

State of Art in Robotics and Embedded Systems: Bangladesh Perspective

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Abstract—The Embedded Systems are everywhere and everyone is very curious about robots and their autonomous activities. These two topics are very integrated with each other. This discussion focuses on robotics: their evolution, applications, recent development and their future. The reconciliation day is coming where very high performance robot will work and communicate with human with the help of their sensory and human-machine interaction capacity. This article surveys the current state of art in robotics and embedded systems. Some innovative researches are identified in robotics and embedded systems with their architecture, communication, motor action, sensors and intelligent control system. Considering the latest trend and innovations in the world we will highlight the importance and uses of robotic applications in developing countries like Bangladesh. Since these researches are highly integrated with natural science, engineering application and also with renewable energy, we conclude our survey by identifying several additional open research issues in Robotics and embedded systems.

Index Terms—autonomous, rescue robots, Agrobots

I. INTRODUCTION

Engineers and researchers of developing countries like Bangladesh are working hard to pull up their countries living standard. Technical innovation can be seen everywhere including self-educated technicians to highly educated academic researchers. Unfortunately, those researches and innovations are hardly effecting on our social and humanitarian developments due to the lack of opportunity and ability of commercialization. Hence, many of our vital projects are not converting to the industrial products and they are not using for the socio-economic development.

From nano chip to satellite operation, from industrial work to our daily use, all the way we are integrated with the embedded system. In fact, nowadays most of the industries and corporate offices of our country are looking for smart systems for automation where budget and funding is not a big issue for them. But only because of poor R&D, we are lagging behind to cope up with demand. We believe, this is the high time for electrical and computer engineers to target this embedded and robotic system market for self-employment. In this research, our team has put an extreme effort to investigate

the progress, problems and prospects of robotics and embedded system in our country. Our research includes deep analysis about the robotics and embedded research developing in Bangladesh, problems that are facing to meet with commercial demand as well as international standard and finally the necessity of R&D sectors to cope up future industrial collaboration in order to reduce our emerging unemployment ratio. After discussing the whole scenario this research also concludes some important applications of robotics and embedded system from our country's perspective which is very crucial for engineers to find their future goal. Finally, we believe this research is going to be a ground breaking initiative to bring revolution for our engineers (especially computer and electrical engineers) to decline traditional job mindset and fetch R&D sectors in corporate with industrial development.

II. EVALUATION OF AGRICULTURAL ROBOTS

Nowadays robotics and automation systems extensively applied agricultural sector. Several motivations are behind the investment to incorporate robotics in agricultural sectors like decreasing labor forces, saving time and cope up with the high product demand. Apart from those, increasing food quality, production security and finally reducing end product cost are also vital parameters for automation revolution in agriculture. Moreover, farmers are getting exemption from extensive physical effort. In fact, those phenomenons are especially considerable and important for developing countries like Bangladesh. Mostly used agricultural robots in developing countries are: mowing grass, spraying pesticides and monitoring crops. This research represents a review on some common robotic technology that is used in agriculture sector of Bangladesh and also other developing countries.

From several decades researches has been performed to develop robots for using in agriculture sector. Cherry, tomatoes, cucumbers, mushrooms, and other fruits are harvesting using different types of robots in different countries [1]. Moreover, in horticulture, robots have been introduced to harvest citrus and apples. In dairy farming, milking robots are currently commonplace in the Netherlands [2] whereas Bangladesh and other developing countries are still following conventional procedure. Example of Advance automated engineering is Japanese “plant factory,” where vegetables are grown

hydroponically under artificial lighting [3]. Nowadays, Bangladesh, India, China, Thailand, Japan and others agricultural based countries are using rice cutter and other crop cutter machine in order to manage their cultivations.

Computers and robots are used to control the process from out planting seedlings, to root cutting, packaging,

and weighing, and the produce is free of any blemish, disease, or insect damage. The automation level in plant factories is so high that over time. They may become completely autonomous production facilities. Considering Agriculture aspect we have divided the scopes of robotics according to the Fig. 1.

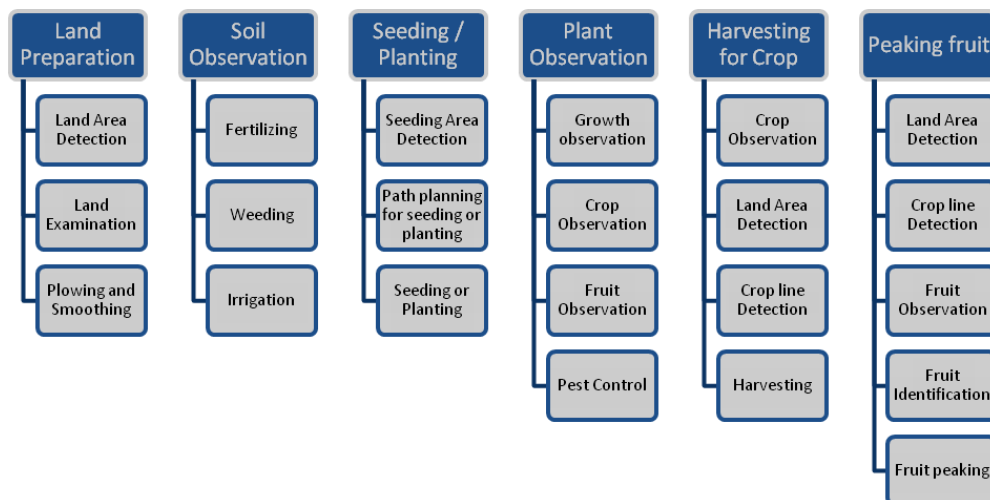


Figure 1. Various sections of implementation of robotic system in agricultural sector

Several advance robotic system has already been developed in order to fulfill the demand of agricultural sectors. In fact, those robots are making agricultural sectors more productive. Here we are going to give some examples of advance robots which can be incorporated in our agricultural sectors: The cost of UAVs has fallen rapidly due to the rapid growth of technology. Private corporations and universities all over the world are working on various types of UAVs to perform tasks which were previously done with enormous expense. The ‘Yamaha RMAX Helicopter’ is one of the most innovative and commercially available UAV in the world right now [4]. This robot can be used to precision in pesticide and fertilizer delivery purpose. In addition, ‘Casmobot’, an advance robot was developed by the University of Southern Denmark (during 2007-2009) as part of Plant Nurturing Robotics. In fact, ‘Casmobot’ is a contraction for Computer Assisted Slope Mowing Robot [5]. In recent years many universities in Bangladesh tried to concentrate about developing UAV resulting numbers of UAV project in national and international seminar and conference. From, early 1980 researchers were working on developing the principle of fruit picking robots. In fact, these principles have disclosed the door of new approaches to the harvesting of crops. However, to develop the fruit picking robotics technology in a notable level, contributions from high-tech industry, agricultural commodity groups and farm equipment manufacturers must be hunted. Vision Robotics, a San Diego company, is working on a pair of robots that would trundle through orchards plucking oranges, apples or other fruit from the trees. In a few years, troops of these machines could perform the tedious and labor-intensive task of fruit

picking that currently employs thousands of migrant workers each season [6]. By developing this technology Bangladesh can be benefited in summer season when lots of labor and cost are invested order to collect the fruits. ‘HortiBot’ robots are used in the hilly areas where cultivation is too much complicated and expensive [7]. This kind of robots can be used in hilly areas in Bangladesh such as Chittagong where lots of crops are harvesting in mountain. High-tech tools for weeding that at a later stage can be implemented are tools like laser, micro spraying and mechanical devices.

University graduates are conducting researches to develop agrobots. A class of undergraduates at the Massachusetts Institute of Technology (MIT) has created a set of robots that can water, harvest and pollinate cherry tomato plants. Carnegie Mellon University’s Field Robotics Center is testing an automated utility cart equipped with laser range- finders to find its way through a Pennsylvania apple orchard, towing sensors that track the progress of the crop.

BRAC University Robotics Research lab has developed Smart Irrigation and Soil Component Test which is shown in Fig. 2. The aim of the projects is to make an embedded system which will provide all the necessary information needed for the production of various crops in an efficient way making the whole process automatic, cost effective, eco-friendly and attaining all other environmental concern. It will also provide the amount of soil nutrients and following to that measurement, an apps database will help to find out the amount of fertilizer to be used in particular field. A soil moisture sensor with low-cost was modeled, simulated and tested for achieving accurate and reliable measurements. A high-performance pH probe is calibrated with linearity of the pH scale.

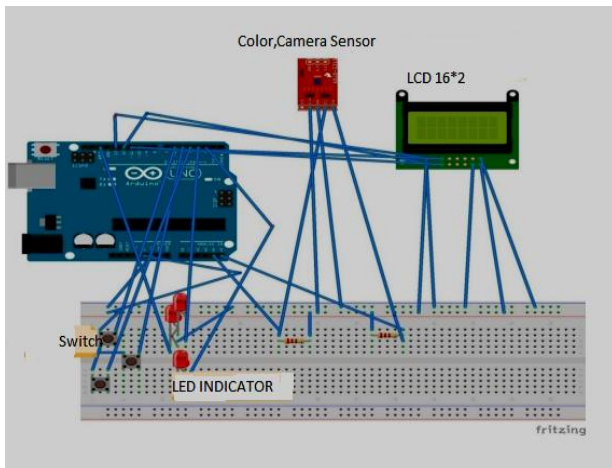


Figure 2. Smart irrigating system integration

An Automatic weather station (AWS) is an automated type of traditional weather station, either to facilitate measurements from remote areas or to save human labor which has been used in developing countries. It has been considered that with the advancement in modern technology the use of combined weather sensor is essential for agriculture of Bangladesh, considering the geographical location, climate change issues, agriculture based economy & weather forecast etc. Hence keeping this in mind a cost effective, reliable and efficient combined weather sensor has been developed at BRAC University. The major contribution of this project will be the acquisition of the data's of the sensors altogether, which makes the weather sensing digital rather than manual which is shown in Fig. 3. This project is focused to get more accurate weather information and to make the system digital rather than conventional ones.



Figure 3. Smart remote sensing weather station

III. EVALUATION OF ROBOTS IN MEDICAL SECTOR

Medical robot is an emerging and relatively new field to assist in diagnosis and treating patient. Medical robot can be highly specialized and can be able to reduce human error. The fields of medical robot that sustain now-a-days are radiology/imaging system, radiation therapy, patient positioning and surgery. The fields of

ongoing research of medical robots are rehabilitation, minimal invasive surgery and laser osteotomy. Magnetic Microbots are a group of tiny robots used in innumerable operations, such as removing plaque from a patient's arteries or helping with ocular conditions and disease screenings [8]. Microsoft Research Cambridge team built an augmented reality system to help brain surgeons visualize 3D brain scans by using their new Kinect API [9]. Kinect Fusion supplies 3D modeling of anything, which could fuel some seriously neat medical innovations. According to a recent article from The Wall Street Journal, in the next few years, thousands of 'service robots' are anticipated to enter the healthcare sector. As less than 1,000 of blue-collar robots currently roam about hospitals, but those numbers are anticipated to increase rapidly [10].

Like many of Toyota's Healthcare Assistants, much robotic advancement are used to better the day-to-day lives of patients, helping them eat, like the Bestic Arm, or helping a patient regain her ability to walk. Moreover, embedded system and robot are used in disease diagnosis for example ECG, EEG, MRI –all medical devices are using the latest development of embedded system and technology. In Bangladesh these devices are mostly imported from developed countries. The development of these instrument and devices within the county are highly needed for Bangladesh. Again, in case of natural calamities or disaster, medical robot plays an important role to give an initiative treatment without presence of human. Fig. 4 illustrates that BRAC University students have developed a special kind of robot called "priSha" that can be controlled by thinking of patient. The purpose of this robot is to give primary control of the robot with the help of thinking of patient.

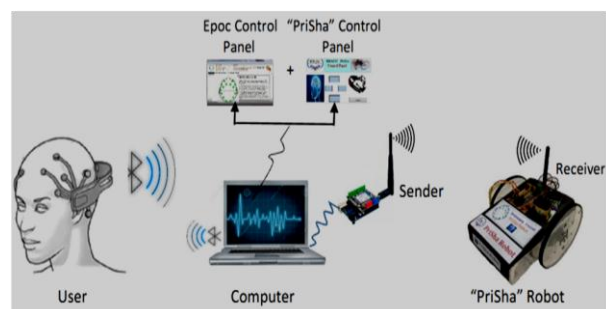


Figure 4. Controlling robot by human brain

The use of medical robot in Bangladesh is very rare; only some of renowned hospitals take initiative to use it. Types of heart surgery that are performed with minimally invasive surgery in Bangladesh include Coronary Artery Bypass Graft (CABG), Atrial Septal Defect (ASD) closure, Mitral valve repair/ replacement. Beside normal heart surgery there is an approach where incision is made very small of about 2 inch to 3 inch long in the chest according to the type of surgery and heart lung machine is connected through a small incision in the groin [11]. This procedure is also done with the aid of robot in the developed countries now a day and gained much popularity. In Bangladesh, robotic heart surgery may not be feasible for economic constraints but with the

development of robotics field in Bangladesh can reduce the cost and make it ease of access for general people. Few days ago, a seminar conducted by Apollo Hospitals, Chennai at Bangladesh opened up new perspectives in healthcare. Doctors including Dr. Anantha krishnan Sivaraman, Consultant Urologist from Apollo Hospitals, Chennai demonstrated the latest surgical interventions using Da vinci Robotic Surgery system in the event organized by Global Telemedicine Company, Representative office of Apollo Hospitals in Bangladesh [11].

IV. EVALUATION OF AGRICULTURAL ROBOTS

A very large numbers of heterogeneous agents in the hostile environment are relating with disaster rescue has becomes more important social issue now-a-days. For example, Sandia's Gemini-Scout is used as a rescue robot for Mining Disaster [12]. This type of robot can be useful for Bangladesh in industrial hazard like "Rana Plaza Tragedy".

BRAC University Robotics Club has also developed a new Intelligent Military Robot (IMV) which is shown in Fig. 5 that can be used for this purpose also. This type of robot can be used for rescue and spying purpose in war field to make a surveillance of opposite actions. Again, the combination of vulnerability to earthquakes and a natural affinity for robotics has led to a surplus of Japanese rescue robots [13]. This type of robot can be useful in Bangladesh as it lays such area where the possibility of earthquake is very high.

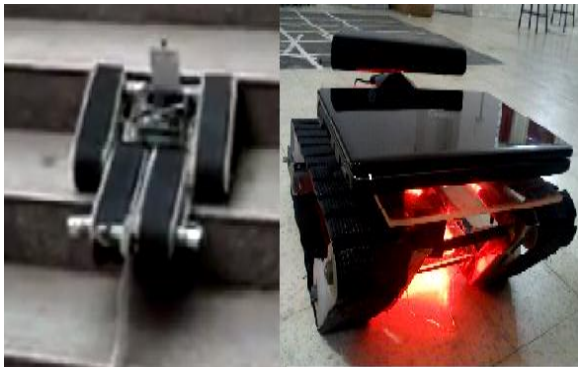


Figure 5. Intelligent Military Vehicle (IMV)

V. EVALUATION OF INDUSTRIAL ROBOTS AND AUTONOMOUS TRANSPORTATION

An industrial robot is an automatically precise, reprogrammable, adaptable manipulator programmable in three or more axes. Typical applications of industrial robots include welding, painting, ironing, assembly, pick and place, palletizing, product inspection, and testing, all accomplished with high endurance, speed, and precision. The most commonly used robot configurations for industrial automation are SCARA robots and gantry robots [14]. Most types of industrial robots would fall into the category of robot arms. As a pioneer in robotics and robotic arm technology, the KUKA Robot Group is one of the leading suppliers and manufacturers of robotic systems worldwide [15]. In Bangladesh, many industries and electronic companies like Walton are growing up rapidly so the necessity of industrial robot becomes acute in now-a-days.

For the past hundred years, innovation within the automotive sector has created safer, cleaner, and more reasonable vehicles, but progress has been incremental. Researchers and makers of driverless cars say the technology will be far harmless than people-driven vehicles because they eliminate volatile human errors like distracted or drunk driving, or poor reactions to emergency situations.

As a result, in developed country the autonomous traffic system is very much popular and reliable. Using GPRS System, the traffic system can be maintained easily in Dhaka city and vehicle can be tracked in highway is also a developed project for ROBU (BRACU Robotics) [16]. Boston Dynamics builds advanced robots with remarkable behavior: mobility, agility, dexterity and speed. By using sensor-based controls and computation, it can turn to unlock the capabilities of complex mechanisms [17].

Organizations worldwide, from DARPA, the US Army, Navy and Marine Corps to Sony Corporation turn to Boston Dynamics for advice and for help creating the most advanced robots on Earth. BRAC University

Robotics has developed RC copter, Quad copter showed in Fig. 6, and two wheels self-balanced motor car showed in Fig. 7a & Fig. 7b. An excavation system has been developed at BRAC university considering simple construction, light-weight and efficient enough to excavate and collect known as Chondrobot I & Chondrobot II to participate in NASA Lunabotics Mining Competition which can be used for beach cleaning purpose or sample collection purpose [18], [19] are shown in Fig. 8a & Fig. 8b.



Figure 6. UAV (RC copter and Quad copter)

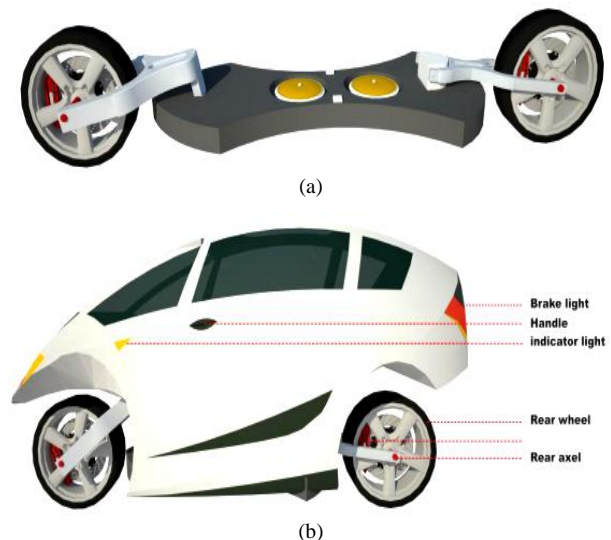


Figure 7. (a) Proposed chassis structure (b) Side view of two wheels self-balanced motor car

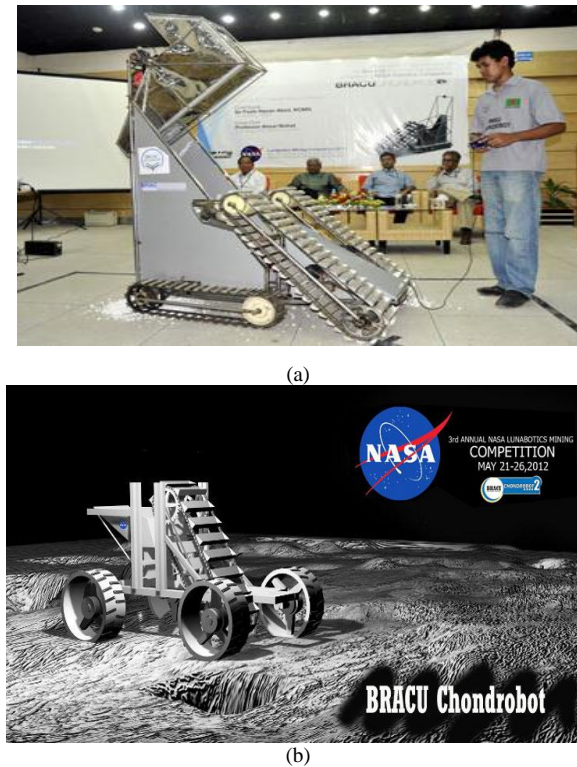


Figure 8. (a) Chodrobot I (b) Chondrobot II

VI. DISCUSSION OF ROBOTICS RESEARCH EVALUATION IN BANGLADESH

The uses of robot are indispensable for every sectors of society as it enables the opportunity to increase the production, guaranteed safety and reduces time. As it may be a little bit concern about many people that if robot will replace the human in workplace then many people will lose their job and become jobless. But the real scenario is little bit different in contrast with people concern. Due to the increment of production by using robot creates an opportunity to work more people in manufacturing and supplier-customer chain related jobs. As a result there is a balance of jobs without contributing any effect on human labor in workplace.

The developing countries are using robots for accomplishing precarious jobs for example rescue people, coal mining and such jobs which have a threat towards human lives. They have also used advanced robots in medical sector which saved number of human lives. As the prices of these robots are very high therefore it is almost impossible for developed countries like Bangladesh to buy and implement them. But some universities and organizations in Bangladesh are opening R&D sector to implement them in a small scale and in a cost effective way which signifies a great promise towards the evolution of technology. To cope up with the advanced world in the field of robotics, more concentration should be taken to get the benefit of robotics.

Due to limitations of R&D sectors the products can't maintain international standard. As a continuous cycle we are not getting international funds and resources for

spreading our R&D. In a long run, new technical job sectors are narrowing down and our traditional technology markets (such as Mobile operator companies, conventional electrical power developments) are going through a saturation mode resulting potential engineering graduate students (especially electrical and electronic graduates) jobless. Most of those graduate students are either dropping out themselves from engineering and going to join banking sectors or going to abroad and never comes back. We have termed this total system as a potential loss of humanitarian technology development in our country.

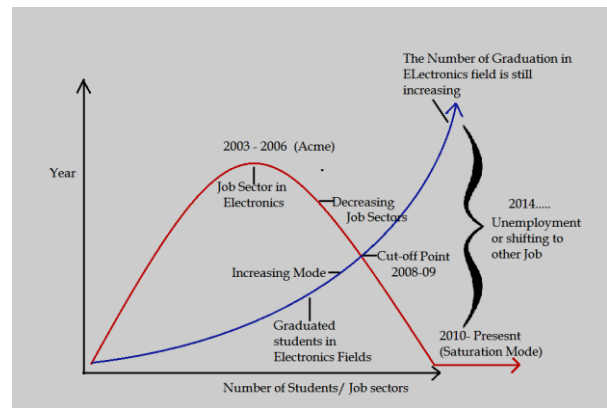


Figure 9. Situation of electronic job sector in Bangladesh

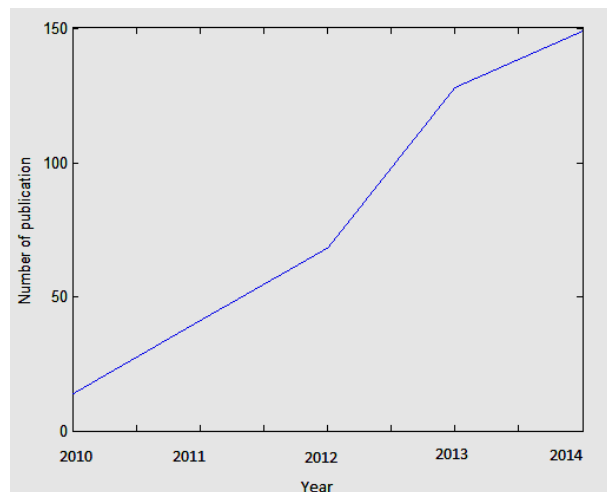


Figure 10. Study of robotics and embedded system research in Bangladesh

Taking this situation in consideration the only alternative is we have to develop R&D sector and create our own job market. By considering this situation, we draw a Fig. 9 to show the job market of electronics in Bangladesh. The good news is that in Bangladesh there are increased numbers of research about robotics and embedded system has been practiced in recent few years. We make an estimation of paper published about robotics and embedded system in Bangladesh. The result indicates that the number of paper about robotics and embedded system published in conference are satisfactory and it is increasing day by day which is shown in Fig. 10.

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