor setting (at each run) using the developed mathematical model [6]. The developed mathematical model is based on the ray tracing technique. Considering the two parallel fiber geometry of the fiber optic displacement sensor, generalized co-ordinates for the source fiber and its image in the reflector is derived using the rotational transformations, reflection, vertical transformation etc. After calculating these co-ordinates, light entering the receiving fiber is calculated by successive addition of the weighted intensity of the rays entering the receiving fiber. The sensor response can be simulated for different geometrical parameters of fiber optic displacement sensor viz. vertical offset (h), horizontal offset(s), source fiber angle (α1), receiving fiber angle(α2) and core radius(a). This model is developed for studying and analyzing sensor performance parameters for different geometrical configurations of fiber optic displacement sensor.

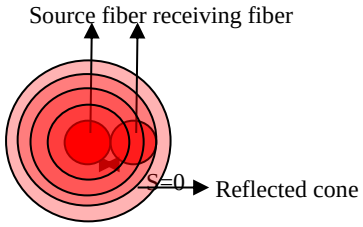
a. Effect of variation in different geometrical and fabrication parameters of fiber optic displacement sensors

The effect of variation in the different geometrical and fabrication parameters of fiber optic displacement sensor on the performance of the sensor are discussed and analyzed here.

i. Effect of variation is horizontal offset(s):

There is no light entering the receiving fiber for smaller values of distance Z between the fiber end faces and reflector. As distance increases the reflected cone starts overlapping the receiving fiber. It shows linear variation in the amount of light entering the receiving fiber

and the distance Z. The rate of overlap of reflected cone to the receiving fiber determines the sensitivity of the sensor. The total overlap signifies the maximum intensity collected by the receiving fiber. The range of distance Z over which this continues is called the operating range of the sensor. Thus linear region is important as it decides sensitivity and operating range of the sensor.



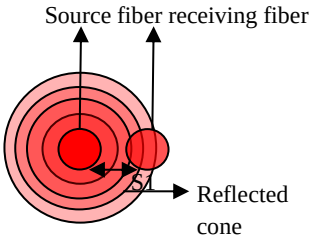
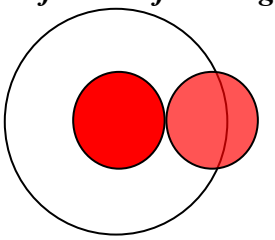


Fig. 3(a) Overlap area for s=0 ***Fig. 3(b) Overlap area for s=S1(>0)***

Fig. 3(a) shows that there is no horizontal offset between them i.e. s=0. The dark circles show the cross section of reflected cone at different Z values from the reflector. The sensor response corresponding to this situation is explained in the previous section. Now if the receiving fiber is displaced from the source fiber for a distance s=S1,as shown in Fig. 3(b), then the receiving fiber get overlapped by the reflected cone at larger value of Z. This increases the blind region. The overlapping occurs towards the peripheral region of the reflected cone. The rate of overlap of the receiving fiber is smaller compared to that in s=0. The amount of light collected by the receiving fiber is also smaller because of the Gaussian distribution of intensity over the reflected cone. Thus variation in the horizontal offset causes significant variation in the sensitivity of sensor.

ii. Effect of source fiber angle(α1)



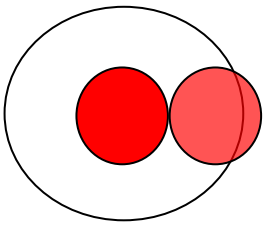


Fig. 4(a) Cross section for source angle α1=0 ***Fig.4(b) Cross section for α1>0***

For uninclined source fiber the reflected light cone is right circular cone as shown in Fig. 4(a). If the source fiber is slightly inclined then the reflected cone gets shifted slightly towards the receiving fiber as shown in the Fig. 4(b). This increases the rate of overlap of receiving fiber cone with distance Z. This in turn increases the sensitivity of the sensor.

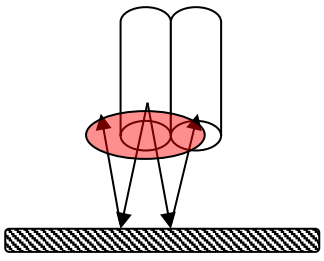
iii. Effect of variation in core radius

Increase in the core radius of source fiber and receiving fiber causes increase in the amount of light collected by the receiving fiber. Thus for small change in the distance Z between the fiber end face and reflector causes large change in the amount of light collected by the receiving fiber. This means that the rate of overlap of receiving fiber with reflected cone increases. This is obvious because of the increase in the core radius of the source as well as receiving fiber.

iv. Effect of variation in h

The variation in vertical offset h between the source and receiving fibers does not show any significant change in the sensitivity of sensor. The relative vertical displacement of the two fibers does not cause any variation in the amount of light intensity received by the receiving fibers. The occurrence of the maximum received intensity takes place at smaller values of Z for negative offset values(receiving fiber shifted towards reflector) and for larger Z values for positive offset values(receiving fiber shifted away from reflector).

v. Effect of variation in receiving fiber angle (α2)



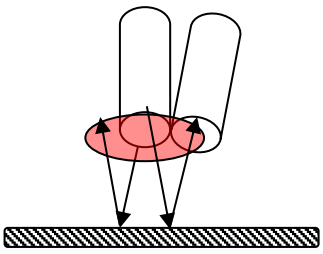


Fig. 5(a) Sensor geometry for (α2=0) **Fig. 5(b) Sensor geometry for(α2>0)**

Figs 5(a) and 5(b) shows sensor geometries with straight and inclined receiving fibers respectively. The inclination of receiving fiber causes shifting of receiving fiber core centre away from the source fiber. This reduces the overlap area of the receiving fiber core with the reflected cone. The effect of variation in receiving fiber angle does not shown any variation

in the sensitivity. Simulations are carried out for the given set of 25 experiments and the sensitivity data for FODS from each run simulation of the noise factors in the outer array are usually aligned in a row, next to the factors settings for that run of the control factors in the inner array.

It is the objective of the design activity to determine the best levels of these factors to achieve the best sensitivity for FODS. Signal to noise ratio is considered as a response of the experiment, which is a measure of variation when uncontrolled noise factors are present in the system. The maximum signal to noise ratio is advocated in the Taguchi approach to maximize the performance of a system using control factors by minimizing the effect of noise variations using adjustable factors. From the ANOVA analysis it is predicted that horizontal offset(s), source fiber angle (α1) and core radius (a) are dominant parameters while vertical offset (h), receiving fiber angle(α2) are neutral or insignificant parameters. One has to find the adjustment factor so as to tune the mean to the target value. For different values of 's' , it is observed that there is improvement in the linear operating range and not the sensitivity of the sensor. For different values of 'h' there is no effect on the sensitivity but slight increase in the linear operating range is observed. Increase in the core radius of fiber increases the linear operating range and not sensitivity. Increase in the source fiber angle improves the sensitivity of the fiber optic sensor. This is because as inclination increases the amount of light entering the receiving fiber after reflection increases w.r.t. distance i.e. rate of overlap increases. Hence source fiber angle is adjustment parameter for getting target value. Two noise factors viz. change in the source intensity function and reflector angle are considered. Effect of variation in the source intensity function decides the weight factor for the intensity which enters the receiving fiber after reflection. This can be adjusted by varying the source fiber angle by proper angle. Effect of variation in the reflector angle also shows change in the sensitivity of FODS. Variation in reflector angle is similar to inclining both the fibers asymmetrically due to which reflected cone becomes elliptical and the rate of overlap of reflected cone with the receiving fiber core increases which in turn increases the sensitivity of FODS. So its effect can be removed or nullified by adjusting source fiber angle.

b. Fine tuning

In order to adjust the sensitivity exactly to the target value two other control factors viz. vertical offset (h) and core radius (a) are considered. The adjustment is done by taking the two values for 'h' viz "0" and "1" and three values for 'a' viz 0.1, 0.3 and 0.5. Six experiments are arranged considering the variations in these values as shown in Table 6.

After the analysis of the graphs for Nominal-the-best and Mean(Larger-the-better) different sets of control factors are found to be useful as shown in TableIII.

Expt no 1:

The configuration is s=0, h=1.0, α1=20, α2=0, a=0.1mm. It has two fibers with no horizontal offset while receiving fiber is vertically displaced by 1.0mm. The source fiber is inclined at an angle of 20 degree with straight receiving fiber. The radius of both the fibers is chosen as a=0.1mm. As the fiber is displaced vertically, the effective distance between the reflector and the receiving fiber is Z+h. The radius of the receiving fiber is small and hence variation in the source light intensity function and reflector angle does not show much variation in the sensitivity of the sensor. Because the radius is small and fiber is displaced vertically, the rate of overlap of receiving fiber by tilted reflected cone does not show significant variation. Hence it is robust configuration. It is insensitive to variations in the noise parameters viz. reflector angle and source intensity distribution. The configuration has source fiber inclined at an angle of 20 degree. The small variation in reflector angle by 4 degree shows 1.5% variation in sensitivity for a particular type of source intensity distribution. The variation in the source intensity distribution function causes 12.5% variation in the sensitivity of the sensor.

Expt 2.:

In this configuration, core radius is 0.3mm for transmitting and receiving fibers. Thus significant variations in the intensity are observed with better sensitivity values compared to expt. 1. As the diameter of the core of the fiber is more, the intensity distribution profile of the reflected cone is spread over the core of receiving fiber. The core of transmitting fiber is larger and hence the reflected cone of light has larger diameter compared to that in expt. 1. The rate of overlap reflected cone and receiving fiber is larger thus sensitivity is more. The change in the reflector angle causes the reflected cone focused at different positions on the receiving fiber core which in turn changes the overlap rate of reflected cone and the core of receiving fiber. Thus 5% variations is in sensitivity is observed for 4 degree variations in the reflector angle while 40% variations in the sensitivity is observed for variation in the source intensity function.

Table III Predictions For The Best Configurations

Expt	**‘s’**	**h’**	**‘α1’**	**‘α2’**	**‘a’**	**Purpose**

no						
1	“0”	“1”	“20”	“0”	“0.1”	Best robustness to I and S
2.	“0”	“0”	“20”	“0”	“0.3”	Optimum FODS sensitivity and robustness to I and S
3.	“0”	“0”	“20”	“0”	“0.5”	Best FODS sensitivity

Expt 3:

In this configuration, the core radius of both fibers is 0.5 mm. The reflected cone has larger diameter. Thus for small change in the distance Z, receiving fiber get covered by large amount. This increases the sensitivity of the sensor. But because of the larger core diameter, source intensity distribution causes significant variation in the sensitivity of the sensor. The reflector angle variations also cause significant variations in the sensitivity. These are found to be 7.6% for source profile variations and 54% for reflector angle variation by 4 degree.

CONCLUSION:

Two fiber retro reflective fiber optic displacement sensor is analyzed for optimized and robust design for best sensitivity. Taguchi method is used for the analysis. Nominal-the-best and Mean(larger-the-better) is used for the finding the best robust, optimized sensitivity and best sensitivity configuration of the fiber optic displacement sensor.

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Design, development and experimental study of novel configuration of reflectivity invariant retro reflective fiber optic sensor for measuring of surface roughness

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ABSTRACT

This paper reports a novel retro reflective fiber optic surface roughness sensor. The sensor probe consists of three parallel fibers and one inclined at an angle of 5^0. The reflector is placed at optimized distance in order to get maximum sensitivity for surface roughness measurement. The configuration makes the sensor immune to variation in reflectivity of reflector. Mathematical modeling of this fiber optic displacement sensor is reported based on ray tracing method. MS surfaces are sprayed with aluminum to get different surface roughness values which are measured on the standard instrument. Experiments are performed for measuring surface roughness values for these surfaces. Experimental results show good agreement with simulation results. These results are also compared and validated with standard instrument used to measure the surface roughness. Experimental validation of the invariance with reference to reflectivity of reflector is also done.

KEYWORDS: fiber optic displacement sensor, self referencing technique, measurement of surface roughness.

INTRODUCTION

Reflector surface is the inherent component of non contact type fiber optic displacement sensor. It is characterized by two important properties namely reflectivity and surface roughness. The sensor response can be made independent of the reflectivity of the surface and sensor can be configured to measure the surface roughness only using the self referencing technique [1]. Different configurations of fiber optic displacement sensor are reported for measuring the surface roughness [2-4] . Even though number of mechanical techniques are used to measure the roughness value of the surface, but optical techniques are found to be best method due to its non contact type and in process measurement ability. Generally

optical detection of surface roughness is related to the amount of light scattered by the surface which is related to specular or diffused reflection. Standardized surface parameters like average roughness value and rms roughness value can be estimated using the optical techniques for different applications such as measuring the roughness of metals, estimating the roughness of corroded metals, dimensional inspection of some complex curved surface components etc. Artificial neural networks (ANN) are also used to characterize the surface roughness [5].

In this paper, we propose a fiber optic sensor for measuring the surface roughness of reflector. A novel configuration of self referenced reflective intensity modulated fiber optic sensor with fixed distance from the reflector and a inclined receiving fiber is proposed. Mathematical modeling of the sensor structure is done using the developed ray tracing model in MATLAB[6]. A sensor probe is fabricated and experimental results shows good agreement with theoretical results. These results are also compared and validated with standard instrument used to measure the surface roughness.

THEORETICAL MODEL

Beckmann-Spizzichino developed the reflectance model for reflection of light using physical optics and Torrance Sparrow developed the model using geometrical optics[7]. Due to the simplicity of the model Torrance Sparrow model is more popular for describing the mechanism of the specular reflection from the rough surfaces. Based on the geometrical optics this model is valid only when the wavelength of light is much smaller than the root mean square surface roughness. The Torrance Sparrow model is expressed as

$$f = \frac{F(\theta)G(\omega i, \omega r)D(\theta r)}{4\cos(\theta i)\cos(\theta r)} \text{----------(1)}$$

where F(θ) is Fresnel term

$G(\omega_i, \omega_r)$ is Geometrical attenuation due to shadowing and masking, $D(\theta_h)$ is Distribution function of microfacets on the surface θ_i is source angle, θ_r is viewer angle. In reality, surfaces are neither perfect polished reflectors nor perfectly rough surfaces. When the light from the source is made incident on the surface whose roughness is to be measured, the random characteristics of the micro profile will make the light scatter at the incident point as shown in Figure 1 [8].

The received light intensity is also a function of geometry and fabrication parameters of the fiber i.e.IR(a,NA,α, z, σ) where a is radius of core, NA is numerical aperture, α is the angle of inclination of the fiber, z is distance and σ is related to average surface roughness Ra.

$$I(\theta) = \frac{1}{\left(2\pi K \exp(-\frac{4\pi Ra\cos(\theta_0^{'})^2}{\lambda})\right)} \exp(-\frac{(\theta-\theta_0^{'})^2}{2\pi K \exp(-\frac{4\pi Ra\cos(\theta_0^{'})^2}{\lambda})^2}) \text{ ----- (2)}$$

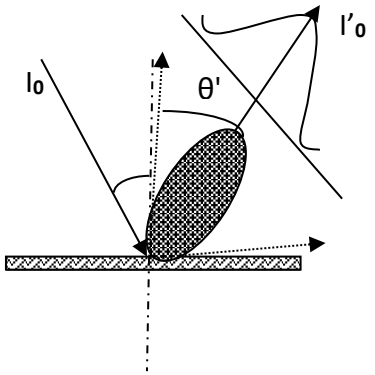

Fig. 1 Intensity distribution on the rough surface

As per the reflectance models the received light is combination of specular reflection (B) and diffused reflection(A) considering guassian distribution of microfacets. Total received intensity is expressed as

$$IR(\theta)_{total} = B + \frac{AIR(a, NA, \sigma, Z)}{\cos(\theta 1)} \exp(\frac{\theta^2}{\sigma^2}) \text{ --------- (3)}$$

In order to have the direct relation between the sensor output and the surface roughness Ra, the dependence of sensor output on geometrical parameters should be nullified. Asymmetry in the sensor structure is added by inclining the fiber R1 by an angle 5^0. Effect of this asymmetry is nullified by taking the difference as IR1(θ) – IR3(θ) and IR2(θ) – IR3(θ). Taking the ratios of the resultant intensities nullifies the effect of variation in source intensity and reflection coefficient. Final expression for the sensor output will depend only on the surface roughness σ

$$IR(\ final) = \frac{IR1(\theta, \sigma) - IR3(\theta, \sigma)}{IR2(\theta, \sigma) - IR3(\theta, \sigma)} \text{ ----------(4)}$$

SENSOR STRUCTURE

The sensor structure is an extension of the self referenced fiber optic displacement sensor. Generally self referenced fiber optic displacement sensor consists of two receiving fibers(R1 and R2) arranged on the either side of transmitting fiber(T) with a reflector at a distance. This arrangement is useful in making the sensor output immune to variations in reflectivity of the reflector and fluctuations in source light intensity. As discussed in previous section specific arrangement of four fibers as shown in Fig. 2 is useful in making the sensor output proportional to surface roughness. Sensor consists of the four optical fibers having following

parameters viz. core radius (a)=0.418mm, cladding thickness(cd)=0.612, fd=2.2mm, NA=0.47.

Out of the four fibers one fiber is transmitting fiber in which light is launched using High Bright RED LED. There are two receiving fibers arranged on the either side of the transmitting fiber. A photo detector L14G3 is used to detect the received light intensity after the reflection from the surface. An asymmetry in the sensor structure is introduced by inclining the fourth fiber at an angle of 5^0. Light received is detected by the photodetector. Distance between the surface and the fiber sensor end face is kept constant

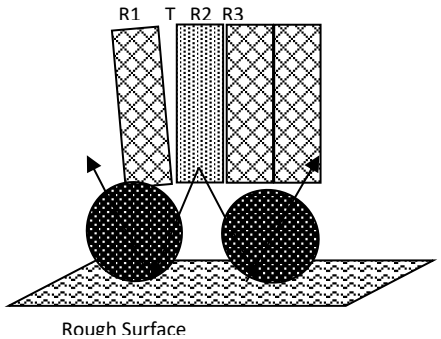

Fig. 2 Geometry of the sensor

EXPERIMENTAL SET-UP

Figure 3 shows experimental setup for the measuring the surface roughness of the surface using fiber optic sensor. Developed sensor is placed on the surface whose roughness is to be calculated. LED driver circuit is used to drive the LED with constant intensity and phototransistor L14G3 is used for the detection of the reflected light intensity received by the three receiving fibers.

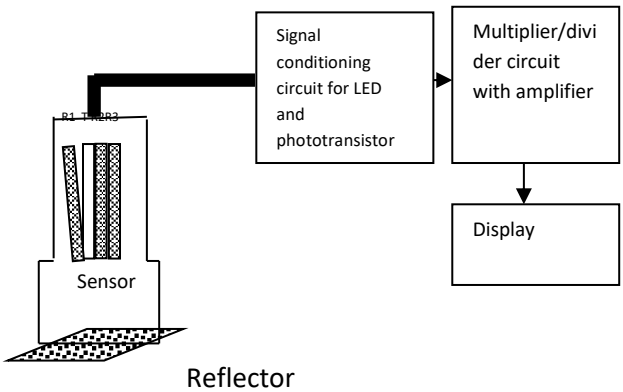

Fig. 3 Experimental Setup

Output of the photo detector is properly buffered and the ratio of differences in the intensity of three fibers is calculated using multiplier divider circuit. Finally the output is direct display of the surface roughness of the surface under consideration.

In order to use the sensor for detection of the surface roughness, different samples having varying surface roughness are fabricated. Sand blasting technique is used to prepare the surfaces of different surface roughness. Aluminum metal sheets are used for preparation of the surfaces. Actual surface roughness is calculated by using standard instrument used for measuring the Ra(average surface roughness) of the sample.

INVARIANCE TO REFLECTIVITY:

Figure 4 shows experimental setup for showing insensitivity to variation in reflectivity of the reflector.

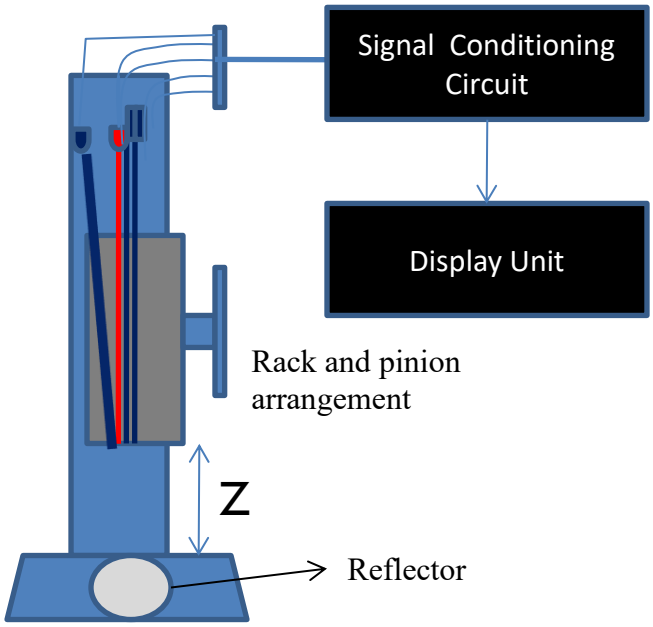

Figure 4 Experimental setup for showing insensitivity to reflectivity of reflector

Structure of sensor probe is shown having one transmitting and three receiving fibers out of which one is inclined to angle 5 degree. Rack and pinion arrangement is used to displace the sensor probe from the reflector. A high bright RED LED is used as a source which launches light into the transmitting fiber. Three photo detectors L14G3 are used which converts received light intensity into electrical form. Outputs of the three receiving fibers are signal conditioned and displayed on the display unit such as DPM. Effect of

variation is reflectivity of the reflector is examined by using different reflectors Experiment is carried out for different reflectors mirror (100%), aluminum(90%) and copper(60%).

The output of the sensor probe is calculated using the proper electronic circuits as per the equation(4).

RESULTS AND DISCUSSION

Intensity of light reflected from the surface depends on the texture of the surface and the distance between the surface and light source. For smooth surface the amount of light entering the receiving fiber R2 is more compared to R1 and R3 because of less scattering of light. Hence output of the sensor is low indicating small roughness value. As the roughness of the surface increases the amount of light entering the R3 and R1 increases while that in R2 decreases because of the scattering effect. Amount of light entering the R1 is more compared to R3 because R1 is inclined so it can capture more diffused light compared to straight fiber R3.Combined received signal voltage increases with increase in the roughness of the surface. Developed sensor is tested on sample surfaces having different surface roughness. Surface roughness sensor is placed on the sample and the roughness is calculated for that sample as per the equation. The actual values of surface roughness Ra in µm for the sample surfaces are measured on the standard instrument Surftest MITUTUYO-SJ-210P, a portable surface roughness tester. It has a stylus which scans the surface over the length of 10mm. Table 1 below shows actual values of Ra measured on this instrument for the samples 1 to 4.

Table 1 Ra values measured on standard instrument Surftest MITUTUYO-SJ-210P

Sample number	**Ra in µm**
1	6.554
2	7.686
3	9.234
4	10.47

Comparison of the simulated values, experimental values and standard data is done by normalizing b data. The Ra values are normalized for type of surface and sensor output is normalized to type of surface and then both are plotted on the same graph as shown in Figure5.

Figure 5 shows comparison of the results and they are found to be following similar trend. Type of the surface from 1 to 4 corresponds to the increase in the value of the roughness in µm. Slight difference in the values is because of the distance between the surface and the sensor head. The developed sensor is made to scan the entire surface by proper mechanical arrangement and then by taking the average of the output voltages of the sensor one can get the Ra value for that surface.

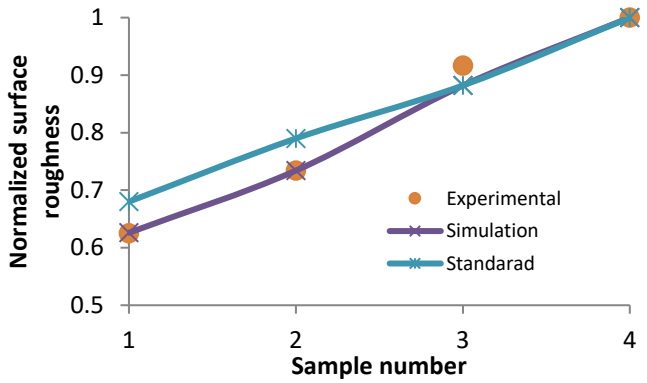

Fig. 5 Comparison with standard values

INVARIANCE TO REFLECTIVITY OF REFLECTOR:

As mentioned earlier, reflectors having different reflectivity are used in experiment. Output of the sensor is tested to see the effect of variation in the reflector property. It is observed that if output is taken only from one of the fibers, then it definitely dependent on the reflectivity as shown in Figure 6.

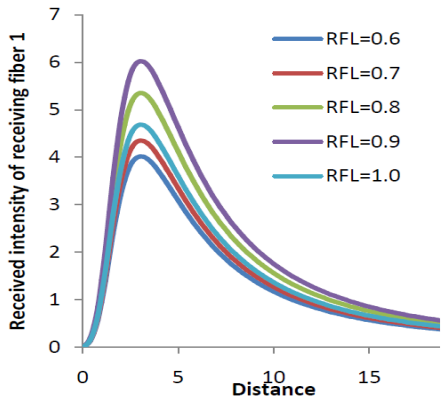

Figure 6 Dependance of reflectivity of reflector for single receiving fiber.

However, in the sensor arrangement shown in the figure 4, if output is calculated as per equation(4) by suitable signal conditioning circuit, one can observe invariance in the sensor output for different reflector types as shown in figure 7.

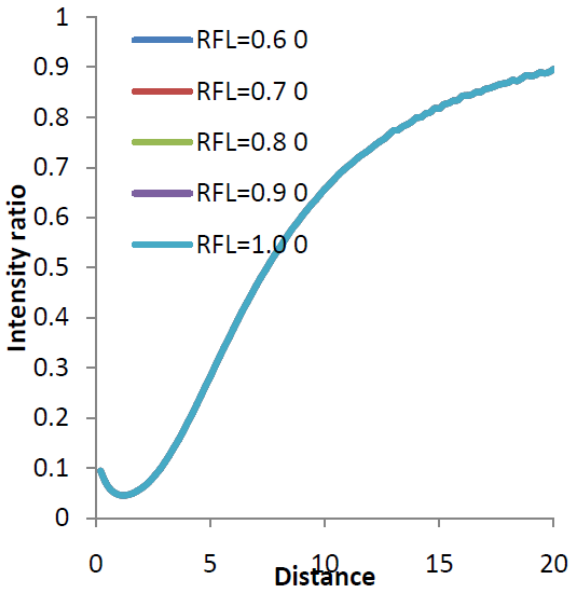

Figure 7 Invariation in the sensor output using equation (4)

Developed sensor is useful in measuring the surface roughness independent of reflectivity of the reflector.

SURFACE ROUGHNESS OF NON REFLECTING SURFACES:

Experiments are carried out not only for reflecting but also for non reflecting surfaces as well. Polish papers of values 50, 100,200 and 400 are used. Table 2 shows sensor output in volts for values of polish papers.

Table 2 Sensor output for non reflecting surfaces (Polish papers)

Polish paper	Sensor output in volts
50	3.2
100	2.0
200	1.2
400	0.6

CONCLUSION

Developed surface roughness sensor is non contact type fiber optic based sensor having all the advantages of using optical technology for sensing. The sensor is useful in measuring the surface roughness irrespective of the type of the metal whose roughness is to be measured. Addition of asymmetry in the geometry is useful in making the sensor output independent of the reflectivity of the surface and the variation in the source intensity variation due to aging or degradation.

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