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ILAT (Software as a Service): Interactive Learning Application Tool for Autism Screening and Assessment in children with Autism Spectrum Disorder

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Abstract— Autism is a type of neurological disorder usually noticeable during the early stage of childhood, especially between one to three years and occurs in all social groups. The common problem experienced by the autism subjects includes lack in social interaction, poor communication skill, overexcited, unable to express their emotions. While these disorders are not fully curable, early detection can reduce the severity with proper therapy. Even though there are no appropriate medications and treatments, still we can improve the lifestyle of the autism subject through various supportive therapies. If this disorder is not detected at early stages, the severity rate may probably increase during the later stage. Developing countries like India witness 0.2 percentage of the autism population in the overall community based on the information provided by the Rehabilitation Council of India. Express growth in the Information and Communication Technologies allows developing various assistive tools to enhance the lifestyle of the autism people. Fourth Generation Technologies like the Internet of Things, Wearable Devices, Cloud Computing, Big Data Analytics, and Artificial Intelligence, Mobile devices, Location-aware technology, Sensors, Augmented and Virtual Reality together provide a smart solution to all the sufferers. The objective of Interactive Learning Application Tool is used for Autism Screening and Assessment in children with Autism Spectrum Disorder and extended to explore the assistive technologies available to serve the community. This will enhance the social interaction, learning and communication skills in children, a tool for analysing the aggressive level, a tool for caregivers and supportive and ranking tool for psychiatrist dealing with autism subject.

Keywords- Assistive Tools, Fourth Generation Technologies, Social interaction

I. INTRODUCTION

The name "autism" refers to the broad range of neurological disorder, and the conditions are characterized by trials with social interaction skills, speech , nonverbal communication, overexcited, failure to express emotions, repetitive behaviors etc. Based on the survey in 2018, the Autism and Developmental Disabilities Monitoring (ADDM) Network, Centre for Disease Control and Prevention (CDC) confirmed that at least one among 59 children is diagnosed with ASD and in the ration of 1: 37 in boys & 1:151 in girls. Boys are four times more affected than the girls. In many cases, children were being detected after age 4; though autism can be diagnosed as early as possible at the age of 2. Autism affects all national & socio-economic clusters. Marginal groups tend to be analyzed later and less often. World Health Organization (WHO) has informed the need to reinforce countries' facilities to indorse the best health and well-being of ASD persons. The habits in which people with autism learn, think, communicate and solve problems can range from highly skilled to severely challenged. Some people with ASD may require momentous support in their daily lives, while others may need fewer supports and, in some cases, live entirely independently. In General, it is observed that there is no known single cause for autism spectrum disorder, but it is usually believed that abnormalities cause it in brain structure or function. The images of the brain scans show differences in the shape and structure of the brain in children with autism compared to in neuro-typical children. ASDs start in childhood and come across the stages like adolescence and adulthood.

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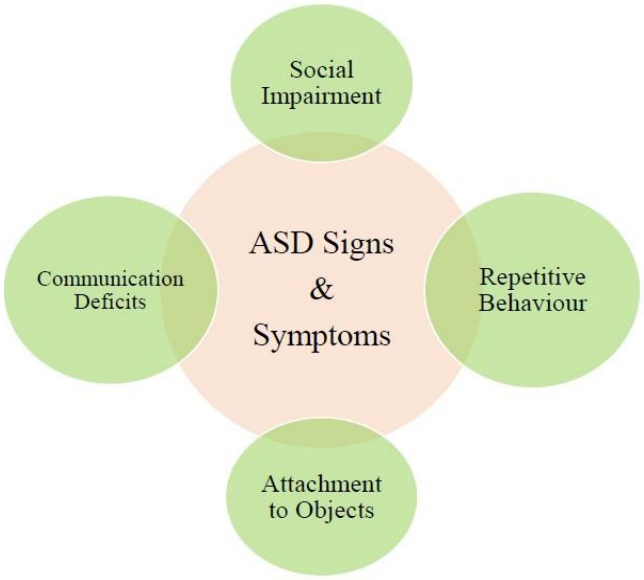

Figure 1. Autism Spectrum Disorder Symptoms.

The exponential rate of growth in information and communication technologies leads to the development of many applications for web-based system and handheld devices. This type of devices supports the autism group in understanding the daily routine activities using a graphical user interface and audio. Several kinds of research have been carried out to improve the learning aspects of the autism community. The applications are available in iPad, tablet and smartphone and Xin et al. have proved that the app developed by them has increased the communication skills through applied learning when tested with a class of students using sonaflex app deployed in Apple iPad [1]. A large number of cloud service providers in the market provide services, platforms and infrastructure for developing and implementing an application for the benefit of the autism group [2]. Therefore the end-users and the application service providers need not invest in the infrastructure; instead, they can connect using a cloud environment. To avoid latency experienced in the real-time environment when connected to the cloud, the latest applications prefer to run on their own environment termed as Edge computing, where the processing happens on the device itself. In order to help with the infrastructure for massive computation, a Fog computing environment is offered where and which the processing happens in the same environment. However, all these computing paradigms are mentioned for developing applications and deploying them in any one of the computing forms to cater to the need of the autism group end users.

Applications are provisioned using web browsers and also through add-ons[3]. Wearable devices are made up of electronic components used in the health monitoring system. Heart Rate, Blood Pressure are some of the readings taken through the support of Wearable devices [4]. Wearable devices read the data and store in the local device, and that can be connected to the cloud or end devices for remote monitoring. The devices are enabled with Bluetooth and connected to the end-user mobile devices through the fitness application developed for the purpose. Different communication technologies like WIFI, Mobile Network offered by various service providers also plays a major role in data transfer from the source device to the destination server [5].

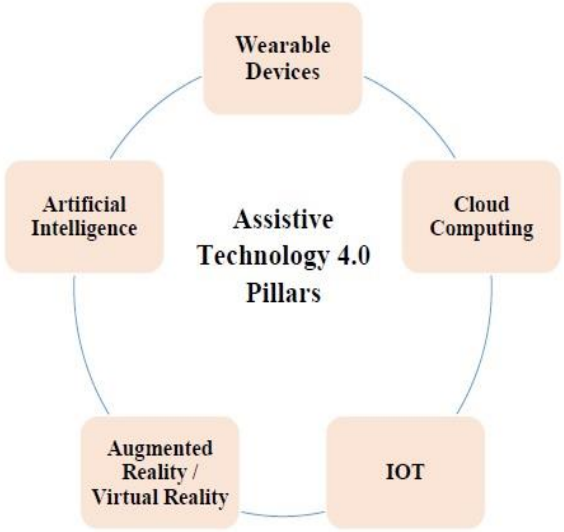

Figure 2. A Fourth Generation Assistive Technologies.

Sensors are the main source of operation for the wearable devices; the data sensed and processed in the human-readable form is displayed through the visual display unit. To process the data, a variety of processing devices ranging from mini computing device like RasperryPI, Udoo, Aurdino Lilly pad to high-end processing devices are popularly used. These devices are connected to medical thing applications that are linked to the autism subject. Internet of Medical Things is extravagantly providing services to improve the cognitive among the individual. Smart Glasses, Chabot, are some of the devices that improve the learning and communicative skills of the autism clusters. Pervasive Games [6] is available for the children with Attention Deficit Hyperactivity Disorder (ADHD) made up of gesture and tangible for the user. Data generated through wearable devices, web application, a mobile application is stored in terms of petabytes and needs distributed and parallel computing paradigms to process the massive amount of data. Health monitoring system delivers various parameter readings per day and that to be analyzed using different algorithms to provide comprehensive knowledge. The applications of Big Data Analytics and the different type of tools and platforms are highly useful in all sectors of the health care systems. Location-aware APIs helps to identify the location of the candidate and

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inform the caregivers. The mentioned technologies are well known across the globe and follow a standard format, and when used in the health care systems and rehabilitation process, the system provides more users interactive for the end-users, and there is a much-proven track of records how information and communication technologies advance the lifestyle of the autism group.

II. Related Works

Wass, et al. [7] has focused the benefits of using technology and to provide cognitive training to the ASD subject according to the severity of the case. The research is focused on reading the emotion and the face using recognition methods, enhancing social skills and improves the learning aspect among the community. The evaluation was conducted, and post-training improvement was noticed with the cases. Hashim,et al.[8] has studied the feasibility of using assistive technology for enhancement of brain impaired children. Humanoid Robot was used in the experiment with the support of primary school teachers and noticed the positive impact on children's spiritual or religious knowledge. Manuel, et al.[9] elaborated the need for using augmented reality for the autism community. Augmented applications in different domains were discussed and proposed the use of AR. Digital applications in mental health were analyzed through randomized studies by Feldman,et al. [10] and the objective was to evaluate the usefulness of superpower glass, derived with artificial intelligence to improve the social interactions among the ASD children. An incorporated system based on the multimedia and interaction based on augmentation technologies was designed, developed and tested among the small age group of between ages 6-10 with autism. The product delivered a very good output with respect to emotional and social skills improvement. Positive feedback by parents was also obtained [11]. A database of the ASD group was created by BAUM containing the audio-video face of the affective and mental states using naturalistic and challenging conditions. This database will help develop different algorithms and test the challenges with the ASD [12]. Respiratory monitoring wearable device using a fiber optic sensor was designed to monitor the airflow in the nasal to understand the slow, normal and fast breathing. This will be highly useful for the autism group for life monitoring [13]. Gesture-based detection will track the user is alive or not in certain circumstances like a child in the disasters management, or the child is in the bore well for a long time and needs assistance. This type of system will be highly useful for ASD cases if there is no proper human care [14]. A collaborating assistive skill for students with autism is developed using combined visual schedules, choice boards, and a token-based reward system is introduced to promote the student individuality. This would be a promising technology for classroom learning for the ASD group [15]. However the existing methods and technologies contribute to the benefits of the Autism subject, but the proposed design and models will enhance the quality of service, in terms of response time, interactive design for social associating, aggressive analyzer, guiding tool for care-giver and psychologist. This proposed system uses the latest information and communication technologies available and will definitely contribute to the ASD group of various ages. A Chabot was designed and developed for the primary health care center for the benefit of the rural users has effective information retrieval for the limited disease diagnosis [16].

III. Proposed System Design

The proposed systems design is organized as three core modules. One focuses on the GUI based tool to improve the learning aspect of the end-user through animation with touch and play effect, the second core module is on developing a Chabot application and finally developing a wearable device focusing on the monitoring the aggressiveness of the ASD group. In addition, the system will provide interactive tools for the caregivers and psychologist.

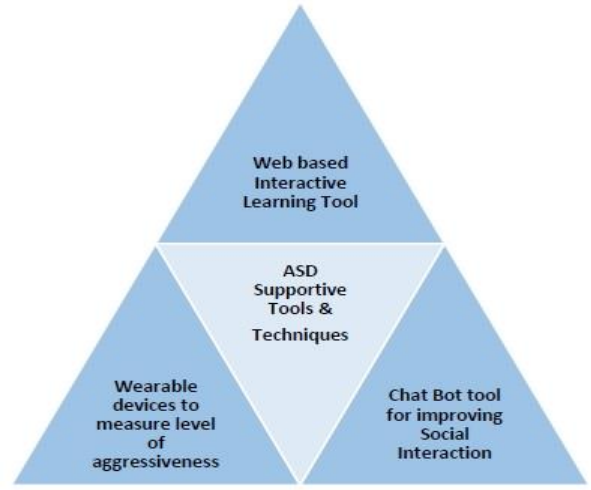

Figure 3. Core Modules in the proposed ASD Supportive System.

A. Interactive Learning Tool

The proposed learning tool will make the ASD group self-learn the content provided in the tool like alphabets through images, Numbers, Drawing Exercises, Games. The tool will also feature the video content to help them to brush, bath, walk, play and related day-to-day activities. The tool will maintain the database and record the activities which can be seen by caretakers and doctors for diagnosing and understanding the performance of the particular autism subject. This module uses

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web technologies and available as a services in the cloud computing environment.

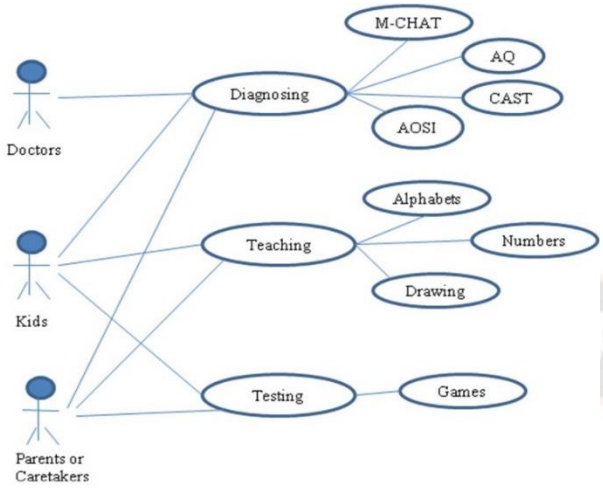

Figure 4. Use case Diagram of an Interactive Learning Tool.

B. Social Interaction

The challenging task among the autism subject is social mingling and behavior aspects. Innovations in Humanoid Robot, available in affordable prices, can be programmed and deployed with the autism group [17], [18]. These humanoid robots will strive to improve the communication aspects in each and every individual. This type of simulated robot and Tele rehabilitation service with autism intervention is highly accepted [19], and the clinical experience has proved the use of the humanoid robot in children with Cerebral Palsy [20]. The proposed pre-programmable humanoid robot will interact with the autism group and make them free to answer the questions and tends to improve the communication aspects. The robot will make them feel as like a real social mingling and feel themselves with emotions. The humanoid robot can use its local processing device, and the connectivity will be provided as multimode in terms of internet connectivity. Therefore the system will be able to connect to the cloud resources and add necessary supporting materials to the autism group.

C. Wearable Device

The proposed wearable device includes Arduino Lilly pad, the Sensor unit and GPS unit and in addition to the Heart Rate monitoring Sensor Unit. Location-based monitoring can be enabled in the wearable device with the help of API and sensor unit will monitor the aggressive level of the autism subject and inform the caretakers through push notification. This wristband is connected to the smartphone with the help of anyone communication technology like Bluetooth, WIFI, and Cellular Network. The smartphone will act as a local processing and storage device for the wearable device and the application is connected to the cloud service provider. The caretakers and the psychologist will be able to know the status of the ASD subject through their mobile phone connected to the cloud service. In case of emergency, the application developed to monitor the ASD community will deliver a Push Notification about the aggressive behavior of the subject. This facilitates the caretakers to take necessary steps to control them personally or remotely with the help of a humanoid robot.

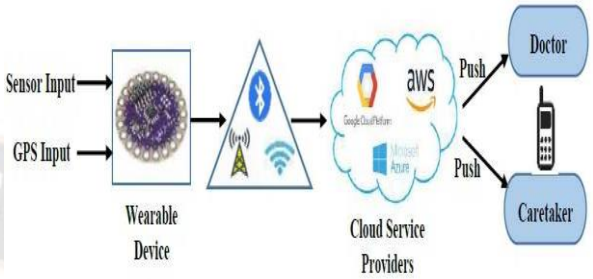

Figure 5. Smartphone as a gateway between User and Caretaker.

IV. Results and Discussion

The interactive learning application tool for Autism Screening and Assessment was developed using Microsoft .Net. This tool will be promising one for the autism subject. It includes alphabets, numbers, and games to cater the different age group. The Figure 6 elaborates the initial screen of the interactive learning application tool.

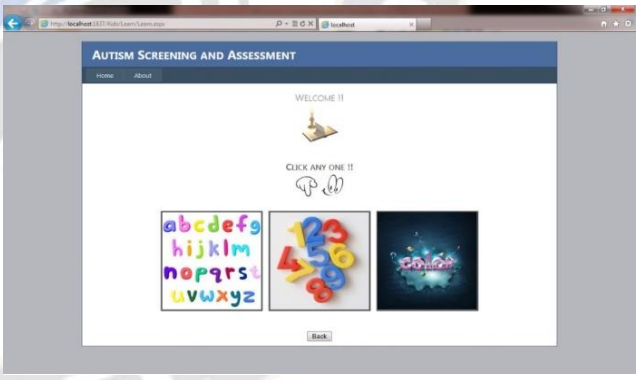

Figure 6. Initial Screen for the selection of the learning subject.

Two different modules are embedded in the interaction tool, one is the Doctor and the Care Taker Module and the other is the Kids module to enhance the activities with interesting factors. The Figure 7. Shows the main menu where the participants select the respective menu.

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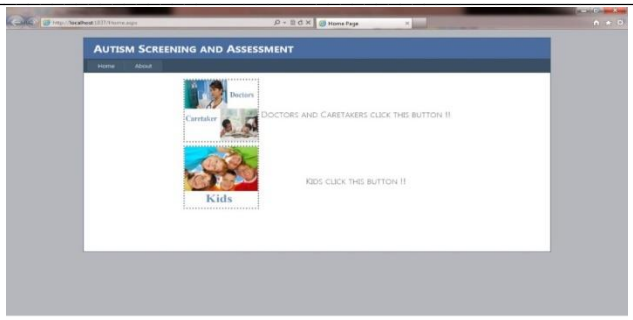

Figure 7. Selection Screen for the Kids and Care Takers.

The system developed will prompt the end user to enter the baby details before using this tool, this will help the care takers map their kids and doctors can observe the behavior of the kids through the cloud. The activities are stored in the local environment and also transferred to cloud using mobile internet. The Figure 8 shows the questionnaire for the baby.

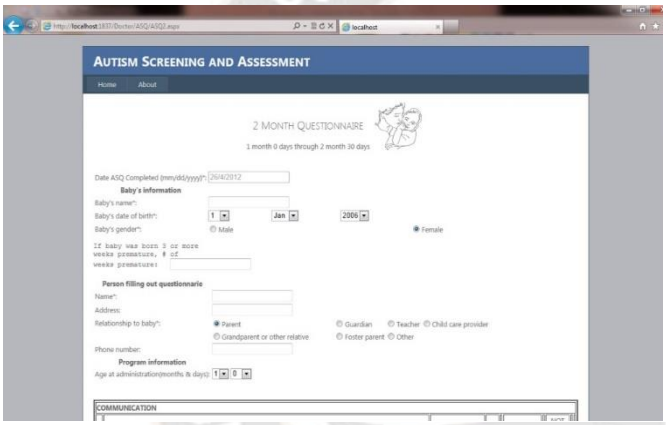

Figure 8. Questionnaire for Baby.

V. CONCLUSION

The technology available for developing the assistive tools is elaborated as Assistive technology 4.0. The development of the proposed tools will definitely address the certain issues like social behavior; communication aspects through self-learning with the help of web-based interactive tools and will be the promising factor for improving the performance among the ASD group. The proposed model is in its infant stage of implementation, the autism screening and the assessment module is implemented and it is available for Autism Subject.

REFERENCES

[1] J. F. Xin and D. A. Leonard, "Using iPads to Teach Communication Skills of Students with Autism," *J. Autism Dev. Disord.*, vol. 45, no. 12, pp. 4154–4164, 2015, doi: 10.1007/s10803-014-2266-8.

[2] S. S. Nuguri *et al.*, "vSocial: a cloud-based system for social virtual reality learning environment applications in special education," *Multimed. Tools Appl.*, vol. 80, no. 11, pp. 16827–16856, 2021, doi: 10.1007/s11042-020-09051-w.

[3] M. Jagadeesh and R. K. Nadesh, "Minimization of system resources for cloud based application using web browser add on," *Int. J. Eng. Technol.*, vol. 5, no. 3, 2013.

[4] C. K. Bhardwaj and R. B. Agnihotri, "Wearable Advancements and its Implementation in Sports," *2019 4th Int. Conf. Inf. Syst. Comput. Networks*, pp. 37–41, 2019.

[5] A. S. Sayem, S. Member, and K. P. Esselle, "A Unique , Compact , Lightweight , Flexible and Unobtrusive Antenna for the Applications in Wireless Body Area Networks," *2019 13th Int. Conf. Signal Process. Commun. Syst.*, pp. 1–4, 2019.

[6] A. L. Brooks, N. V. Eds, G. Coulson, and D. Ferrari, "Interactivity, Game Creation, Design, Learning, and Innovation," *Interactivity, Game Creat. Des. Learn. Innov.*, vol. 265, no. January, pp. 385–394, 2019, doi: 10.1007/978-3-030-06134-0.

[7] S. V. Wass and K. Porayska-Pomsta, "The uses of cognitive training technologies in the treatment of autism spectrum disorders," *Autism*, vol. 18, no. 8, pp. 851–871, 2014, doi: 10.1177/1362361313499827.

[8] R. Hashim, S. F. Mahamood, H. Yussof, and A. F. Aziz, "Using Assistive Technology for Spiritual Enhancement of Brain-Impaired Children," *Procedia Comput. Sci.*, vol. 76, no. Iris, pp. 355–359, 2015, doi: 10.1016/j.procs.2015.12.308.

[9] R. Manuel, N. Jorge, and M. I. Processing, "VipIMAGE Thematic Conference on Computational," no. September, 2019, doi: 10.1007/978-3-030-32040-9.

[10] E. Feldman, "Digital applications used in mental health treatment: Two randomized studies," *Integr. Med. Alert*, vol. 22, no. 8, pp. 89–92, 2019, doi: 10.1001/jamapediatrics.2019.0285.

[11] M. Magrini, O. Curzio, A. Carboni, D. Moroni, O. Salvetti, and A. Melani, "Augmented interaction systems for supporting autistic children. Evolution of a multichannel expressive tool: The semi project feasibility study," *Appl. Sci.*, vol. 9, no. 15, 2019, doi: 10.3390/app9153081.

[12] S. Zhalehpour, O. Onder, Z. Akhtar, and C. E. Erdem, "BAUM-1: A Spontaneous Audio-Visual Face Database of Affective and Mental States," *IEEE Trans. Affect. Comput.*, vol. 8, no. 3, pp. 300–313, 2017, doi: 10.1109/TAFFC.2016.2553038.

[13] D. Lo Presti *et al.*, "A Magnetic Resonance-compatible wearable device based on functionalized fiber optic sensor for respiratory monitoring," vol. XX, no. XX, pp. 1–8, 2020, doi: 10.1109/JSEN.2020.2980940.

[14] V. K. Ajay, R. Desai, M. Gawannavar, and R. K. Nadesh, "HGD: A rescue system for an alive human gesture detection in disasters management-an experimental study," *ARPN J. Eng. Appl. Sci.*, vol. 11, no. 11, 2016.

[15] M. Cramer, S. H. Hirano, M. Tentori, M. T. Yeganyan, and G. R. Hayes, "Classroom-based assistive technology: Collective use of interactive visual schedules by students with autism," *Conf. Hum. Factors Comput. Syst. - Proc.*, pp. 1–10, 2011, doi: 10.1145/1978942.1978944.

[16] B. Kidwai and N. Rk, "Design and Development of Diagnostic Chabot for supporting Primary Health Care

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Systems," *Procedia Comput. Sci.*, vol. 167, no. 2019, pp. 75–84, 2020, doi: 10.1016/j.procs.2020.03.184.

[17] S. F. S. M. Hashim *et al.*, "Humanoids in autism therapy: The child perspective," *Procedia Comput. Sci.*, vol. 42, no. C, pp. 351–356, 2014, doi: 10.1016/j.procs.2014.11.073.

[18] S. Shamsuddin, H. Yussof, L. I. Ismail, S. Mohamed, F. A. Hanapiah, and N. I. Zahari, "Humanoid robot NAO interacting with autistic children of moderately impaired intelligence to augment communication skills," *Procedia Eng.*, vol. 41, no. Iris, pp. 1533–1538, 2012, doi: 10.1016/j.proeng.2012.07.346.

[19] S. Shamsuddin, H. Yussof, S. Mohamed, F. A. Hanapiah, and H. A. Ainudin, "Telerehabilitation Service with a Robot for Autism Intervention," *Procedia Comput. Sci.*, vol. 76, no. Iris, pp. 349–354, 2015, doi: 10.1016/j.procs.2015.12.306.

[20] R. A. A. Rahman, F. A. Hanapiah, H. H. Basri, N. A. Malik, and H. Yussof, "Use of Humanoid Robot in Children with Cerebral Palsy: The Ups and Downs in Clinical Experience," *Procedia Comput. Sci.*, vol. 76, no. Iris, pp. 394–399, 2015, doi: 10.1016/j.procs.2015.12.316.

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