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Role of AICTE-IDEA Lab in Experiential Learning and Acquisition of Multidisciplinary Skills for Execution of Undergraduate Projects

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Abstract : This article emphasizes on the importance of skill- based training and multidisciplinary approach in the technical education. To ascertain the effectiveness of such concepts, the activities and projects carried out in IDEA (Idea, Development, Evaluation and Application) Lab established under AICTE-IDEA Lab Scheme are focused and discussed in this paper. After undergoing an experiential hands-on training on the machines and software's available, as the resources of IDEA Lab, eight interdisciplinary and multidisciplinary engineering projects were completed by the students under the facilitation of faculties called Technical Gurus. The methodology involved in carrying out two such projects are discussed in detail whilst the other projects are listed. From the accomplished projects, it is observed that the training imparted in IDEA Lab and the experiential learning certainly enhanced the acquisition of multidisciplinary skills in the students, which are essential in converting the Ideas into Prototypes.

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Keywords: IDEA Lab; skill-based training; multidisciplinary projects; ideas; prototyping.

1. Introduction

Experiential learning plays a vital role in understanding the technical concepts and applying them in a better way to convert ideas into prototypes. Apart from that, acquiring the multidisciplinary skills is also equally important to handle the societal and industrial challenges. In the field of technology, an advent of Industry 4.0 [1,2,3, 4] has revolutionized the way companies are manufacturing and distributing their products. The major technologies which emerged out of Industry 4.0 revolution are digital or smart manufacturing and Internet of Things (IoT). Thus, it is essential to spread the awareness and importance of these newer technologies to society and the educational institutes. In this direction, the Fabrication Laboratories established in Kenya and South Africa developed a strong relation with social entrepreneurs for availing of the 3D printing services. Social entrepreneurs not only relied on the Fabrication Laboratories for 3D printing but also could setup economical 3D printers and get integrated with low-cost Computer Aided Design software [5]. Maker's space and Fabrication Laboratories plays an important role in fostering the 21st Century skills using the two main skill frame works: Entrecomp and Digcomp[6].Fabrication Laboratories are accessible to public for digital manufacturing and electronic tool

services. Such laboratories promote a technique of do-it-yourself in the invention and tinkering activities. Such Laboratories also changed the perception of media and public in treating 3D printing as a general-purpose manufacturing method [7].Further, Fabrication Laboratory based learning makes the school students feel more interested in scientific concepts and promotes a more engaged technical learning [8].

In this direction, AICTE-IDEA Lab is one such platform where the students undergo an experiential learning to acquire the multidisciplinary skills. AICTE-IDEA Lab is an initiative of All India Council for Technical Education, New Delhi to financially support the technical institutions to establish such a facility and provide an environment for the students undergo skill-based training, ideate, develop, and convert the same idea into prototype. IDEA Lab also facilitates the students to gain the entrepreneurship skills and promotes the students to have their own startups. To help the students learn these newer technologies, KLE Technological University, Dr. M. S. Sheshgiri Campus Belagavi AICTE-IDEA Lab has the state-of-the-art equipment (Example: 3 in 1 machine -3D Printing / Laser engraving / CNC carving, CNC wood router, Laser cutting machine, micro milling machine, high resolution 3D scanner, electronic equipment along with high performance computer workstations) established under AICTE-IDEA Lab scheme. The present work is an attempt to utilize this facility in pedagogical initiative to meet the present needs of Engineering Education. This experiential and pedagogical research is to train the students of different levels from primary schools to engineering graduates to imbibe the multidisciplinary concept, which is line with the goals of the National Educational Policy 2020 of India. The utilization of IDEA Lab facilities by the 6th semester undergraduate (BE) students to carry out their projects of multidisciplinary nature are demonstrated in this paper. Two such projects completed are reported in detail in this article and others are listed.

2. Concept Of Idea Lab

IDEA Lab Scheme, an initiative of All India Council for Technical Education, New Delhi (AICTE), mainly focuses on training and developing the individuals to become entrepreneurs. It basically encourages the students to apply the concepts of Science, Technology, Engineering and Mathematics (STEM)to acquire hands-on experience. In IDEA Lab, learning happens by self-doing for the better experience with machines and through the actual product visualization. AICTE-IDEA Lab comprises of the state-of-the-art multidisciplinary facilities which encourages the students to utilize them in addressing the societal and industrial problems through critical thinking and problem-solving skills. The objectives of the AICTE-IDEA Lab are inclined towards the goals of National Educational Policy 2020 of India. Inventive IDEA laboratory promotes the students to take up multidisciplinary / interdisciplinary projects and internships. It also helps in collaborating with industry which will enrich the students with need-based and innovative project ideas. The collaboration with industries and institutions will expedite the process of design and development of products from Lab to Land (market) by providing training to students with right tools for experimentation. It also provides end to end facilities for product development and start-ups at affordable prices. The faculty development programs (FDPs), multi disciplinary projects and research projects through IDEA Laboratory with High tech equipment will offer all facilities and services required for faculty in research and development.

3. Objectives Of Idea Lab

The main objective of the AICTE-IDEA Lab is to augment employment and self-employment potential of graduates from colleges and enhance innovativeness of companies by fostering students: entrepreneurship, creation of business start-ups and open innovation approach in collaboration with universities and enterprises. Following are few of the objectives:

- To support students to generate, develop and commercialize their own innovative ideas through entrepreneurship and/or open innovation.
- To leverage and explore innovation ecosystem of faculty and students to achieve an innovation-driven, self-reliant, and entrepreneurial enabled for building strong environment in straightening the multifaceted real time societal challenges.
- To foster student entrepreneurship and start-up creation at institute by improving infrastructure, entrepreneurial culture, and skills.

- To introduce and implement open innovation as a new form of partnership among key stakeholders in knowledge triangle in WBC.

- To revise and adapt curriculum to include entrepreneurial skills and problem-based learning.

4. Case Studies

The normal practice in the affiliated colleges is that the students were trained only for the prescribed curriculum.There were challenges to impart hands-on training to the students on multidisciplinary domains due to limited facilities those were required for the industry needs. The state-of-the art facilities provided under AICTE-IDEA Lab is used to train the students to provide skill development, impart the multidisciplinary concept.It also creates a platform to take up the projects and come up with prototypes as a result of practical implementation. This helped in addressing the challenges.The students from different disciplines were trained on various disciplines of Engineering and they were assigned with a task of executing the projects under the supervision of faculty called technical gurus.This is the uniqueness of the present study wherein the students of different disciplines are trained on multidisciplinary concepts and alsothey take up the projects addressing the social needs. A total of 8 projects were done as listed in Table – 1, out of which 2 projects are described in this article in the sections A and B and the working model of others are displayed in Fig. 1.

Table-1: List of projects

Sl. No.	Title
1	Agriculture Pesticide Spraying Robot
2	IoT based Virtual Doctor Robot
3	Assistive Glove for stroke rehabilitation
4	Advanced Fire Extinguisher
5	Automatic Drill bit Dispenser
6	Arduino driven belt conveyor
7	Pick and place robot
8	Automatic ship lifter

Fig. 1. Multi-Disciplinary Projects done in Idea Lab: (a) Assistive Glove for stroke rehabilitation (b) Advanced Fire Extinguisher (c) Automatic Drill bit Dispenser (d) Arduino driven belt conveyor (e) Pick and place robot (f) Automatic ship lifter.

The authors actively participated in the development and execution of the projects, working closely with the students and technical gurus. Authors oversaw the design, fabrication, and integration of technologies, ensuring the successful completion of the projects. Through this hands-on involvement, students gained first-hand experience and insights into the practical challenges and outcomes of the projects.

A. Agriculture Pesticide Spraying Robot

Agriculture is the main profession in the rural India which represents about nearly 60% of the population. Farmers use huge quantity of pesticides for the increased yield to meet the demand. Conventionally the pesticide is sprayed manually and has many drawbacks such as time consuming, operator health hazards and others. The unregulated spraying of pesticide may result in less coverage leading to wastage. In addition, in the recent years, there is a drasticdearth of labor availability and their wages are getting increased day by day. To overcome these problems, the use of Internet of Things (IoT) based Agriculture Pesticide spraying Robot is proposed. For the fabrication a chassis was designed and fabricated using wooden plywood. A plastic box is used to house the electronics components like Node MCU, relay module, bread board etc. and the container in which pesticide is put is also a plastic box. A 12Vbattery is employed to supply the power and using a bug convertor voltage is reduced to 5V. Each of the electronics/electrical components, pump, battery, and

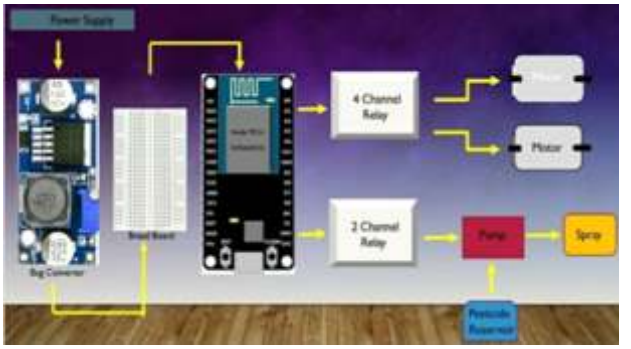

Fig.2: Connection details of Agriculture Pesticide spraying Robot.

pesticide supply tank are mounted on a plywood chassis. A 4channel/2channel relays, with help of jumper wires, are connected to NODE MCU. The connection between the electronics/electrical components with the NODE MCU and Mechanical components is as shown in Fig. 2.

Blynk IoT, an android based application, is used to manure the robot in the desired direction for spraying of the pesticide. A program is written and dumped into NODE MCU to switch off/on the pump and a motor. The working prototype of an Agriculture Pesticide spraying Robot with the detailing of parts is as shown in Fig 3. It is worth mentioning that, the cutting of plywood is done using a Marksys CNC WR 13.25 Wood router Machine and the funnel used in the project is 3D printed in a Snap Maker A350 Machine.

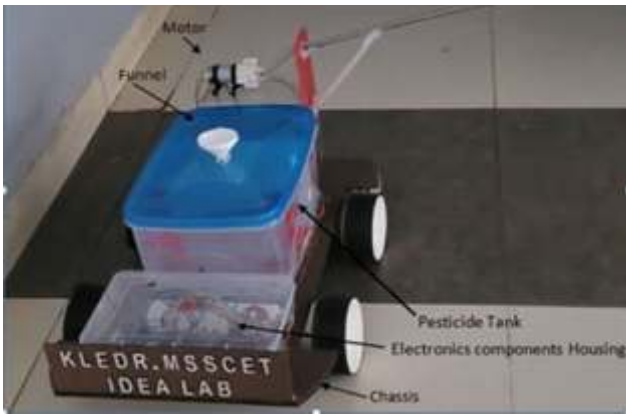

Fig.3 : Working Prototype model of Agriculture Pesticide spraying Robot

B. IOT based Virtual Doctor Robot

During the Covid period, doctors found it difficult to go near the patients for treatment. Also, it is not possible for doctors to be present at each and every place at the same time as they need to attend the emergency cases at several places. This makes it difficult for the doctors to monitor the health condition of the several patients when they are off the workplace. IoT based virtual doctor robots can address this issue by making the doctors to treat the patients by sitting at remote places[9-16]. Inspired by the cited references, a task was assigned to the students to develop the IoT based virtual doctor robot by incorporating some of the new features. The new features incorporated in the developed virtual doctor robot are as follows:

1. Drawers are provided for keeping medicines, documents and medical instruments. These drawers can only be operated by the authorized doctors with the help of switches provided in the BLYNK APP.

2. A motor assisted 360-degree rotatable tablet is provided at the top of the robot to give a complete view.

3. Battery drain status to know the amount of charge left through an inbuilt charger provided in the Robot.

4. Manual operation feature in case the automatic mode suffers an accidental breakdown. The Manual switches provided in the Robot can enable the features.

A virtual 3D model is created in a 3D model software named SolidWorks for a better visualization of the Prototype beforehand. The 3D modeling feature named EXTRUDE, CUT-EXTRUDE and REVOLVE are used to create the entire model. Each part is modeled separately and are assembled as shown in Fig. 4. Acrylic material is used for the fabrication of pillar, base, and drawers. The wheels made of Plastic material are procured and are fitted on to the model.

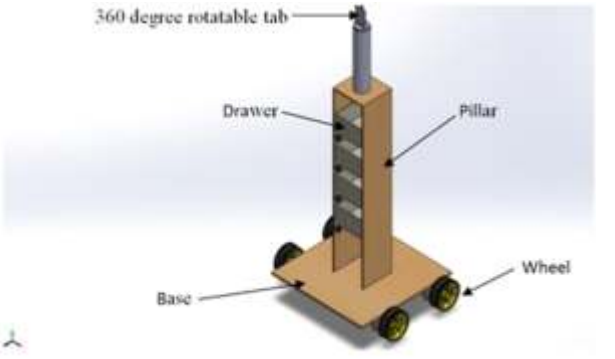

Fig. 4 : 3D virtual model of an IoT based virtual doctor robot

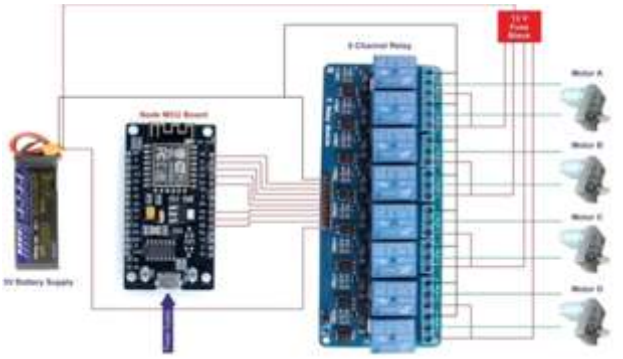

Fig. 5: A detailed Circuit diagram for Drawer operation

An8-channel relay, as shown in Fig. 5 is used for the opening and closing of drawers through a 3D printed rack and pinion gear via servomotors. Two channels are used by each drawer where one channel is used for opening and another for closing. Fig. 5 shows the integration of NODE MCU board with the servomotors through an 8-channel relay. NODE MCU communicates with the BLYNK APP of a Mobile phone.

A 2-channel relay, as shown in Fig. 6, is used for the 360-degreerotation of a Tablet device through DC Motor where one relay is used for the clockwise rotation and the other for anti-clockwise rotation.

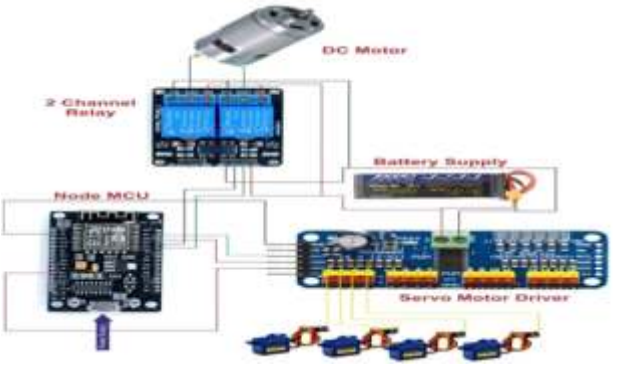

Fig.6: Circuit diagram for 360-degree rotation of a Tablet device

Fig.7 shows the architecture diagram which is used for the overall functioning of an IoT based virtual doctor robot. In the architecture, the components of the system are connected through an ESP 8266 based Node MCU, which integrates GPIO, 1-Wire, ADC and IIC in a single board. Servo motor drivers are used to control the working of servomotors through the NODE MCU and the relay modules are used as a switch to operate the drawers. It can also be depicted from Fig.7 that the user can issue the commands to the drawers and motors through a Mobile App via Node MCU.

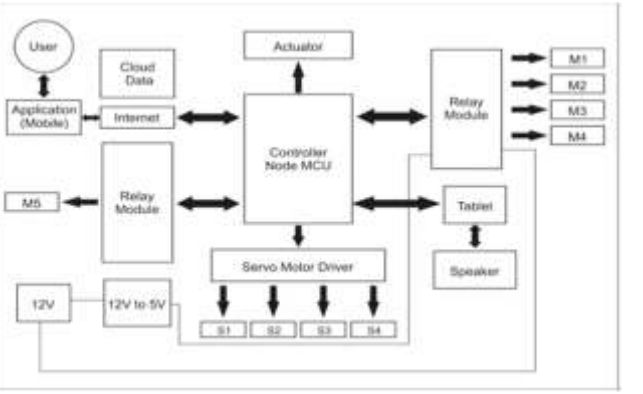

Fig.7: Architecture of IOT based virtual doctor robot

The zoomed view of an IoT based virtual doctor robot working prototype depicting thedifferent parts and electronic connections is as shown in Fig 8.Figure9 shows the assembled working model.

Fig. 8: Exploded view of Working prototype of IoT based virtual doctor robot

Fig. 9: Working model of an IoT virtual doctor robot

5. Experiential Learning Feedback

In the AICTE-IDEA Lab, a total of 8 projects were done using the multidisciplinary skills imparted through training to students of different branches of engineering. Totally 300 plus students underwent the training. The feedback was taken from the students who participated in the execution of projects in the AICTE-IDEA Lab (60 in number). It served multiple purposes within the study. Firstly, the feedback helped in understanding the students' perspectives, experiences, and the impact of the lab on their skill development. Even though the feedback does not directly reflect on the outcomes of the study in terms of statistical analysis or quantitative measurements, however, it plays a crucial role in portraying the effectiveness of the AICTE-IDEA Lab.

Following are the points on which feedback was taken,

1. Improvisation in the ability to convert ideas into prototypes in IDEA lab.

2. Development of ability to make judgments about alternative perspectives.

3. Development of ability to communicate effectively with others.

4.Improvementin the ability to use knowledge to solve problems in the lab.

5. Acquisition of multidisciplinary skills through the IDEA lab.

6. Building of confidence in dealing with a wide range of people by attending IDEA lab training.

7.Stimulationof the interest in engineering through IDEA lab.

8. Overall, satisfaction with the quality of the support from mentor during the project work.

The feedback scores in terms of percentage for all the above listed evaluation points are plotted in Fig.10.

From Fig. 10 illustrates the feedback of students who have executed the projects. All the evaluation points scored more than 84% and more importantly

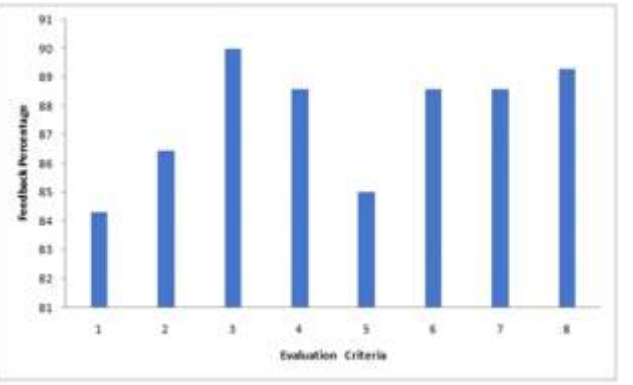

Fig. 10 : Percentage feedback scores of students, who executed the projects, for different evaluation points

evaluation point number 7 scored 88.57% thus suggesting the role of AICTE-IDEA Lab in stimulating the interest of students in Engineering. The criteria evaluating the Acquisition of multidisciplinary skills through the IDEA lab has a good percentage feedback score of 85%.

Furthermore, the feedback was taken from other students who were trained through AICTE-IDEA Lab activities on the same points and the Feedback scores in percentage are as shown in Fig. 11. It is evident from Fig. 11 that, feedback score for Acquisition of multidisciplinary skills through the IDEA lab, which is the focus of this study, is 81.5%. Thus, it can be concluded that, AICTE-IDEA LAB plays an important role in imparting multidisciplinary skills to the students.

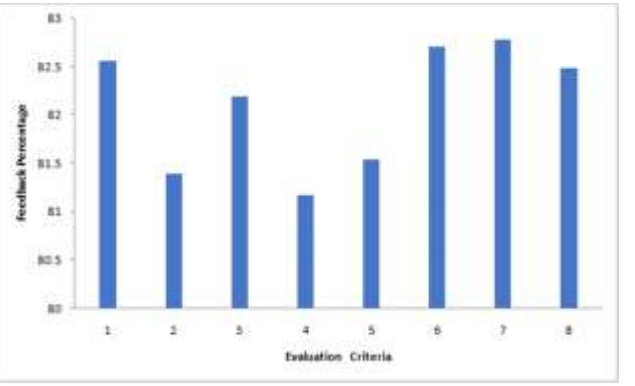

Fig.11: Percentage feedback scores of students, who underwent training, for different evaluation points

6. Conclusion

In the AICTE-IDEA Lab, consisting of state-of-the-art equipment, students of various branches were imparted the multidisciplinary skills through hands-on training. The students of 6th Semester Engineering were assigned a task of choosing the relevant projects

and executing them in 8 different groups. Based on the accomplishment of their training, tasks, and their feedback the following conclusions are drawn,

1. The hands-on training or the experiential learning enables the students to become self-sufficient in the execution of the projects with a lesser intervention of the guiding mentor.

2. According to the feedback taken from the students it is evident that, the training imparted in the AICTE-IDEA Lab helped the students to gain multidisciplinary skills.

3. The student's feedback suggests that the experiential learning attained in the IDEA Lab helped them to convert ideas to prototypes.

4. The experience of the IDEA Lab enables them to communicate with the wide range of people and solve their problems.

5. The active involvement with students and staff helped in understanding students' interest in learning multidisciplinary concepts, idea conversion, communication abilities, and problem-solving capabilities of the students in the development and execution of the projects.

6. The highlights of the specific projects and their outcomes do inspire other educational institutes and researchers to adopt similar experiential learning pedagogical approaches and explore the potential of multidisciplinary projects.

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